

# Travelling patterns associated with different urban forms and population classes in the Porto Metropolitan Area

**Nuno Quental**

Bursar of the Portuguese National Foundation for Science and Technology (FCT)

*Lnquental@esb.ucp.pt*

Phone: +351-93 375 39 10

**Júlia Lourenço & Fernando Nunes da Silva**

University of Minho & Instituto Superior Técnico

*jloure@civil.uminho.pt & fnsilva@cesur.civil.ist.utl.pt*

Phone: +351- 96 413 14 50 & +351- 21 841 81 48

**Keywords:** mobility; modal split; car; public transportation; urban form; Porto Metropolitan Area.

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## 1. Introduction

The usage of public transportation has been decreasing across European Union (EU). Besides this trend, which is visible for more than a decade, a recent report released by the European Commission shows that in the last years there has been a stabilization of the modal shares of transport. In 2001, traveling by car accounted for 70 to 75% of all passenger transportation, while train and bus altogether accounted just for 16%. These values refer to the EU before its enlargement to the East, since these countries have a pattern of transportation that is, comparatively, more favourable to the collective modes.

The relation between transport and environment is more and more evident, mainly if we consider the duties that follow the Quioto Protocol, which entered into force last 16 February. With the automobile traffic steadily rising, the emission of greenhouse gases from the sector of transportation has increased some 20% during the last decade, accounting nowadays for 20% of all greenhouse emissions. In much the same way, this sector is responsible for 35% of all the energy consumption in the Union.

The concentration of 80% of the European population in urban areas induces the adoption of consumption and travelling behaviours that are more resource demanding. However, higher densities of people, services and labour in geographically limited areas make it possible, through a rigorous territorial planning, to counteract those trends and motivate citizens to choose more sustainable modes of transportation.

Of the several variables that help explain the modal split, this article will deal with the socio-economic profile of the population, urban structure and access to highways. Through comparative analysis conclusions will be drawn about the aspects that favour the use of public transportation and those that do not.

## 2. Methodology

Core information used in this article comprised the following items, all of them available for the Porto Metropolitan Area (AMP) although in different scales<sup>1</sup> and grouped in classes of values:

- population using automobile and public transportation in 2001 (for each statistical unit);
- socio-economic classes of the population in 2001 (for each statistical unit);
- population density in 2001 (for each statistical unit);
- Corine Land Cover in 1990 and 2000 (1:100 000);
- mean trip duration in 2001 (for each statistical unit);
- highway, metro and train network, including road nodes and stations in 2005.

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<sup>1</sup> - A large part of the information was available for each statistical unit in classes of values. These statistical units vary in size but are generally of district or neighbourhood level, allowing a very precise spatial analysis of the information.

Car usage was used as the dependent variable and cross-compared with the other variables in order to establish relationships according to the details presented in Table 1. Multivariate comparisons were not performed because of data insufficiencies.

Table I: Variables and classes of values considered in the analysis.

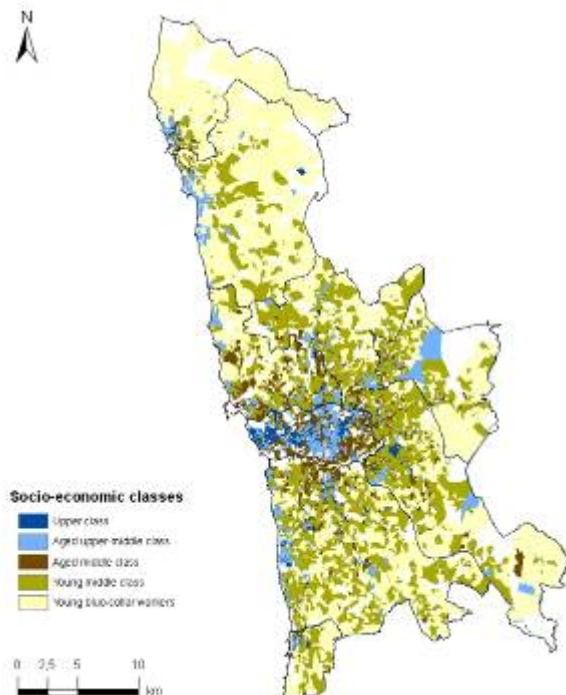
Variables	Classes of values considered	Reference
Car usage (independent variable)	0-30, 30-47, 47-65 and 65-100% (of the population)	INE, 2004
Socio-economic classes of the population	Upper class, aged upper-middle class, aged middle class, young middle class and young blue-collar workers	INE, 2004
Population density	5-1000, 1000-2000, 2000-3000, 3000-5000, 5000-5570, 5570-8500, 8500-14370, 14370-30120 and 30120-96350 inhabitants / km <sup>2</sup>	INE, 2004 and FAUP, 2002
Corine Land Cover in 2000	Continuous urban fabric (1.1.1), discontinuous urban fabric (1.1.2) and the aggregation of other areas (all other Corine classes)	Instituto do Ambiente
Corine Land Cover in 1990	Consolidated urban areas: aggregation of continuous urban fabric (1.1.1), discontinuous urban fabric (1.1.2) and construction sites (1.3.3)	Instituto do Ambiente
Changes in Corine Land Cover between 1990 and 2000	Urban expansion areas: aggregation of continuous urban fabric (1.1.1), discontinuous urban fabric (1.1.2) and construction sites (1.3.3). Around each polygon was drawn a buffer of 50 meters which was also considered in the analysis.	Instituto do Ambiente
Highway, metro and train network, nodes and stations	Highway nodes, metro stations and train stations. The area considered for analysis was a buffer of 1000 meters around each one.	FAUP, 2002

### 3. Trends and situation in the Porto Metropolitan Area

#### 3.1 Socio-economic classes

A recent study about the socio-demography of AMP used factorial analysis to compare different variables and define groups of people with similar characteristics (INE, 2004: 72).

Fig. 1: Socio-economic classes AMP inhabitants in 2001.



The main results are presented in Figure 1 according to the following classes:

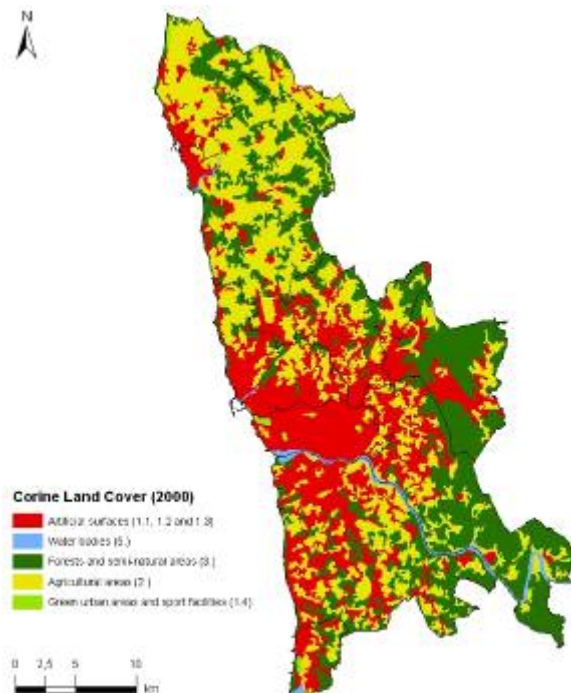
- upper class: highly qualified, well paid and long working managers of the tertiary sector living in lower than average density areas and older buildings, and moving mainly by car. The cluster occurs rich places like Foz and Antas in Porto;
- aged upper-middle class: this cluster integrates the oldest people and buildings, where a significant part is vacant, and high density areas. There is a higher than average proportion of highly qualified managers of the tertiary sector. The centre of Porto concentrates a large part of this cluster, albeit it also appears in the littoral strip and scattered throughout the region;
- aged middle class: older people living in dense areas with a higher than average representation of administrative workers of services and commerce. This cluster is more abundant in Porto;
- young middle class: youth people with a higher

than average representation of skilled workers, moving mainly by car, living in expensive places and recent buildings with several stories. This class shows up specially in the municipalities around Porto, though with a fragmented pattern;

- young blue-collar workers: this cluster distinguishes itself from the previous because of the lower skills of the residents, the higher proportion of blue-collar workers and the presence of more overloaded houses. The cluster covers a higher area of the region but, again, it's almost absent from Porto.

### 3.2 Urbanization patterns

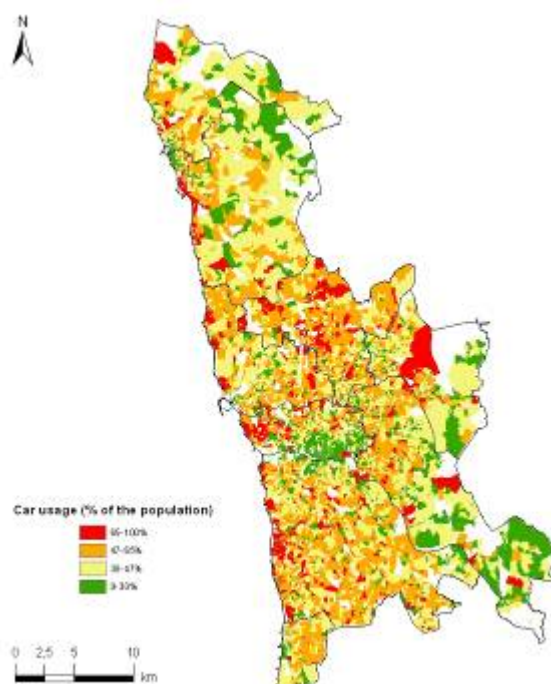
Fig. 2: Corine Land Cover of AMP in 2000.



The artificial area in the Porto region has been steadily growing. According to the Corine Land Cover data (see Figure 2), the urbanized area corresponding to classes 1.1, 1.2 and 1.3 grew some 7000 ha (37%) between 1990 and 2000, occupying now 30% of the total land area (22,5% in 1990). This a substantial difference, even though similar patterns can be found in other European regions (EEA, 2002). The highest grow can be found in Vila Nova de Gaia, Maia, Valongo and Gondomar – that is, the municipalities around Porto. There is an obvious correlation between this land use modifications and changes in population and the number of buildings.

### 3.3 Car usage

Fig. 3: Percentage of residents using car in their trips in 2001.



Mobility patterns in AMP are becoming more dependent on private car and less on public transportation. In 2001 more than half of the residents used some kind of individual transportation in their trips. Only in Porto, Valongo and Gondomar the proportion was smaller. At the same time, public means of transportation gather not more than 34% of the residents. Figure 3 show a detailed transportation pattern in the region.

In 1991 mobility in the region was mainly based on public transportation. This situation has dramatically changed in ten years. The variation was more pronounced in Gondomar and Valongo (though they still show the highest levels of public transportation). Walking has also suffered a significant reduction, which can be associated with smaller a willingness to do it because of faster alternatives and with increasing distances to be covered from home to work.

## 4. Transportation, socio-economy, land use and urbanization

Several variable comparisons were performed in order to better understand the dependence on automobile and its evolution since 1991. The results are presented below.

### 4.1 Relationship with socio-economic classes of the population

Observing Figure 4 it becomes clear that higher socio-economic classes prefer travelling by the car. Older people rely more on public transportation modes than younger residents, which is a relevant cultural symptom of nowadays.

Fig. 4: Car usage according to the five socio-economic classes of population considered (2001).

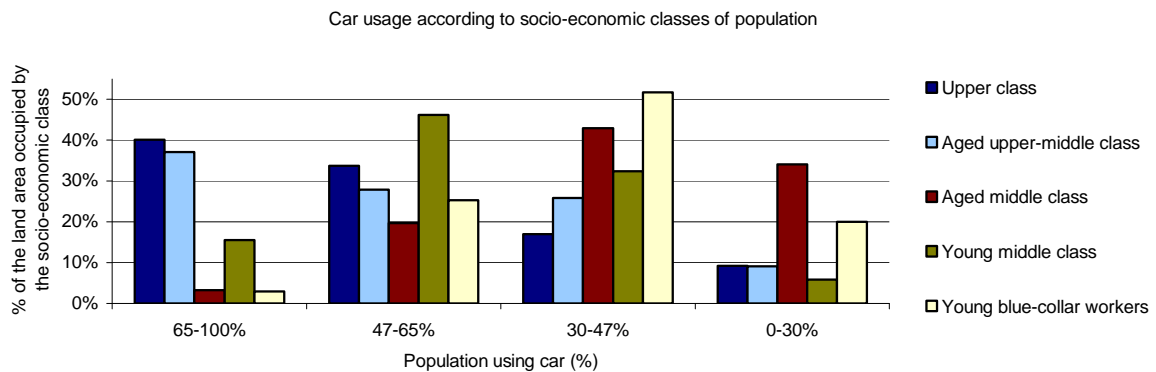
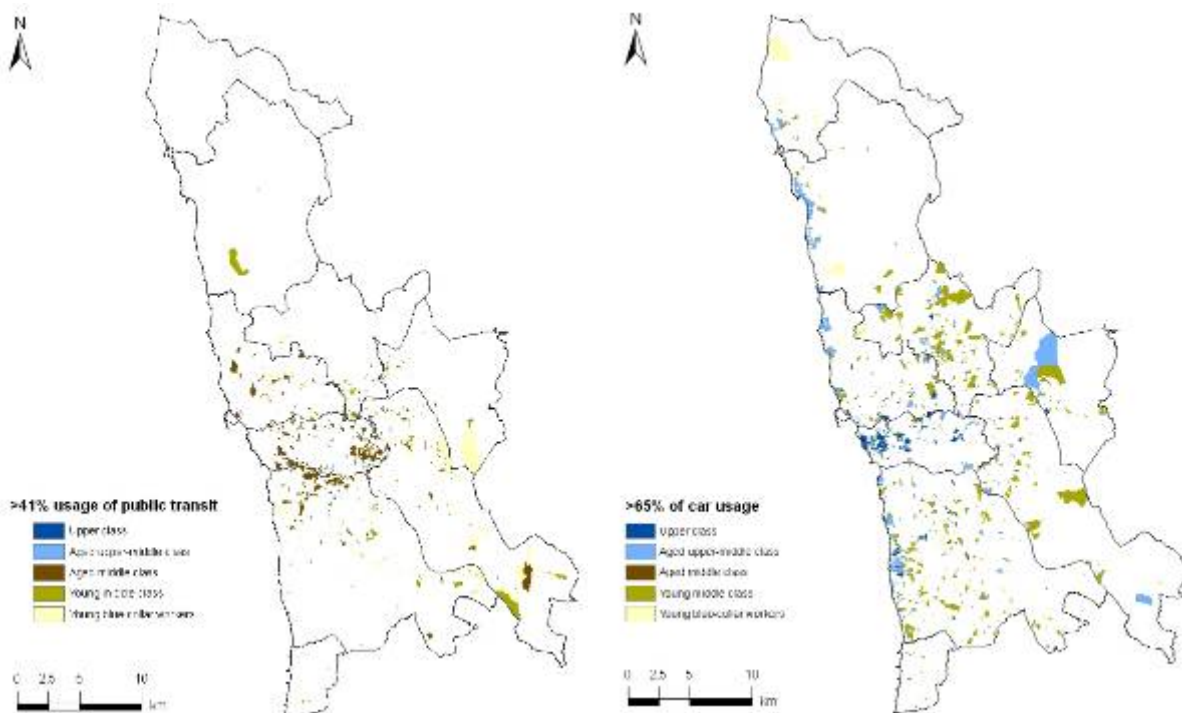


Figure 5 provides spatial information about the relation between socio-economic classes and the use of automobile and public transportation. While the highest reliance on car can be found more or less scattered through the region, although more heavily in Porto, Maia and Vila Nova de Gaia, the largest use of public transportation is geographically concentrated and strongly correlated to the aged middle class that inhabits the historic centre and the eastern part of Porto.

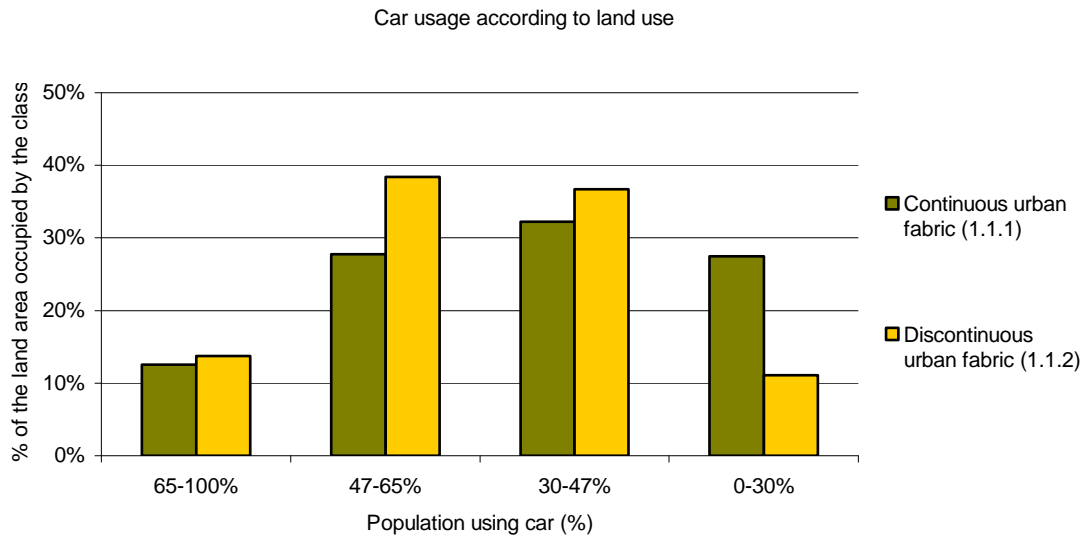
Fig. 5: Socio-economic classes where more than 65% of the population travel by car or more than 41% travel by public transportation (2001).



### 4.2 Relationship with land use

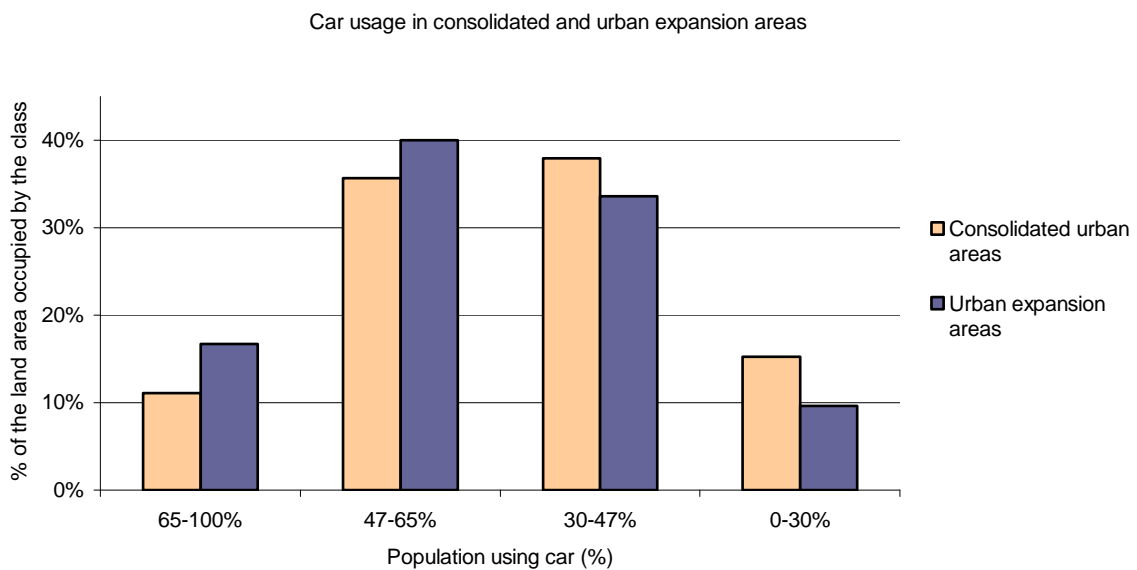
Land cover obtained from Corine data (in 2000) was compared with the use of automobile (in 2001). It was found that class 1.1.1 (continuous urban fabric) – the denser urban areas – are the less dependent on cars than class 1.1.2 (discontinuous urban fabric), as can be depicted from Figure 6.

Fig. 6: Car usage according to Corine Land Cover classes (2000).



Since data from 1990 was also available, new urban areas detected in 2000 and corresponding to classes 1.1.1, 1.1.2 or 1.3.3 (construction sites) were considered “urban expansion zones”. At the same time, it was assumed that these same classes in 1990 were nowadays “consolidated urban zones”. Because the source data had different scales, buffers of 50 meters around each polygon representing new urban areas were also included in the analysis. The time span of 10 years may seem too large to carry out the comparison, but the results show significant differences between both typologies of spaces. Expansion zones systematically exhibit a stronger reliance on automobile than consolidated urban areas and, conversely, a smaller use of public transportation (Figure 7).

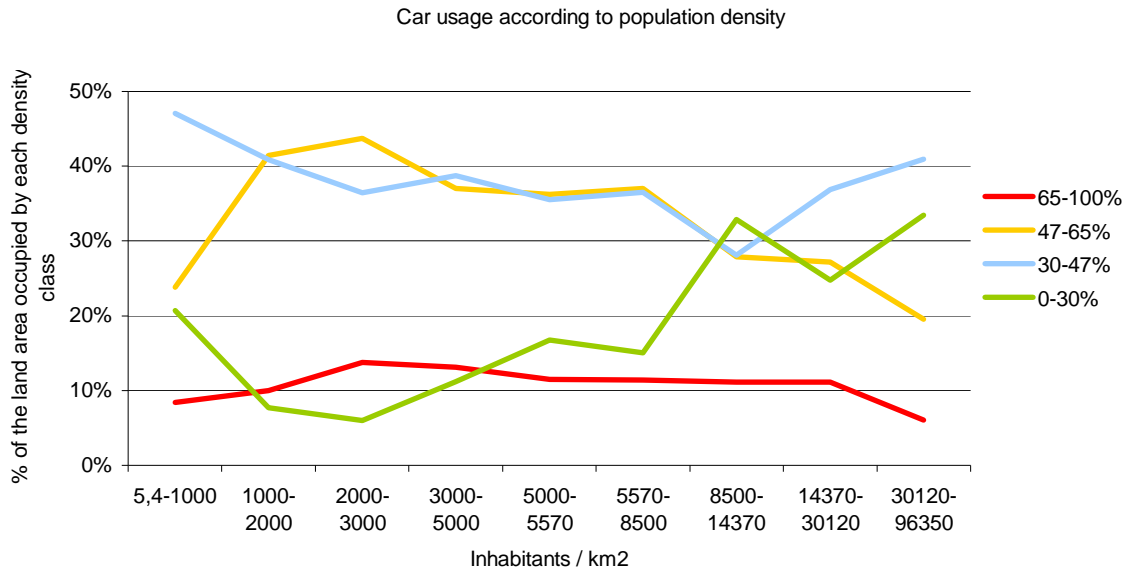
Fig. 7: Car usage in consolidated and urban expansion areas.



### 4.3 Relationship with population density

The relationship between car use and population density is sometimes ambiguous, which is probably due to the influence of other important factors such as socio-economic differences. Nevertheless, Figure 8 shows a general decreasing trend of the car use classes 65-100% and 47-65% and, necessarily, an increase of the classes 0-30% and 30-47%. Very high dependencies on automobile don't seem to be affected by population density.

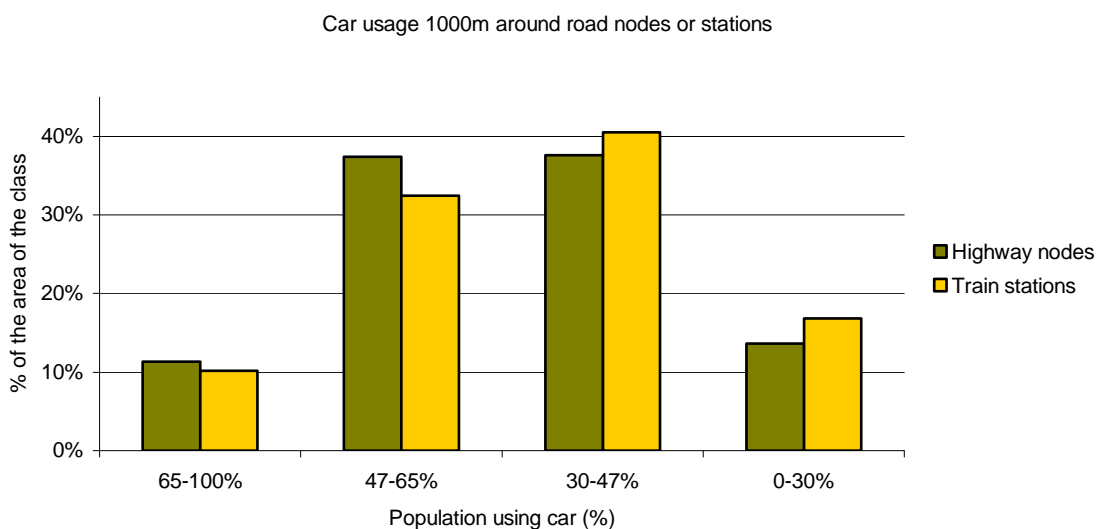
Fig. 8: Car usage according to population density in 2001.



### 4.4 Relationship with highway, metro and train networks

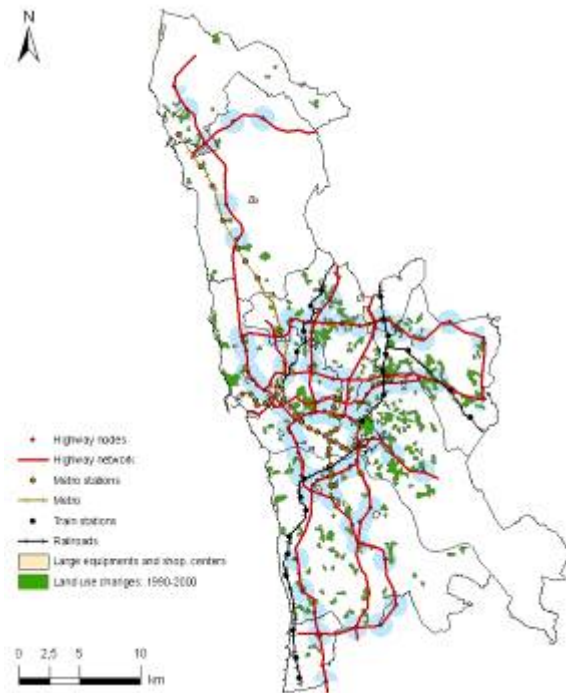
A buffer of 1000 meters was applied around each highway node and metro and train stations. The transportation patterns in these areas were, again, compared, as can be seen in Figure 9. Interestingly, highway nodes seems to be associated with higher uses of automobile and, at the same time, a smaller reliance on public means of transportation.

Fig. 9: Car usage 1000 meters around road nodes or stations.



Bus stations were not analysed because, at least in Porto, the network reaches almost every part of the city. In Vila Nova de Gaia, Gondomar, Valongo, Matosinhos and Maia it becomes more fragmented, even though these municipalities are served by private operators.

Fig. 10: Urban expansion zones and the highway, metro and train networks.



The main transportation networks, new urban areas and recent large equipments were overlapped in Figure 10. Most of the development is taking place near recent highway nodes and not so much around the train stations (which are also older). The data suggest that the main soil transformation is being dictated by the expansion of road network or, perhaps, in the other way around as well. It is important to note that the metropolitan network wasn't in place in 2000 and, therefore, its influence on land use changes should not be considered.

## 5. Conclusions

Bivariate analysis limit the significance of possible conclusions. Yet, data suggests that smaller dependence on automobile and higher public transportation rates are associated with:

- adverse socio-economic conditions. Porto, although having a high proportion of instructed inhabitants and a strong middle class, concentrates most of social housing of the region, specially in the centre and in the outer ring of the city;
- denser typologies of urban spaces (travel by car is less pronounced in consolidated urban fabric) and higher population densities;
- consolidated urban areas in contrast with expansion zones;
- availability of public transportation.

The correlation between some of the variables considered is probably high. One can never be sure about the *first* or the *main* reason that explain a certain behaviour or situation. The choice about the mode of transportation seems to result from a complex relation between personal desires and physical (*i.e.*, urban) and monetary limitations. On a broader scale, the emergence of the automobile has defined a new regional geography, bringing with it an ever expanding highway network and more and more citizens willing to rapidly travel long distances. Urban developments taking place near highway nodes are just the result of this general trend and, in this sense, the heavy reliance on car is taken for granted. People that prefer alternative ways of mobility will surely opt for other places to live, probably near centres well served by public transportation and services.

Preserving the soil from unnecessary development and avoiding the waste of energy will only be possible by avoiding unsustainable land use transformations and travelling patterns. Also, if we want our cities dominated by people and not by cars, we'll reach the same conclusion.

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## Acknowledgements

The author acknowledges the financial support from the Portuguese National Foundation for Science and Technology (Fundação para a Ciência e Tecnologia, <http://www.fct.mct.pt>) and wishes to thank the collaboration of PhD supervisor Prof. Júlia Lourenço (University of Minho) and co-supervisor Prof. Fernando Nunes da Silva (Lisbon Technical University – Instituto Superior Técnico).

## Abstract

The usage of public transportation has been decreasing across European Union (EU). Besides this trend, which is visible for more than a decade, a recent report released by the European Commission shows that in the last years there has been a stabilization of the modal shares of transport. In 2001, travelling by car accounted for 70 to 75% of all passenger transportation, while train and bus altogether accounted just for 16%. These values refer to the EU before its enlargement to the East, since these countries have a pattern of transportation that is, comparatively, more favourable to the collective modes.

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Of all the variables that can play a role in the decision of the travelling mode by citizens – among them the structure of prices and costs should be emphasized – this article will deal with the urban structure. The main goal of this paper is to test the relationship between recent urban expansion projects and the travelling patterns associated with its residents.

A recent study about the Porto Metropolitan Area showed that its territory is increasingly fragmented and that many new urban projects are distant from existing urban centres. These findings may be correlated to the drastic decrease of public transportation usage – from 48 to 27% – in the area in the last decade. A number of these urban expansion projects in the region will be analyzed according to variables such as proximity to main transport routes and nodes, density (dwellings per hectare), mixture of uses, public transport accessibility and frequency, etc. This data is afterwards compared with the modal split of the residents in order to portray recent trends in the Metropolitan Area of Porto.