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MEASURING EQUITY AND SOCIAL SUSTAINABILITY THROUGH ACCESSIBILITY TO PUBLIC SERVICES BY PUBLIC TRANSPORT. THE CASE OF THE METROPOLITAN AREA OF VALENCIA (SPAIN)

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Abstract
Spatial equity in complex spaces such as metropolitan areas is a very interesting subject for research, particularly in view of its enormous potential public policy applicability. An approach to the subject based on the population's access to essential public services (education, health care and social services) is proposed. Geographic Information System (GIS) tools have made a powerful contribution to the ease with which both spatial and statistical data can be handled. The study covers the Metropolitan Area of Valencia, in Spain. It is based on the location of public facilities and the population's ability to move around using public transport. Its objective is to give a general overview of the situation and point to problem zones, with the aim of suggesting answers for these that could help to improve social and spatial sustainability and equity in this metropolitan area.

Keywords: *Spatial equity, accessibility, public services. Valencia Metropolitan Area, social sustainability, mobility*

1. INTRODUCTION

The study reported in this paper aimed to measure equity in the population's access to basic public services, based on their accessibility to the population as a whole, by means of a GIS (Geographic Information System). The study area is a Spanish metropolitan area, in this case Valencia. Its inherent spatial complexity makes it a laboratory-territory of the utmost interest for verifying the results at local level. The applied part of this study comprises two major sections: the development of a method for measuring accessibility and the application of the method, based on constructing a GIS. The latter was highly complex, largely because of the lack of information on the provision of public services in the area, or its inaccuracy, and because there was no map of public transport networks, which had to be drawn up in order to carry out this survey. The result is a very powerful analytical tool, not only for the study presented in this paper but also for future territorial studies.

The concept of accessibility has an interesting dual dimension, being both geographical and social. The present paper focuses on the former as an indirect measurement of the latter. In other words, the measurement of physical or geographical accessibility contributes to the

knowledge of whether public services are being provided adequately – equitably – to serve the whole population of the study territory irrespective of where people live.

Many authors have published papers and studies, both theoretical and empirical, on the subject of accessibility. There are many different indicators of acceptability, mostly based on distance and user satisfaction. The main difficulty resides in the measurement process itself, more because of the quantity of data that need to be handled than because of the formulation of the indicators. The use of GIS has helped to make this task easier and, consequently, to expand the possibilities of present and future analyses.

In the more advanced countries, the welfare state sees to providing the population with universal basic services. This has become an inalienable social right that guarantees equal opportunities for every group of citizens and reduces marginalisation and poverty by guaranteeing unpaid access to these services. New social demands have arisen that call for better quality services, including the need for them to be suitably located: this is considered one of the main conditions for their meeting the minimum requirements of both equity and efficient public investment. The dynamism of society, and all the more so in complex spaces with multiple living interrelations such as metropolitan areas, involves changes in the location of homes and workplaces, rises and falls in the populations of certain areas, etc. This also entails changes in access to services unless the services are adjusted, relocated or adapted to the changes so that the minimum threshold of equity is never lost. GIS makes it possible to carry out this analysis continuously by updating the information, making it a very powerful tool, as shown in this paper.

Of the different types of service provided, this study centres on ones that a number of authors consider fixed (the user goes to the service) and with free universal access (Mérenne-Shoymaket, 1996; Calvo et al., 2001). These are public services that are required by the entirety of the potential demand and therefore need to be located in spaces with good access. It should also be pointed out that public services, together with community facilities and communication infrastructure, are currently one of the motors of local and regional development that make a clear contribution to territorial rebalancing and, consequently, to meeting social equality and equity criteria, fully justifying studies such as this which are of great practical use for decision-makers.

The present study centres on a tangible, measurable aspect, accessibility based on public transport (city bus, metropolitan area bus, the underground/tram network and the local railway network), which has clear repercussions for social and territorial equity (based on the location of public service provision and of the population), with reference to a specific area, the metropolitan area of Valencia (Spain), which covers nearly 500 km^2 and has a population of over 1.8 million. These three factors give a closer view of local realities that may provide a useful example for the study of other similar urban areas, although this study is also of interest in itself, since an examination of territorial equity based on access to public services is one of the components of basic preliminary studies for local land use plans, which are still non-existent in many metropolitan settings.

Accessibility is one of the possible measures of social sustainability, as mentioned above, but it is not the only one. The public transport network is not the only way to reach public services, either, nor are these all of the same type, nor do consumers all show the same behaviour. However, the combination of public services and public transport gives an initial picture of the degree of equity in the study area that can serve as a starting point for subsequent, more detailed studies.

2. PUBLIC SERVICES AND SPATIAL EQUITY

The subject of spatial equity and how to measure it through accessibility has seen little variation since the 1970s (Garner, 1971; Harvey, 1973; Domanski, 1979). The main research aim continues to be concerned with how to achieve greater spatial equity without necessarily sacrificing a degree of economic efficiency. Accessibility is a frequent basis for models and explanations that attempt to throw some light on the implications of the geographic location of public services. Different types of model have been proposed, ranging from highly centralised ones to others that favour extreme dispersion, and from the most theoretical to the extremely applied, but what almost all of them have in common is maximising the population served by government-backed public facilities, programmes or action. One way to achieve this objective is to improve their access by public transport.

Harvey (1973) was one of the first geographers to define the term *spatial equity*, also known as *spatial justice*. Spatial justice must pursue the following aims: respond to the needs of people in each territory, assign resources to maximise spatial multiplier effects and assign extra resources to help overcome the problems that have their origin in the physical and social environment. Spatial justice depends on accessibility and on other factors such as supply quantity, the degree of availability of the services, etc. Both efficiency and spatial equity are particularly relevant for public services, as has been pointed out.

The economic activity location models that have been developed since the 1950s, particularly those for public services, attempt to find an optimum location to achieve the maximum return on the supply. However, the reality is often far more complex than the models take into account. Political factors associated with local decision-making or with very different public priorities have created a network of public provision of the main welfare services (health, education and social services) that does not always respond to this optimum location. Traditionally, the standard measurement tool has been the ratio of variation of demand inputs (such as pupils per teacher, doctors per thousand inhabitants, etc.). However, this bears little relation to measurements of accessibility, which clearly contribute to measuring the efficiency and equity of the location of public services. The balance between two factors that roughly speaking can be called size and distance helps to define equity in access to the service and efficiency in its use, in that it can serve a particular demand. This subject is particularly relevant in urban and metropolitan areas with high population concentrations in particular spaces and considerable dispersal in others.

Nowadays, studies are adopting a more practical bent as an aid to decision-making. The location of services already exists and is difficult to change, although it can always be improved. The best location for a service does not always entail moving it: on occasion, as already mentioned, better access would be the answer. Improving the transport network and/or setting up new networks is essential nowadays to integrate and organise urban and metropolitan areas, where the spread and complexity of urban development are inevitable. What is known as smart urban growth takes sustainability as the basis for urban planning, but its bias towards managing growth and environmental aspects would seem to sideline somewhat the problems of social equity (Foster-Bey, 2002).

Accessibility is a basic geographical concept. Equitable accessibility is a complex matter (Crooks and Andrews, 2009). It is related to many questions such as decisions about assigning resources, the location of the service or activity, information, or even the quality of the service. In short, it means how "easily" a user can obtain the service that he or she needs. For this, physical accessibility is important but so is its measurement in terms of time, since as Miralles (2011) pointed out, the social times (mobility times) of the city "draw the everyday spaces of the metropolitan regions" (p. 127). Travelling time contributes enormously to the citizens' view of the quality of the public services provided and, therefore,

the quality of their everyday life. Time is a measurement that relates activities to places (May and Thrift, 2001; Davovidi, 2009). This refers to social time, which brings together a spatial variable, related to the location of the activities in the territory, and a time variable, the result of the time spent on everyday activities, including journeys. The social use of time is, therefore, closely related to the use of the city and of the metropolitan space. The physical makeup of this space and of the infrastructure supporting mobility strongly influences every type of territorial dynamics and makes a powerful contribution to defining the quality of life of its citizens (Mückenberg, 2009; Miralles, 2011). Proximity is an increasingly valued aspect of a territory's quality and of social welfare.

Moreover, one of the problems most frequently studied and condemned by social scientists in many countries is that the social structure of cities and, particularly, of metropolitan areas, is undergoing major changes that are not being paid the attention they deserve. In Spain, for instance, urban planning is based almost exclusively on reference to the land, its ownership and its price, obliging the citizens to adapt to the city rather than the other way round, which is what should happen. Spanish urban planning has an effect on social cohesion or disintegration (Bueno Abad and Pérez Cosín, 2008).

It is true that much progress has been made on the subject of the impact of accessibility on the equitable provision of services, but the question of optimum travelling distances is still not clear. Schuurman *et al.* (2010) suggest that the term 'optimum' is best used when comparing methods rather than for seeking or modifying spatial accessibility. The key lies in the process of interpreting the results so that they will be useful in a possible political decision-making process.

3. SUSTAINABILITY AND EQUITY IN METROPOLITAN AREAS

Metropolitan areas are complex spaces in which interactions between the different territorial processes that take place in them are both the cause and the consequence of how they are organized, how they have evolved, and where infrastructure, services, residential spaces, industrial spaces, etc. are located. Metropolitan areas are becoming especially relevant because they are territories that have traditionally been made up of a central city and its hinterland but are now organised in a complex way, with multiple peripheral situations and new centres within the periphery which are fostered by mobility and not always by proximity to the centre (Corral, 1994).

Metropolitan areas in Europe have seen enormous growth over the past five years, as have urban areas in general, leading the European Union to develop various policies to help manage the different problems found in them. The *Leipzig Charter on Sustainable European Cities* adopted by the European ministers recommends that Member States pay particular attention to the growth and planning of urban spaces from an integrated and sustainable perspective, particularly in the most deprived neighbourhoods. In the EU's recent cohesion policy (the 2007-2013 plan) the urban dimension has been brought fully into the programmes and projects co-financed by the European Regional Development Fund (ERDF), meaning that integral development was set in motion in these areas, both horizontally and vertically, with greater responsibilities and investments devolved to the local level in response to the growing complexity of these territories (European Commission, 2009).

In Spain, a pronounced decentralisation process is taking place within the metropolitan areas but the cities at their centre are not losing their influence. The population shift from the central areas to the metropolitan rings has also joined that from the most populated and densest nuclei to medium-sized and smaller ones, generally with a low population density (Nel.lo, 2001). The structure of metropolitan space is closely linked to transport infrastructure, which is both the consequence of and a contributor to the suburbanisaton

process and to a shift from monocentric to polycentric structures in the internal organisation of the transport infrastructure itself. This is due to changes in the basic patterns of accessibility, which also explains the strength of the demand for journeys and their modal distribution (Schwanen, Dieleman and Dijst, 2001; Albertos et al., 2007; Gutiérrez and García, 2007; García, 2010).

All this tells us that, at the very least, spatial equity has varied over the course of this process. The changes in accessibility induced by new road infrastructure, cause and consequence of the suburbanisation process, create new inequalities for the population in both the old and the new areas of development.

Public services are not equally accessible everywhere, in other words, space introduces some forms of exclusion. In their complexity, metropolitan areas present imbalances that can, on occasion, be particularly striking. In an attempt to reduce these exclusions to as few situations as possible and achieve a fairer spatial distribution, some localisation models have been developed with criteria such as public utility (the number of people who use the service) or travel costs.

The latter notion is the basis of the nodal or functional region concept and is also fundamental for mobility models and to explain the spacing of certain activities. Whatever the activity, but particularly if it involves services to the population, its area of influence extends beyond the exact spot where it is located. Since these centres are spatially at a distance and their services are mainly provided face to face – in other words, the user has to travel to the place where the service is located – connections between them are essential and one of the basic premises for studying them is to consider them nodes or focal points of the transport network.

The quest for social equity, together with territorial equity in metropolitan areas, is key to achieving sustainable territories, with all what that implies in terms of improving the inhabitants' quality of life. From this perspective, the current economic climate (which involves greater competition between territories and less availability of public resources) entails, among other things, a greater need to manage local resources efficiently, to lead the shared effort of local bodies and organisations to pursue more sustainable development and to introduce innovative management models that will make it possible to improve the quality of life of the population. Decision-makers must increasingly have strategies to make local government policies easier for industry, the unions and the public in their areas to understand. The EU has therefore been using different strategies to strengthen this aspect, such as the EU Territorial Agenda or the EESC Opinion on European metropolitan areas (OJEU C 168/10, 20.7.2007).

4. METHOD: THE SPATIAL SEPARATION INDEX

In this accessibility analysis the first data obtained were the distances between the basic territorial unit for which census information is available, the census tract (taking its built-up centre as the starting point for any journey), and the exact point where the facilities of each of the three types of basic service considered in this study are located. The distances were calculated in time (minutes), as this is this measurement that determines user satisfaction and gives a better comparison of the efficiency of each of the possible public transport modes. The three types of service considered were health care, education and social services. Within the first type, a distinction was made between hospitals and health centres; within the second type the distinction was between primary and secondary schools; of the social services, only the basic ones were considered. In every case strictly private facilities were excluded and only public and subsidised services were taken into account.

The model employed involves calculating urban mobility over the networks on which it takes place, in other words, the aim is as real a model as possible. To achieve this, TRANSCAD 6.0 transportation GIS software was used. Three types of transport or mobility networks were studied: the pedestrian network (it will always be necessary to make at least part of the journey on foot), the city bus and metropolitan bus network, the underground/tram network and local trains. In all cases, the transport service frequencies and their operating speeds were considered for all the different lines. In this way it was possible for the distance calculations to include the time taken to get to the public transport, wait for it and change between transport modes as well as the actual travelling time. In other words, the journey time calculation is door-to-door, from the centroid of the census tract to the exact location of the service in question.

Out of the wide range of existing indices (Garrocho y Campos, 2006; Bhat et al. 2000), the Spatial Separation Index was chosen. This calculates the mean distance in minutes between two points. It is simple and easy to interpret. In this type of index, all the starting points carry the same weighting in the calculations and the index only reflects the data on distances. Because it is so simple, it can be used to compare different situations (such as access to public and to private services or to different classes of service) clearly and efficiently. Complexity was introduced by using the real, verified times of the real mobility network, making these results very reliable.

Accordingly, the Spatial Separation Index (*Índice de Separacion Espacial*) for spatial unit *i* (ISE_i) is:

$$ISE_i = \sum_{j=1}^{n} \frac{D_{ij}}{n}$$

where

i is the basic spatial unit (census tract) for which the index is calculated, which is taken as the possible starting point for a journey

j is each of the possible journey destinations (the services)

D_{ij} is the distance in minutes between the starting point *i* and the destination *j*, based on the matrices calculated and

n is the number of possible destinations.

The calculation only took into account the basic public service nearest to the census tract where the population lives. This analysis therefore assumes that the citizen will travel to the public service closest to his or her home.

5. THE METROPOLITAN AREA OF VALENCIA

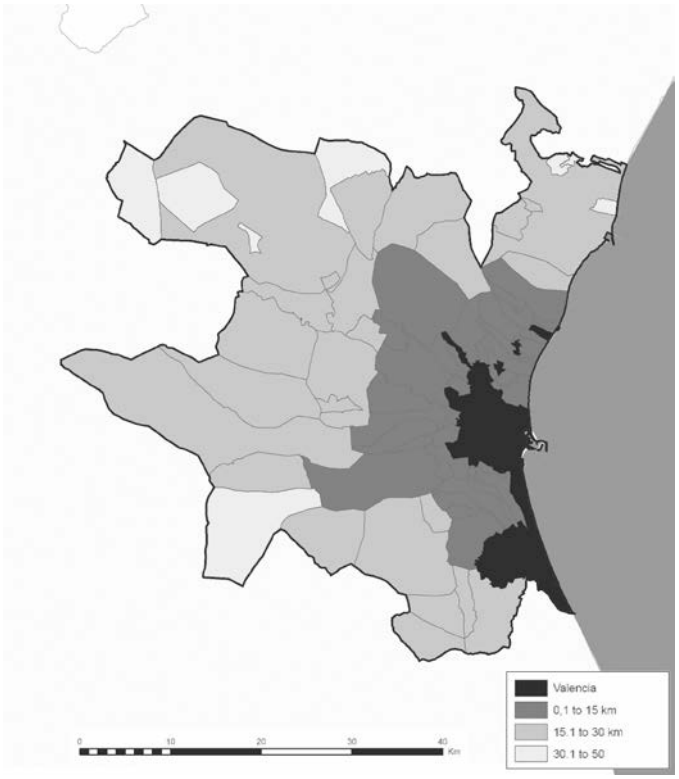
The case analysed here is the Metropolitan Area of Valencia (MAV), on the east coast of Spain, south of Barcelona and east of Madrid (Map 1). Industry and the service sector predominate in this area, which has good communications. It is part of the Autonomous Region of Valencia, the fourth most-populated in Spain, with 5,011,548 inhabitants at 1 January 2012. The region's main cities are Valencia, Alicante and Castellón, but only Valencia has a true metropolitan area, the largest in Spain after Madrid and Barcelona, which accounts for 37% of the population of the region and 75% of that of its province.

The MAV revolves around a central city, Valencia (population 798,033 in 2011), and 75 municipalities with slightly over one million inhabitants within a radius of almost 40 kilometres, taking the total to 1,862,053 inhabitants. It is a complex area in terms of the dispersion of its population and built-up areas. Over the 2001/20011 period its population

increased by 261,255. Since the city of Valencia only grew by slightly over 50,000 inhabitants over the decade, a real mean annual growth rate of under 1% and less than the 1.67% of the metropolitan area as a whole, this growth mainly took place in medium-sized settlements and, to a lesser extent, in the larger centres with better communications (Torrent, Sagunto, Paterna, Mislata, etc.).

Map 1. Location of the study area

In the past twenty years the MAV has undergone a major urbanisation process that has increased the density of both its built space and its population (Table 1). At the same time, new communications infrastructure has been put in place, particularly the building of the underground and the extension of bus lines within already urbanised spaces and to the newly built-up areas (Map 3). The expansion of the road network for private vehicles has been fundamental for the spread of an extensive urban development model based on family houses strongly linked to open natural spaces, not forgetting the development of inner city spaces and expansion of their edges through the mushrooming of comprehensive action plans (*Plan de Acción Integrada* – PAI), used as a way to modify the general town plan (*Plan General de Ordenación Urbana* – PGOU) and reclassify agricultural land as urban or building land. Although it is also a result of space infilling, the combination of three factors as both cause and, in turn, consequence, namely demographic growth, expansive urbanisation and the building of a wider network of communications infrastructure, explains the consolidation of a metropolitan structure in which the zone that is furthest away from the central city is precisely the one that has seen the greatest increase in population density, indicating a relatively greater population growth and urban development expansion towards the periphery, which offers advantages like lower land prices and closeness to natural spaces (Graph 1).

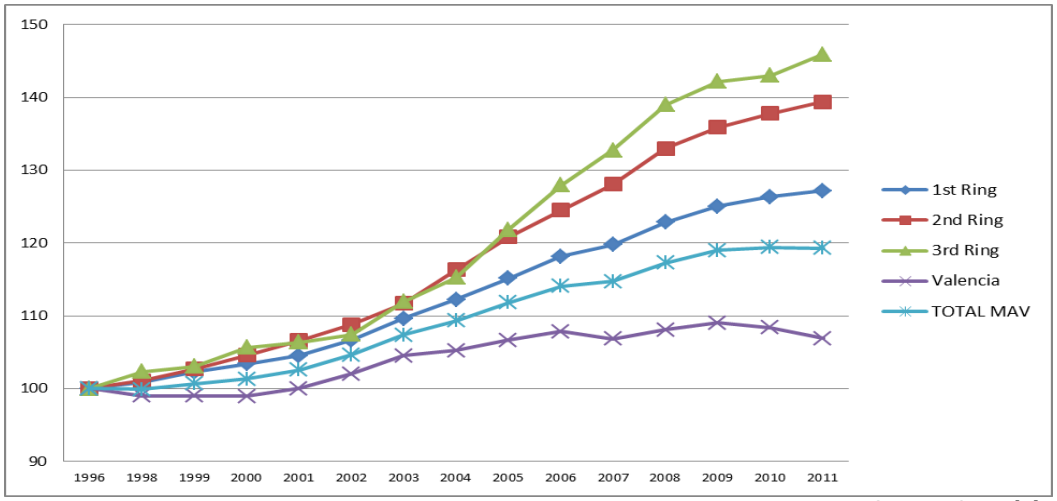


Map 2. Metropolitan rings according to distance from the centre of Valencia city

Table 1. Population and density by metropolitan ring

Scope	Distance from Valencia	Surface area (km^2)	Population density 1996 ($inhabs/km^2$)	Population density 2000 ($inhabs/km^2$)	Population density 2011 ($inhabs/km^2$)
Valencia	0	134.63	5546.19	5489.22	5927.60
First ring	1-15 km	456.42	1250.91	1293.72	1591.14
Second ring	15.1-30 km	1317.71	168.95	176.72	235.54
Third ring	>30 km	277	67.84	69.90	98.98
Total MAV	-	2185.8	714.24	723.86	851.89

Source: Own elaboration



Source: Own elaboration

Graph 1. Evolution of population density by metropolitan ring

This territorial restructuring has not always been accompanied by an improvement in the provision of public services and facilities, particularly as regards public transport and the services in greatest demand: health, education and social services. The urban expansion has therefore generated considerable private mobility, compounded by the proliferation of shopping and leisure centres on the periphery of the MAV in recent decades. The public transport network is particularly dense in the central area and the first ring, but sparse or non-existent in the second and third metropolitan rings. These are precisely where the most intense growth is taking place, as mentioned above, and since the public transport network and public services tend to be located in the central zones, the outer rings are also where the greatest inequalities in access to these services are found. The result is considerable private mobility, with the sustainability problems it entails, or growing inequalities in access to services which are accentuated in particular population groups such as old and young people, who have more limited access to private transport. The problems of spatial equity are real and a complex territory such as the MAV is an interesting laboratory for testing some of the ways of measuring the imbalances and inequities introduced by the space and its characteristics.

6. EQUITY IN ACCESS TO PUBLIC SERVICES BY PUBLIC TRANSPORT IN THE VALENCIA METROPOLITAN AREA

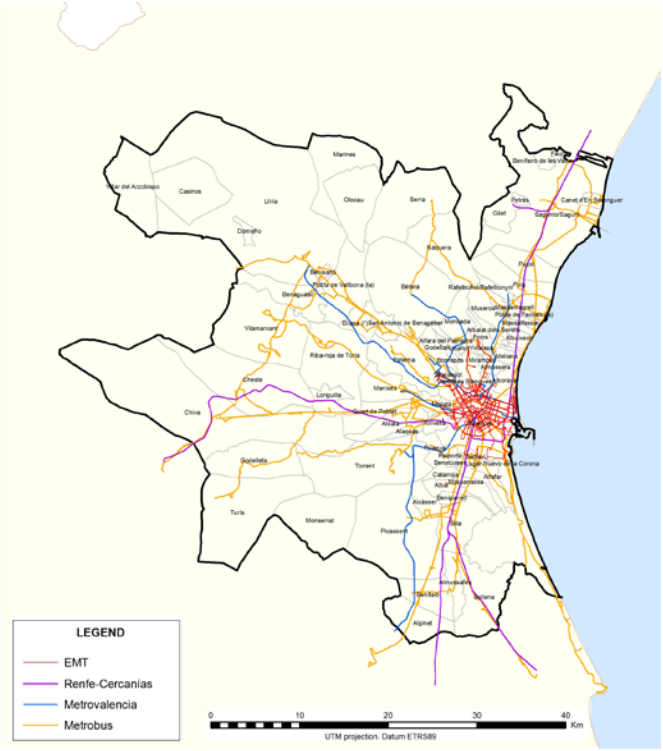
6.1. Overall Results

Calculating the index of accessibility by public transport in the MAV has produced some interesting results. Although public transport is not the most efficient in terms of journey time, what is of interest is its public nature, which in principle makes it accessible to the entire population and enables the equity of a territory to be measured. Generally speaking, because the provision of transport in the metropolitan core and first ring is greater than in the periphery, the further away from the central city the longer the travel time by public transport. The MAV shows a two way process: on the one hand decentralisation of activities and residence, and with them the provision of services, and on the other hand, intensification of the most immediately local space in the main city and town centres.

The Spatial Separation Index calculated in this study showed significant differences by type of service (Table 2). The best access was clearly to primary schools (mean ISE = 7.12), as this is a lower (and therefore better) value than those for the social services (mean ISE = 13.85) and primary health care (mean ISE = 13.88), always bearing in mind that these figures refer to public not private services reached by public transport alone. For comparison, the same index was calculated for private transport. The journey times were better in every case and very significantly so in the case of hospital accessibility (ISE = 10.38). As this is a more specialised level of health care, hospitals are fewer in number and dispersed over the area, so those living in the most distant zones have a longer journey time if they use public transport because they need to change buses or trains, involving waiting times which the use of private transport avoids.

The services that were most evenly and equitably distributed over the metropolitan area in relation to the population were primary schools (some of which are also secondary schools). They form a dense network in which closeness to the demand is a priority and constitute the nucleus of service provision. The fact that a large number of them are subsidised rather than exclusively public explains their dispersion over the territory and the very low mean journey times. The same is true of secondary schools, which also present low journey times. Social services and health centres were in an intermediate position, with good territorial distribution, in keeping with the fact of their often being neighbourhood services. Also, in the case of the social services, political initiatives by many town halls have been

decisive in improving their spatial distribution. Lastly, as is only natural, the worst accessibility is to public hospitals, of which the MAV has nine.



Map 3. Public transport network in the MAV

EMT: city buses; Renfe-Cercanías: local trains; Metrovalencia: underground/trams; Metrobus: Metropolitan area buses

Table 2. Spatial Separation Index for the Valencia Metropolitan Area

	Mean ISE in minutes (simple)		**Mean ISE (weighted by population)**		**Number of centres provided**
Service	Public transport	Private transport	Public transport	Private transport	
Hospitals	34.80	10.38	37.14	11.02	9
Health Centres	13.88	4.34	14.65	4.55	77
Basic social services	13.85	4.08	14.21	4.17	98
Primary schools (public and subsidised)	7.12	2.77	7.62	2.92	447
Secondary schools (public and subsidised)	9.94	3.40	10.65	3.60	263

Source: Own elaboration

The above analysis was complemented by considering the population involved (Tables 3 and 4). The health and social services present asymmetrical distribution. In these two cases the highest percentage of the metropolitan population has middling accessibility (between 10

and 30 minutes), whereas for education services the highest percentage of the population is under 10 minutes away from a school.

The social service provision is slightly worse than for health centres, as 31.4% of the metropolitan population is between 5 and 10 minutes away from the nearest health centre, whereas 24.8% of the population has a similar journey time to reach the closest social services (Graph 2).

In view of these accessibility indicators, it is evident that public and subsidised schools are services with good accessibility for the highest percentages of the metropolitan population, whereas the situation of the health care and social services presents more problems, in principle. Nevertheless, generally speaking the provision of services in the MAV can be considered good, as most of the population residing in the area can reach a public service by public transport in under 30 minutes. Evidently, any improvements in accessibility should address transport to hospitals and bringing basic services closer to the population, in other words, expanding them in the most isolated and disadvantaged zones, as will be discussed here below.

Table 3. MAV population by journey time to services (vertical percentages)

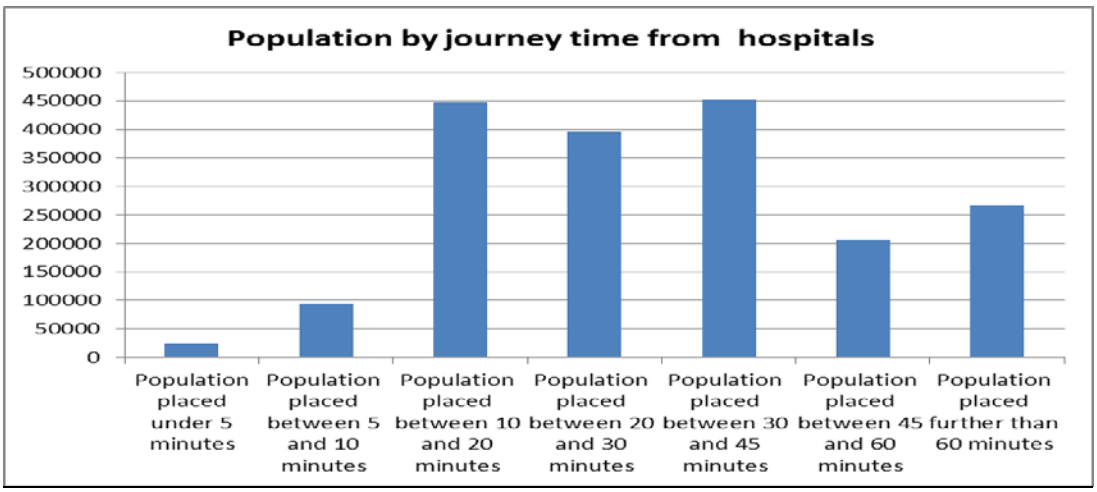
	Population under 5 minutes away	Population 5-10 minutes away	Population 10-20 minutes away	Population 20-30 minutes away	Population 30-45 minutes away	Population 45-60 minutes away	Population over 60 minutes away
Hospitals	1.02	3.94	19.81	42.35	62.18	61.41	69.80
Health Centres	13.05	24.88	29.52	14.78	11.95	14.91	9.65
Social services	12.69	19.71	33.15	24.27	11.07	7.43	7.69
Primary schools	45.13	21.31	5.96	7.30	6.07	7.15	5.20
Secondary schools	28.11	30.17	11.56	11.31	8.74	9.09	7.66
Total	100	100	100	100	100	100	100

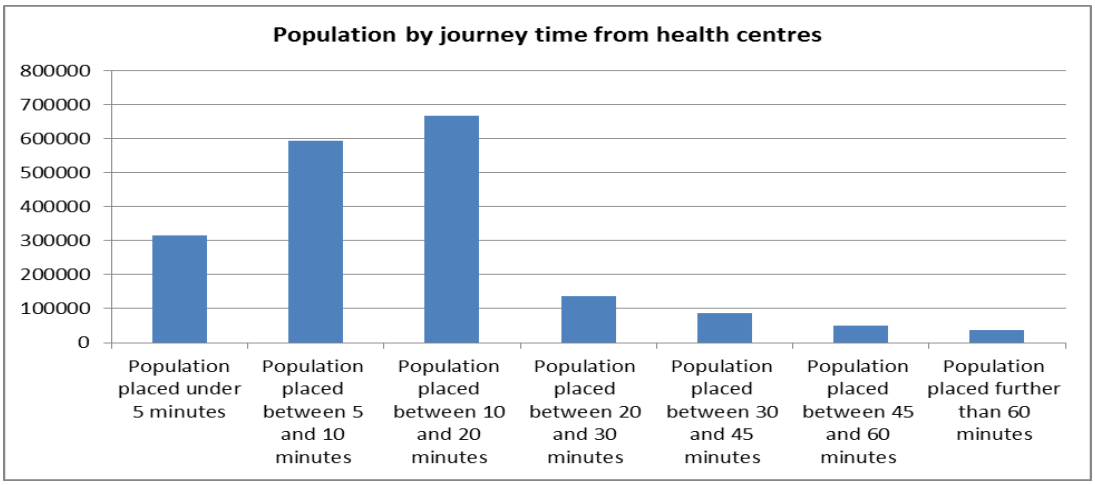
Source: Own elaboration

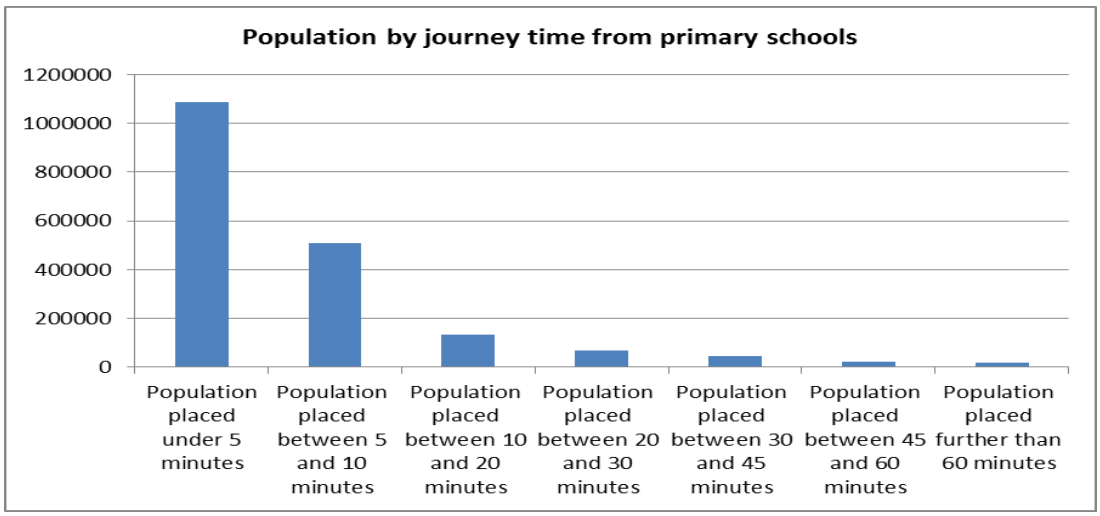
Table 4. MAV population by journey time to services (horizontal percentages)

	Population under 5 minutes away	Population 5-10 minutes away	Population 10-20 minutes away	Population 20-30 minutes away	Population 30-45 minutes away	Population 45-60 minutes away	Population over 60 minutes away	Total
Hospitals	1.30	4.97	23.75	20.95	23.98	10.94	14.12	100
Health Centres	16.68	31.41	35.38	7.31	4.61	2.65	1.95	100
Social services	16.22	24.88	39.74	12.00	4.27	1.32	1.55	100
Primary schools	57.67	26.90	7.15	3.61	2.34	1.27	1.05	100
Secondary schools	35.93	38.08	13.86	5.60	3.37	1.62	1.55	100

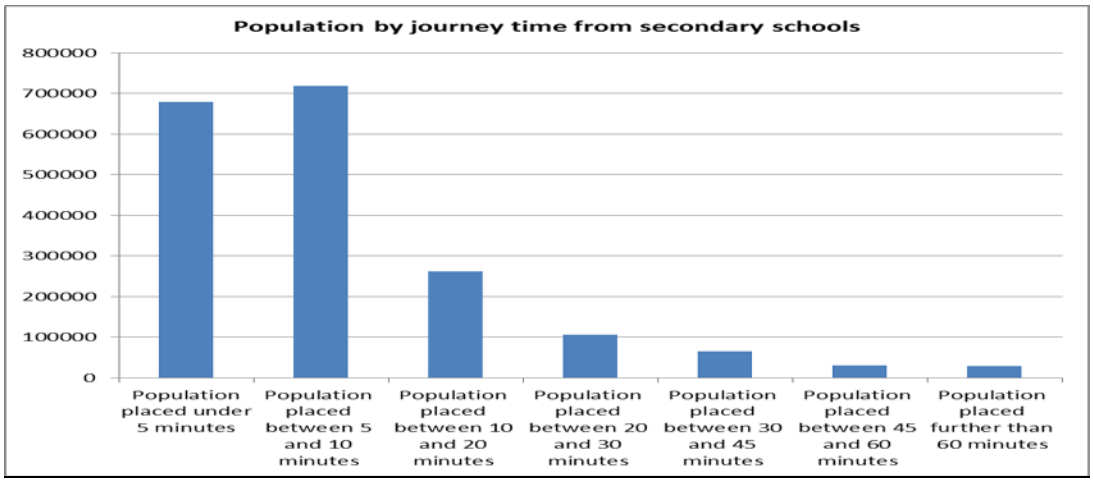
Source: Own elaboration

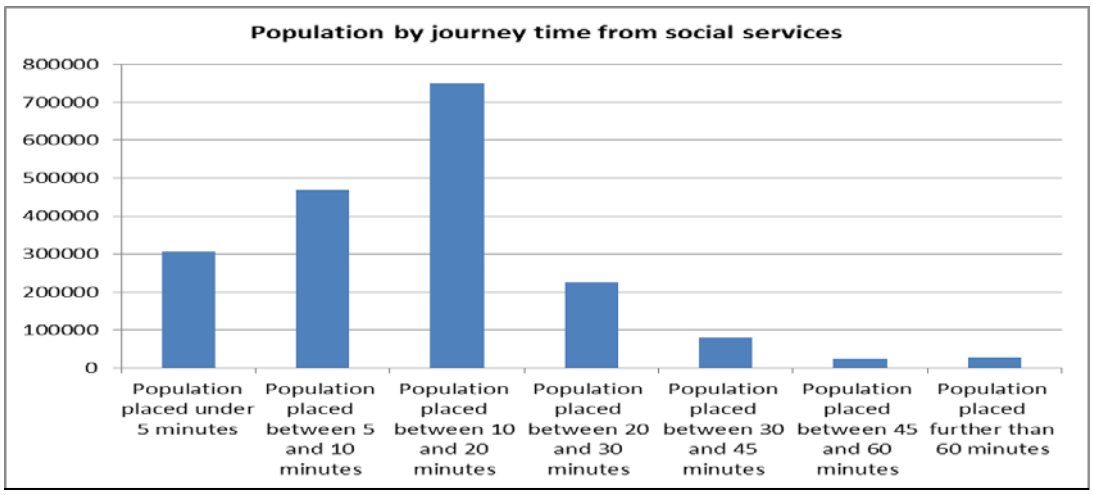






Graph 1 to **3**





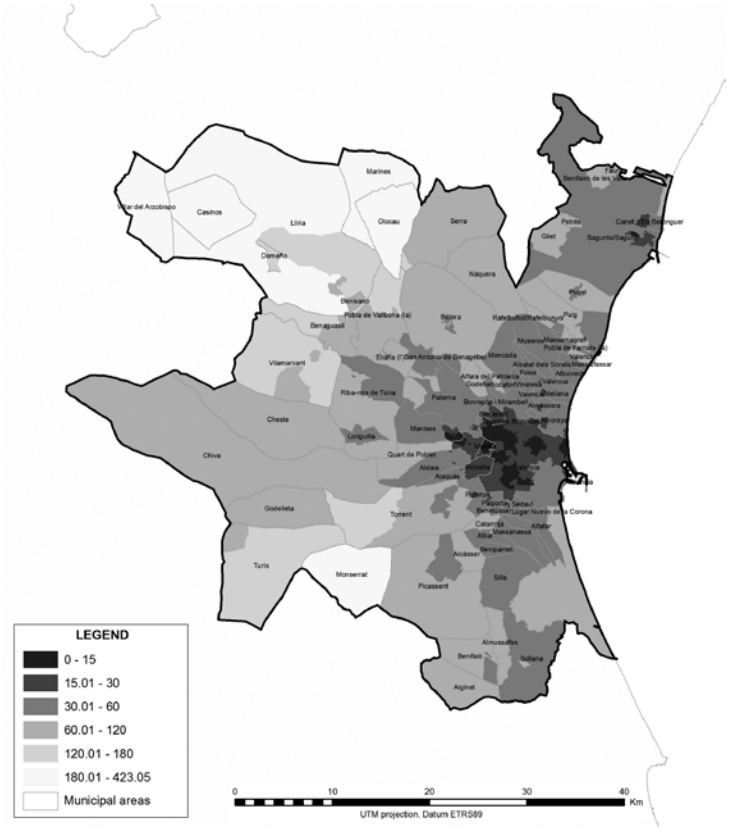
Graph 4 to **5**

6.2. Areas of Influence of the Public Services

In terms of territorial variations in the accessibility of the public services studied, the five maps based on the Spatial Separation Index (ISE) calculations (Map 4) make it possible to draw two fundamental conclusions. Firstly, in general there is a centre-periphery type spatial pattern in which the accessibility levels are highest at the centre of the metropolitan area and decrease in concentric rings towards the periphery. This arrangement is particularly clear-cut in the case of the ISE values for health and education services, although the latter seem to combine the concentric rings with radial structures that coincide with the main routes (public and private) towards the north-west and west, matching the MAV's main areas of urban growth. The concentration of service provision in the larger population centres is explained not only by the generic location of the facilities (greater density in the central areas) but also by the greater quality (frequency and density of routes) of their public transport, particularly in the city of Valencia.

Secondly, the metropolitan space is not homogenous, particularly on its periphery. It is not homogeneous either from the urban development point of view or from that of accessibility. Accessibility does not diminish in the same way or at the same rate in every direction. This can be seen on some of the maps of ISE values, particularly the one for social

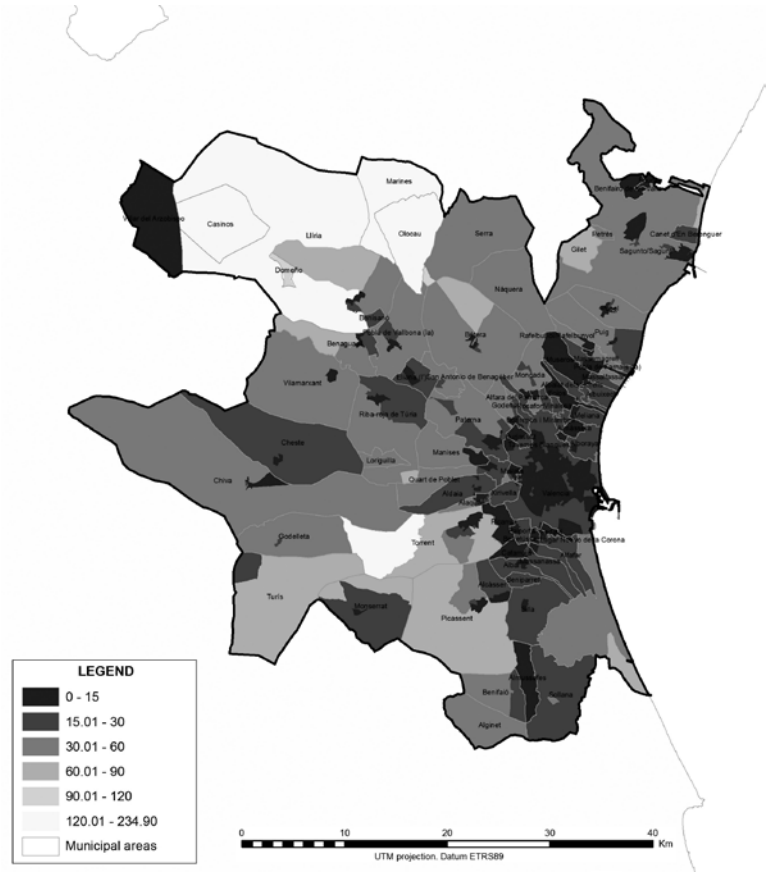
services. Two axes of high accessibility are clearly visible there: a north-west axis and a north axis, which converge on the urban nucleus of the city of Valencia. This part of the MAV contains the spaces with the greatest access to public services and therefore, presumably, the greatest potential wellbeing; in short, better conditions for sustainability and equity. These spaces are favoured by both a denser provision of public facilities and public transport of greater quality.



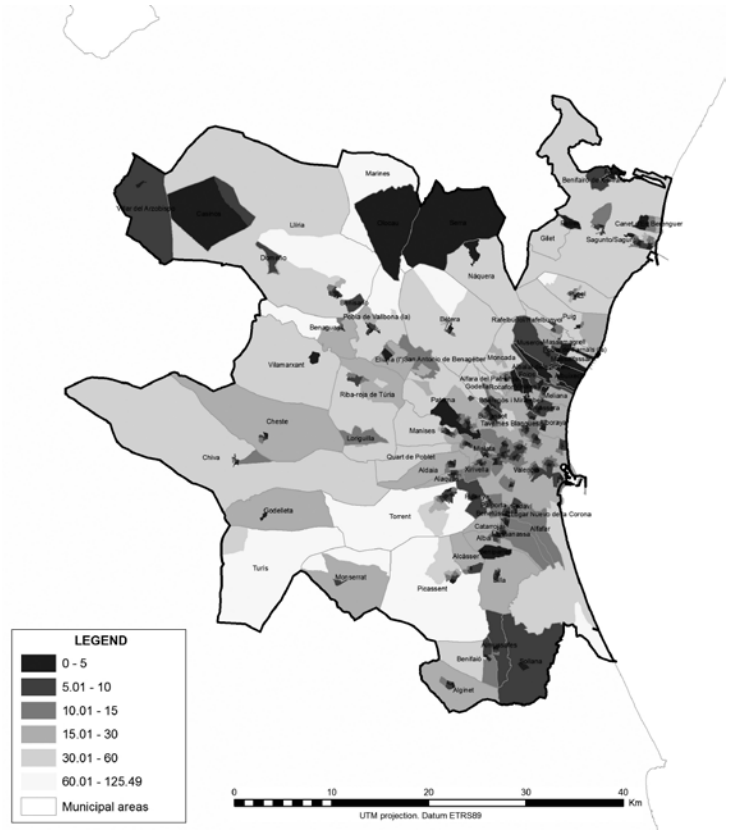
Map 4. Time in minutes (ISE) to the nearest hospital

6.3. Spaces of Inequality: Privileged Zones and Problem Territories

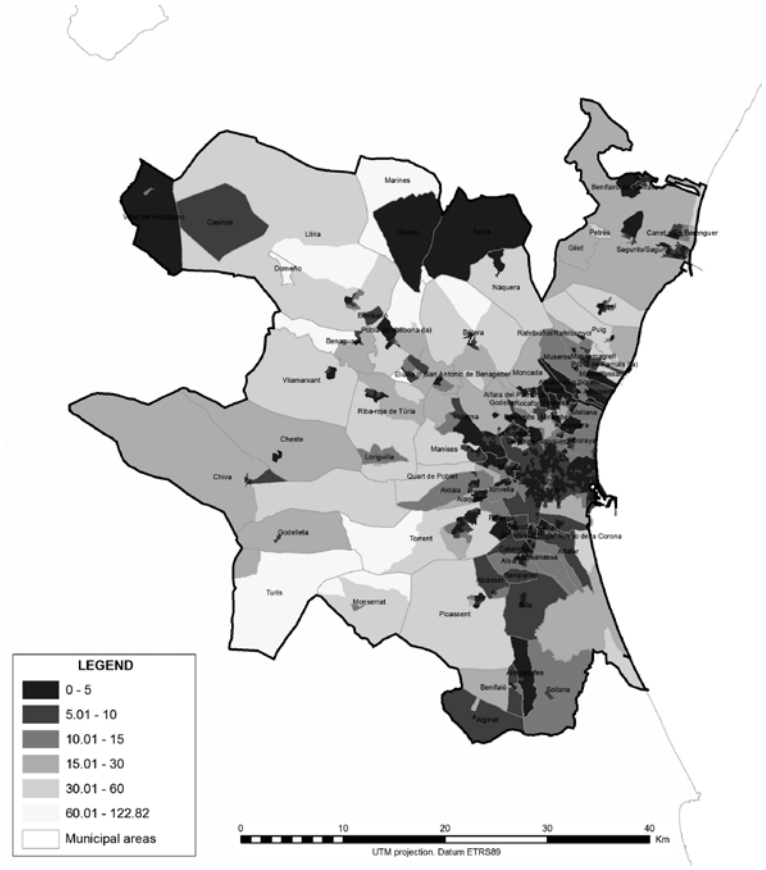
The method applied makes it possible to detect the zones with the best and worst access to public services within the area studied. In general, as was to be expected, the centres of the different urban areas, particularly the city of Valencia, showed higher accessibility values for all types of services. The first element that needs to be taken into account is access to the public transport network itself, as the zones with a worse transport service will also present a worse accessibility indicator for the other types of service (ISE).
In peripheral census tracts or neighbourhoods or in ones with a scattered population the opposite is the case: poor accessibility, a general lack of public service provision nearby and on occasion even a lack of public transport. The less advantaged zones from the point of view of accessibility respond to two socio-territorial models. One is census tracts in high-income districts, in other words, suburbs with a structure of family houses at a distance from urban centres where the predominant means of transport is private vehicles. The other is census tracts in run-down, low-income neighbourhoods. Some are on the periphery of the metropolitan area but others are close to the centre.



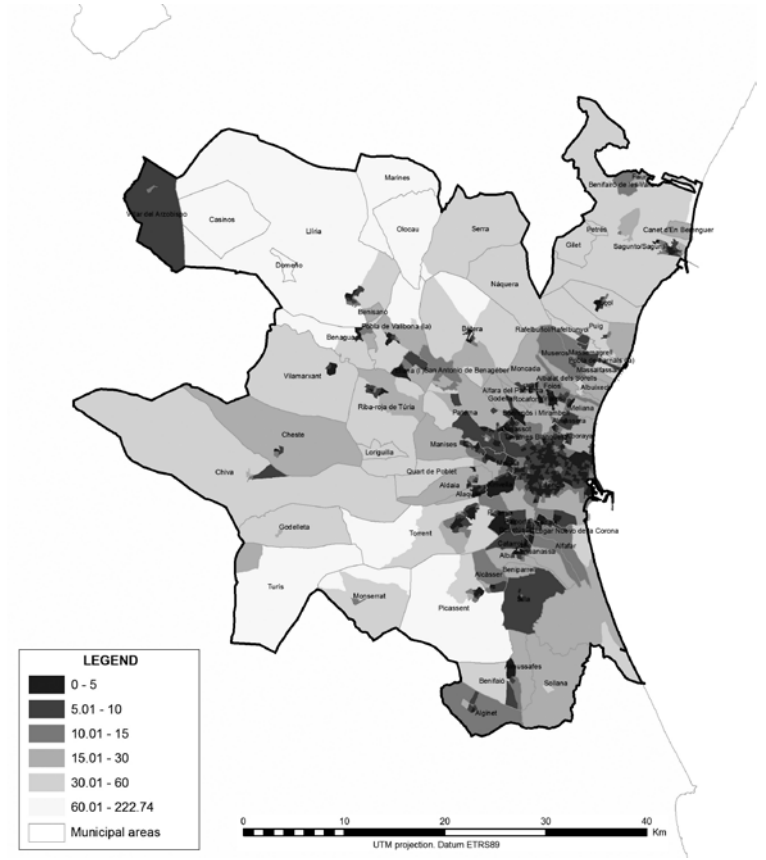
Map 5. Time in minutes (ISE) to the nearest health centre



Map 6. Time in minutes (ISE) to the nearest basic social services centre



Map 7. Time in minutes (ISE) to the nearest public or subsidised primary school



Map 8. Time in minutes (ISE) to the nearest public or subsidised secondary school

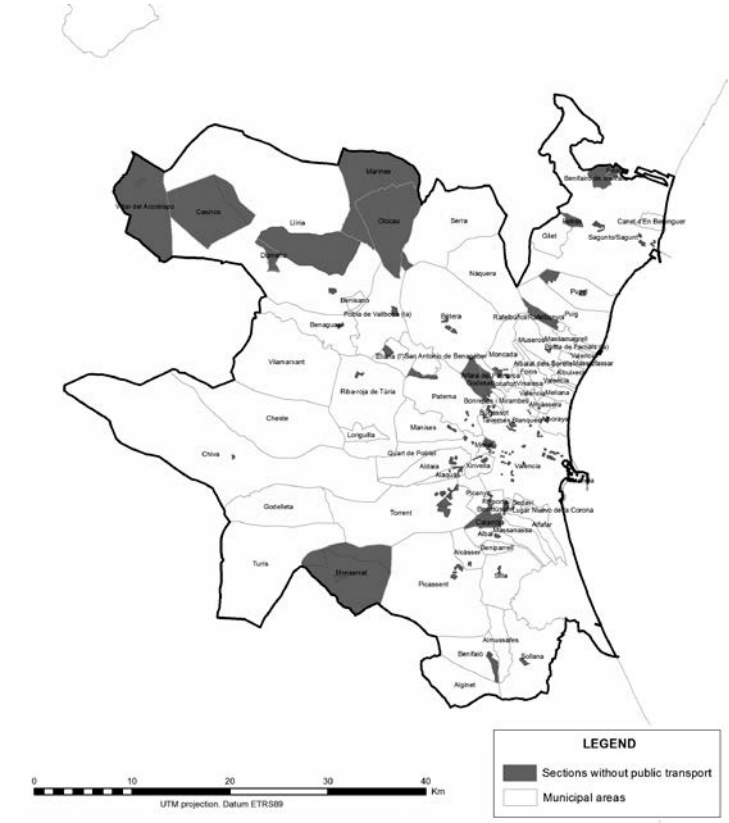
In the first of these types, access by public transport is not a priority as owing to the high income of the inhabitants it is assumed that private vehicles will be used most, although that is not sufficient reason to justify a total lack of access to the public transport network. About 100,000 inhabitants of the MAV are in this situation. Reasons of sustainability, energy efficiency and safety clearly justify an adequate service for these zones, all the more so since their residents are known to be more mobile than average. The reason is that as these districts are mainly residential, their inhabitants' places of work are normally at a distance that requires the use of some form of transport. Another reason for their greater tendency to daily mobility is that both the services studied here and those related with shopping and leisure are also located some way away.

Census tracts without any type of public transport at a distance from the centre, in peripheral municipalities without access to the public transport network, account for a small proportion of the metropolitan area's population. The fact that most of the services are located in their population centre makes it unnecessary to travel elsewhere, except in some cases such as going to a hospital, which requires a journey as these are centrally located. In that event this 27,000-strong population needs to use private transport, which can be a problem for many, such as old people who do not own a vehicle.

Lastly, census tracts without public transport in urban areas are found in socially and territorially peripheral neighbourhoods. The population of the zones in this situation is slightly over 200,000, making this the most populous group of the three. Almost 20% of them live in the main city, Valencia, and over 30% in large towns or cities: Torrent, Sagunt, Mislata and Manises. As these are urban census tracts it is not impossible for their inhabitants to access the public transport network, although it is further away than in other neighbourhoods or tracts. Their isolation is considerable but not total (Map 9).

On combining the ISE results for the different public services with the existence or otherwise of a public transport network nearby, very different results appear for the different census tracts. Even within the same municipality the situation can be very heterogeneous. The accessibility of public services is better the closer the census tract is to a major urban centre and worse, generally, in the second metropolitan ring, which is more rural and further away from the city of Valencia and other cities and towns in the MAV.

However, some census tracts in the main cities and towns present a similar situation to that of the rural areas, despite their urban setting. They are usually but not always at a distance from the centre, have no public transport services or very unreliable ones and no provision of the type of public service in question. Using different criteria, it is possible to establish levels of inequality or scarcity for the different types of service. Schools are the service with the best distribution over the area, so very few of the population are affected (Table 6), while poor access to health services, particularly hospitals, causes problems for a higher percentage of the population. In the case of hospitals, 10% of the inhabitants of the MAV have to travel for over 30 minutes by public transport and for 3% the journey takes over an hour.



Map 9. Census tracts with no public transport stop

Table 5. Number of people in the MAV with poor public transport access to public services

	Hospitals	**Health Centres**	**Social services**	**Primary schools**	**Secondary schools**
Over 30 minutes away	198,830	29,017	22,882	17,407	27,228
Over 60 minutes away	59,904	13,192	8,386	9,117	13,192

Locating the population that is affected by a greater scarcity of both public transport and public services is essential in order to identify where to invest in improving their provision and building new facilities. Although the overall figures for the MAV are not unfavourable, attention needs to be paid to zones which are no less important than others despite only accounting for a small proportion of the total population (Table 6). It is possible to identify the census tracts with the worst results for all the services studied.

Table 6. Impact of the accessibility by public transport of all the public services

	Number of census tracts	Population	% of total MAV population
Over 60 minutes from ALL the public services	10	16,934	0.8
Over 30 minutes from ALL the public services	40	69,206	3.6
Under 30 minutes from ALL the public services	588	909,759	48.2
Under 15 minutes from ALL the public services	137	180,086	9.5

It is useful to identify the worst-served census tracts, but also to find out which districts are best-positioned for access to the public service network, in other words, the location of equity. The worst-situated zones are, as mentioned, those that do not have a nearby public transport stop either, but they are not the only ones. Some census tracts are so large that the public transport network access point is at some distance from where part of the population lives.

In short, based on the accessibility indicator employed, equity is fairly adequate in the MAV. However, the best-served districts are those of the city of Valencia. Most census tracts that are less than 15 minutes away from all the services are in the central city or in municipalities that form part of its conurbation, although they only account for 9.5% of the population of the metropolitan area. The data are even more positive for journey times of 30 minutes at most. Over half the population is less than half an hour away from all the public services.

The worst situation is found in the municipalities on the periphery. The ten census tracts that are over an hour away from all the services belong to municipalities that are not part of the Valencia conurbation, are all at a distance from the urban centre of their own municipality and are of the dispersed habitat type, at times combined with weekend homes. The population in this situation comprises under 1% of the total inhabitants of the MAV. It is no less important for that, and at least as regards basic services (primary schools and health centres) its situation should be improved considerably. Quantitatively, the population that lives over 30 minutes from all services is larger. It makes up less than 4% of the total and also corresponds to dispersed habitat areas. The city of Valencia barely figures in this group, but the largest municipalities in the first metropolitan ring do. These are census tracts with low population densities at a distance from the town centre, where private transport predominates, as does the use of private services, in consonance with their income levels.

The differences by type of service are also interesting and noteworthy. The situations mentioned above are the extremes, the cases of best and worst accessibility of all the services. However, situations where there is adequate access to one service but not to the others abound and the combinations are very varied. Half the population is to be found in this somewhat unbalanced position, particularly as regards basic health care and social services.

7. CONCLUSION: SOCIAL EQUITY WITHIN THE TERRITORY. A MEASUREMENT OF INEQUALITY

The method explained and applied in this article shows considerable potential. The most laborious aspect of it is undoubtedly drawing up a GIS that includes the necessary information on the different territorial entities and elements. The basis is the location of the services and the structure of the transport network. This is completed with the most detailed

demographic, social and economic information possible regarding the territory. Socio-demographic information is available in Spain at census tract level, considered the smallest territorial unit that does not breach statistical confidentiality. If this information were available at street block or, even better, housing level, it would bring a substantial qualitative improvement in the results of the model.

At all events, measuring equity through access to the education, health and social services by public transport provides very reliable results even when the exact location of the demand (the population) is not available. This is compensated for to a certain extent by the correct location of the centre offering the service. The indicator of real-time accessibility is extraordinary suitable for drawing closer to the real situation in a complex territory such as a metropolitan area, making it possible to arrive at conclusions that could not have been reached with a less precise method.

Once the various ISE limits have been established, the different zones and municipalities can be classified according to their greater or lesser equity. Setting these limits is an important aspect for public policy-making at municipal level or, more appropriately, at metropolitan level. In the case under study, the authorities can take action in two ways: they can provide or relocate the centres that offer these services and they can act on the public transport network. Optimising the former and expanding the latter so that it reaches most of the territory would bring a considerable improvement in the area's equity. In the case of the MAV the provision of public services is broad and varied, with only a few exceptions, and extending the public transport network would improve the journey times.

Evidently, the structure of the public transport network determines the results regarding equity, but that is the whole point. A more detailed analysis of the demand would highlight the worst-affected social groups, generally children, young people and old people, the main users not only of public transport but also of the most important services. Consequently, a study of the socio-economic and demographic characteristics of the neighbourhoods with the worst levels of equity would give a deeper insight into the real impact of the worst accessibility on particular population groups.

In short, this method holds out many and varied possibilities for the future. One of the most interesting vistas it opens up is the ability to run simulations to measure the consequences of new locations or closures, which is highly relevant in the current economic climate. The prospect of closing some centres may not necessarily be negative if the service is not reduced and is located efficiently and, above all, if territorial equity is borne in mind: it may even be improved.

REFERENCES

Albertos, J.M., Noguera, J., Pitarch, M.D., Salom. J. 2007. “La movilidad obligada en la Comunidad Valenciana entre 1991 y 2001: cambio territorial y nuevos procesos”. *Cuadernos de Geografía,* 81-82, 93-118.

Bhat, C., Handy, S., Kockelman, K., Mahmassani, H., Chen, Q. and Weston, L. 2000: *Development of an Urban Accessibility Index: Literature Review.* Centre of Transportation Research, The University of Texas at Austin.

Bueno Abad, J.R., Perez Cosin, J.V. *et al.* 2008. O*bservaquart. Informe sobre la percepción social de los servicios socioculturales.* Valencia: PUV.

Calvo, J.L. *et al.* 2001. “Análisis, diagnóstico y ordenación de equipamientos mediante formulaciones cartografiables: valoración de la accesibilidad y requerimientos de la asistencia hospitalaria en la CCAA de la Rioja mediante la técnica de potenciales”. *Berceo* 141, 247-268.

Castells, M. 2001. "La crisis de la sociedad de la red global: 2001 y después". *Anuario internacional CIDOB* 1, 15-19.

Cebollada, À. , Avellaneda, P.G. 2008. "Equidad social en movilidad: reflexiones en torno a los casos de Barcelona y Lima". *Diez años de cambios en el Mundo, en la Geografía y en las Ciencias Sociales, 1999-2008. Actas del X Coloquio Internacional de Geocrítica*. Universidad de Barcelona, 26-30 de mayo de 2008.

Cervero, R. , Kockelman, K. 1997. "Travel Demand and the 3Ds: Density, Diversity and Design". *Transportation Research D*, 2.3, 199-219.

Corral Sáez. C. 1994. "El centro de la ciudad en las periferias". *Ciudad y Territorio. Estudios Territoriales*. II (100-01), 421-432.

Crooks, V.A. , Andrews, G.J. 2009. *Primary health care: People, practice, place*. Ashgate Publ. Ltd.

Davouidi, S. *et al.* 2009. "El desarrollo territorial: entre la perspectiva ambiental, la cohesión social y el crecimiento económico". In Feria. J.M. *et al* (eds.) *Territorios. Sociedades y Políticas*. Sevilla: Universidad Pablo de Olavide and AGE.

Domanski, R. 1979. "Accessibility, efficiency and spatial organization". In *Environment and Planning A*, 11(10) 1189-1206.

European Commission 2005. *Measuring progress towards a more sustainable Europe. Sustainable development indicators for the European Union*. Brussels, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-68-05-551/EN/KS-68-05-551-EN.PDF (viewed 10 August 2011).

European Commission 2009. *Sustainable development in the European Union*. Brussels: Eurostat, European Commission, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-78-09-865/EN/KS-78-09-865-EN.PDF (viewed 10 August 2011).

Feria, J.Mª 2004. "Problemas de definición de las áreas metropolitanas españolas". *Boletín de la Asociación de Geógrafos Españoles* n.38, 85-99.

Foster-Bey, J. 2002. *Sprawl, smart growth and economic Opportunity*. Washington: The Urban Institute.

Garcia Herrero, G. (Coord.) 2004. "*Ciudades socialmente sostenibles"*. Grupo trabajo 19, VII Congreso de CONAMA, Madrid, http://www.conama.org/documentos/GT19.pdf. (viewed 02 May 2011).

García, J.C. 2010. "Urban sprawl and travel to work: the case of the metropolitan area of Madrid". *Journal of Transport Geography*, 18, 197-213.

Garner, B.J. 1971. "Modelos de Geografía Urbana y de localización de asentamientos". In Chorley, R.J. and Haggett, E. (eds.) *La Geografía y los modelos socioeconómicos*. Madrid: IEAL.

Garrocho, C. , Campos, J. 2006. "Un indicador de accesibilidad a unidades de servicios clave para ciudades mexicanas: fundamentos, diseño y aplicación". *Economía, Sociedad y Territorio*, VI (22).

Gordon, P. , Richardson. W.H. 1997. "Are compact cities a desirable planning goal?". *Journal of the American Planning Association*, 63 (1): 95-106.

Harvey, D. 1973. *Social justice and the city*. London: McMillan.

Hine, J. 2003. "Social exclusion and transport systems", *Transport Policy*, 10: 263.

Holmes, J.H. 1985. "Policy issues concerning rural settlement in Australia's Pastoral zone". *Australian Geographical Studies*, 23-3, 3-27.

Mallarach, J. ,VIlagrasa, J. 2002. "Los procesos de desconcentración urbana de las ciudades españolas". *Ería. Revista de Geografía* n.57, 57-70.

Massam, B.H. 1980. *The right place*. New York: John & Son Inc.

May, J. , Thrift. N.J. (eds.) 2001. *Timespaces. Geographies of temporality*. London: Routledge.

Mérenne-Shoymaket, B. 1996. *La localisation des services*. Coll. Géographique d'aujourd'hui. Paris: Ed. Nathan Université.

Miralles, C. 2002. *Transporte y ciudad. El binomio imperfecto*. Barcelona: Ariel.

Miralles, C. 2011. "Dinámicas metropolitanes y tiempos de la movilidad. La región metropolitana de Barcelona, como ejemplo". *Anales de Geografia*. 31,(1) : 125-145.

Montero-Serrano, J., Bosque, J. , Romero-Calcerrada, R. 2008. "Cuantificación y cartografía de la sostenibilidad social a partir de tipologías urbanísticas". In Hernández, L. and Parreño, J.M. (eds.). *Tecnologías de la Información geográfica para el desarrollo territorial*, 76-91. Las Palmas de Gran Canaria: Servicio de Publicaciones y Difusión científica de la ULPGC.

Moreno, A. 1992. "Modelos para el estudio y previsión de la demanda de servicios colectivos". *Actas del V Coloquio de Geografía Cuantitativa*, 501-514. Universidad de Zaragoza.

Moreno, A. 1987. "Planificación especial de equipamientos públicos: el diagnóstico". *X Congreso Nacional de Geografía*, 2, 357-366. Departamento de Geografía, Universidad de Zaragoza.

Mückenberg, H. 2009. *Familia, política del temps i deservolupament urbà. L'Exemple de Bremen*. Barcelona: IERMB.

Nel.Lo, O. 2001. *Ciutat de ciutats. Reflexions sobre el procés d'urbanització a Catalunya*. Barcelona: Empúries [Translated into Spanish: *Cataluña, ciudad de ciudades.* Lleida: Milenio, 2002.

Rosero-Bixby, L. 2004. "Spatial Access to health care in Costa Rica and its equity: a GIS-based study". *Social Science and Medicine*, 58 (7) : 1271-1284.

Rode, P., Burdett, R., Brown, R., Ramos, F., Kitazawa, K., Paccoud, A. , Tesfay, N. 2009: *Cities and Social Equity: inequality, territory and urban form*. London: Urban Age Programme, London School of Economics and Political Science. Available from http://lsecities.net/publications/research-reports/cities-and-social-equity/.

Schuurman, N. *et al.* 2010. "Measuring potential spatial access to primary health case physicians using a modified gravity model". *Canadian Geographer*, 54: 29-45.

Schwanen, T., Dieleman, F.M. , DIJST, M. 2001. "Travel behavior in Dutch monocentric and policentric urban systems". *Journal of Transport Geography*, 9:173-186.

Tsour, K.W., Hung, Y.T. , Chang, Y.L. 2005. "An accessibility-based integrated measure of relative spatial equity in urban public facilities". *Cities*, 22 (6): 424-435.