Socio-spatial dynamics forecast in the international basin of the river Tajo

JULIÁN MORA ALISEDA
Department of Territory Sciences
University of Extremadura
Avda. Univesidad no number.
10003 Cáceres, SPAIN
jmora@unex.es // tajoguadiana@gmail.com

JACINTO GARRIDO VELARDE
Department of Territory Sciences
University of Extremadura
Avda. Univesidad no number.
10003 Cáceres, SPAIN
jgvelarde@unex.es // jgarridoif@gmail.com

JOSE CASTRO SERRANO
Department of Territory Sciences
University of Extremadura
Avda. Univesidad no number.
10003 Cáceres, SPAIN
josecastro@unex.es

Abstract: Over the last few decades, distribution and redistribution of the population within the territory has gained in importance as a subject of social interest, both regionally and nationally. This study is part of research which analyzes changes in how the population is settled and its effect on spatial organization of the urban network. The aim of this research is to analyze the changes in the population distribution of the municipalities located in the international basin of the River Tajo. This is an investigation of a quantitative nature, in its methodological approach, through the use of population census data covering the period 2001-2011. In the study of the municipalities in the international basin of the River Tajo, population size categories are applied. Likewise, the structure of the current population is examined and a predictive model of the population evolution will be performed to enable us to anticipate rationally future trends in the populations analyzed.

Key-Words: Socio-Spatial Dynamics, Predictive Models, Population Evolution, Spatial Distribution

1 Introduction

Population density is generally used as an indicator to distinguish between rural and urban areas. The definition of rural areas established by the Organization for Economic Cooperation and Development (OECD 1996) is based on a combination of the size of territory and population density. The territory may be the administrative unit corresponding to the municipality (in terms of the UE / Eurostat NUTS-Framework: LAU 1). LAU 1 set criteria to consider a rural area as one which has a population density lower than 150 inhabitants/km^2.

From our perspective, this does not appear to be very accurate when is applied to some countries (Johansen, Nielsen 2012).

It is necessary to break with the rigid economical pattern in which the role of the rural sector has been placed, and move it into the context of politics and institutions (Pérez, 2001). The rural environment is thus a socioeconomic entity within a geographical space, consisting of four components: territory; population; settlements as a whole; and public and private institutions as whole (Muñoz, 2012). It seems clear that, due to so many partial and,

sometimes, opposite definitions, the difficulty in distinguishing what is rural from what is urban, both quantitatively and qualitatively, is almost a more intuitive issue than a discursive one, according to the bibliography review (Brennan et al., 2008; Svendsen, Sørensen, 2007; Lee et al., 2005; Bridger, Luloff, 1999; Braden, Mayo, 1999)

The reality of rural areas in Europe exhibits many important regional imbalances of different types and levels (EC, 2010a). The permanent character of these regional disparities has increased since the recent enlargement of the EU and the need to advance towards territorial convergence, propitiating the inclusion of the principle of territorial cohesion in the EU objectives (art. 158 del Tratado de Lisboa). Territorial cohesion has become an important issue in EU policies and a priority in the legislative proposals of the cohesion policy for the period 2014-2020 (EC, 2011) (Sanchez-Zamora et al., 2014).

In this context of territorial disparities, it is clear that Europe's rural areas do not evolve homogeneously, confirming the existence of different spatial dynamics. The concept of rural territorial dynamics refers to the processes of development in the socioeconomic structure, the institutional framework, environmental capital in rural areas and the changes that accompany the effects of development (Rimisp, 2007). It could be said that there are two types of rural areas that coexist within the EU: those that have developed dynamics defined by strong economic growth, social cohesion and environmental sustainability, and those where the economic stagnation, depopulation and environmental degradation persist (Sanchez-Zamora et al., 2014).

In the last years, the increase in intensity of the changes and diversity of the dynamics that are occurring in rural areas have highlighted the need for research that can cope with the intellectual and political challenges that arise as a result of these issues. As a consequence, several projects have tried to distinguish between rural "leaders" and "laggards" in order to compare their characteristics and to identify factors that might explain these different processes of change (Sanchez-Zamora et al., 2014).

Some of the most important projects in Europe include the Study on Employment, Growth and Innovation in Rural Areas (SEGIRA) (EC, 2010b), European Development Opportunities for Rural Areas (EDORA) (Kahila et al., 2009, Copus et al., 2011), and Dynamics in Rural Areas (DORAS) (Bryden, Hart, 2004). Beyond Europe's borders, one of the most important projects in Latin America is the Rural Territorial Dynamics Project (Rimisp, 2007). In this regard, several authors have tried to identify the key factors that influence the dynamics of territorial development from an economic perspective (Terluin, 2003; Agarwal, et al., 2009), social (Putnam, 1993; Whiteley 2000; Nelson, Sampat, 2001; Kahila et al., 2009) and environmental perspective (Hoggart et al., 1995; Courtney et al., 2006; Langlais, Tepecik, 2009).

1.2. Objectives

The accelerated worldwide urbanization progress over the last few decades has given rise to the consolidation of an uneven pattern of concentration, that is to say a heterogeneous population distribution over a geographical space, thus creating territorial imbalances (United Nations 2008; Prieto, 2011). The spatial intensity and speed of recent changes in Spain and Portugal provides a paradigmatic example of the rapid shift to a new system of urban-rural relationship in the international basin of the River Tajo, based on a modified dichotomy between urban and rural areas (Stellmes et al., 2013). In this regard, our research fits into the studies which analyze recent changes in the population settlement system and its effect on the spatial organization of the urban network in the international basin of the River Tajo (Prieto, 2011).

The main objective therefore is to determine population flows in the Spanish-Portuguese municipalities of the international River Tajo basin. This objective is complemented by more specific ones, such as: a) Analyzing population structure; b) Drawing up a predictive model for population evolution starting from the analysis of the current population.

2. Materials and methodology

2.1. Area of Research

The international basin of the River Tajo is the third largest in the Iberian Peninsula, spreading over an area of some 88,700 km2: 55,800 km2 (69%) belong to Spain and roughly 24,900 km2 (31%) are in Portugal. The international basin of the River Tajo is the longest river in the Peninsula, with 827

km. in Spain, 230 km. in Portugal and 43 km making up the border between the two countries, which gives a total of 1,100 km. (Fig. 1).

Over 12 million people rely on the international basin of the River Tajo for their urban water supply, of whom nearly 8 million are to be found on the Spanish side, while more than 4 million are located in Portugal.

It should be pointed out that both national capital cities in the Peninsula rely on the basin, as well as Europe's main transfer channel. In Spanish territory, 120,000 ha. of public irrigated land and 110,000 hectares of private irrigated land receive this water supply (HISPAGUA 2014).

2.2. Methodology of work

The methodological approach of this research is quantitative. An analysis of spatial distribution of the population located in the international basin of the River Tajo is performed. Starting from censual data we try to reproduce the make-up of the population system of the latest demographic census (2011).

One of the ways of presenting the results of municipal censual data is by grouping localities according to their population size. To this effect, 5 population strata were defined, thus achieving representation of all the municipalities in the international basin of the River Tajo: under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants (Mora et al., 2015a).

In order to find out upcoming trends in that population, a predictive model of demographic evolution will be performed, bearing in mind demographic variables and ageing of the current population along the international basin of the River Tajo (Requés and Rodríguez, 1996).

This paper is supplemented by the application of the database into a Geographical Information System (GIS), in order to establish both spatial and temporal dynamics and their expression in the international basin of the River Tajo (López, Pérez, 2005; Prieto, 2011; Mora et al., 2015b).

3. Results and discussion

3.1. Grouping of localities by population size

Within the basin taken as a whole, most of the municipalities are small-sized ones, since 68.28% of

them have a population under 2,000. On the contrary, the most populated centres (more than 10,000) represent 11.44% of the whole (Table 1).

Going into a more in-depth study of both demarcations, most of the municipalities are in the Spanish demarcation. Overall, 1,020 of the 1,119 municipalities which have the international basin of the River Tajo as their axis are Spanish: 91.15% of the whole.

Most of the municipalities on the Spanish side are small-sized ones, since 74.90% of them (764 municipalities) have fewer than 2,000 inhabitants (Table 2). These population centres are chiefly to be found on the west side of the basin, Cáceres province and the south of Salamanca, while localities in the provinces of Guadalajara and Cuenca stand out on the eastern side. It is to be noted that among the towns in the western side, the most numerous populations range from 501 to 2,000 inhabitants, while in the east, populations with fewer than 500 inhabitants are the majority.

On the contrary, the most populated localities (more than 10,000 inhabitants) are the least represented, since they are only 6.47% of the whole (66 municipalities) (Table 2). These municipalities are to be found in the central part of the basin, where the city of Madrid stands out with all of its metropolitan area (Alcalá de Henares, Alcorcón, Coslada, Móstoles, among others). However, other important localities such as Talavera de la Reina, Plasencia o Cáceres must be noted.

In the Portuguese demarcation we find 99 of the 1,119 municipalities which the international basin of the River Tajo urban system includes, accounting for 8.85% of the whole. As opposed to the Spanish localities, the Portuguese ones are characterized by the fact that most of the municipalities have a population over 10,000, which constitutes 62.63% of the whole (Table 3). Nearly all the most populated municipalities are gathered at the mouth of the Tajo, where Lisbon, Portugal's capital, and all its metropolitan area (Sintra, Amadora, Cascais, among others) is located. Nonetheless, Castelo Branco and Fundão o Covilhã are also worthy of mention in the north of the demarcation, while population centres like Estremoz or Montemor-o-Novo stand out in the south.

On the other side we can find the least representative municipalities in the Portuguese demarcation. There are some whose population

ranges from 2,001 to 5,000 inhabitants, which constitutes 19.19% of the whole (19 municipalities), and there are others whose population varies between 5,001 and 10,000 inhabitants, representing 18.18% of the whole (18 municipalities) (Table 3). As a kind of paradox, it is to be noted that there is no locality with fewer than 2,000 inhabitants in the Portuguese demarcation, while on the Spanish side these municipalities constitute 74.90% of the whole (Table 2). However, it must be pointed out that the Portuguese population system is very different from the Spanish one, since municipalities there consist of many minor local entities, called *freguesias*, and many of them have far fewer than 2,000 inhabitants.

3.2. Population size by number of inhabitants

Altogether 12,276,941 people live in the international basin of the River Tajo, of whom 7,879,123 inhabitants (64.18% of the whole) dwell on the Spanish side and 4,397,818 inhabitants (35.82% of the whole) are settled on the Portuguese side. As for the whole of the basin, roughly 11 million people (88.86%) are settled in municipalities with more than 10,000 inhabitants, while just 651,503 people (2.86%) live in localities with under 2,000 inhabitants (Fig. 2).

64.18% of the whole basin population (7,879,123 inhabitants) live in Spain. Most of the population is gathered in towns of over 10,000 inhabitants, since they represent 85.17% of the whole (6,710,363 inhabitants). The three largest towns are Madrid, with 3,265,038 inhabitants, Móstoles, with 205,015 inhabitants, and Alcalá de Henares, with 203,686 inhabitants, coming to 3,673,739 inhabitants, which makes up 46.63% of the whole population dwelling on the Spanish side of the international basin of the River Tajo (Table 4). However, just the city of Madrid accounts for 41.44% of the whole, since it is the Peninsula's largest city.

On the other hand, the population living in municipalities ranging from 5,001 to 10,000 inhabitants comes to 405,863 people, making up 5.15% of the whole. The 411,394 inhabitants (5.22% of the whole) living in municipalities ranging from 2,001 to 5,000 dwellers come next, while the least numerous group of population is in localities smaller than 2,000 inhabitants, since they only include 351,503 people, which means 4.46% of the whole population in the Spanish demarcation of the international basin of the River Tajo (Table 4).

The same applies to the Portuguese demarcation as to the Spanish demarcation, since we can observe 95.49% of the population (4,199,429 inhabitants) is settled in centres larger than 10,000 inhabitants. The three largest cities are Lisbon, with 2,821,699 inhabitants, Sintra, with 377,837, and Cascais, with 206,429 inhabitants, altogether coming to 3,405,965, which accounts for 77.44% of the whole of the demarcation (Table 5).

On the contrary, 126,426 people live in localities ranging from 5,001 to 10,000 inhabitants, which represents 2.8% of the whole, followed by the 71,963 inhabitants (1.64% of the whole) dwelling in municipalities smaller than 5,000 inhabitants. It should be pointed out that, unlike on the Spanish side, on the Portuguese side there is no locality with fewer than 2,000 inhabitants, (Table 5). Nonetheless, as mentioned in the previous section, it must be pointed out that the Portuguese population system is very different to the Spanish one, since municipalities there consist of many minor local entities, called *freguesias*, and many of them are smaller than 2,000 inhabitants.

3.3. Population structure

Looking at the population pyramid of the international basin of the River Tajo in the year 2011 we can observe a predominance of the female gender (400,000 more women than men), with a masculinity ratio of 93%[2] (Fig. 3)

However, the number of females is not always higher all across the pyramid. During the first years there are more males, since more boys than girls are born (106 boys for every 100 girls), as can be seen in the pyramid's longer bottom bar on the male side. From that point on, the balance steadily increases as we rise in the age groups within the population pyramid. It can be observed that, from 25 years of age onwards, women start to predominate across the cohorts of the pyramid, even doubling the number of men in the final cohort (>85). This is due to a higher female life expectancy: 84 years as against 78 years for men. Higher life expectancy is women is due to male mortality because of biological, working and social reasons (a life style more exposed to risk factors) (Fig. 3) (INE 2001).

The basin's population pyramid is clearly bulb-shaped, with a narrow base, indicating progressively decreasing cohorts, due to a low birth rate, and a peak with wider steps showing a large adult population, because of higher life expectancy. We can therefore confirm that we are dealing with an ageing population, a trait of developed societies.

Following an age-group analysis we find a large number of people in the population group over 65. In this group, we can observe a clear predominance of females (58.53% of the whole population over 65), as opposed to the male group, due to higher female lifespan and the high rate of emigration, consisting mainly of males, which significantly affected the localities in the international basin of the River Tajo (INE 2001).

Most of the basin's population (67.16%) is adult (16-64 years). In this group, the most significant demographic issues could be, first of all, the increase in birth rate following the so-called baby boom of the 1960s and early 1970s. The cohorts born between the years 1957 and 1975 (35-54 years) fit into this boom. This phenomenon was caused by the economic growth of the country from the late 1950s till the mid 1970s.

The second demographic aspect to be considered regarding the adult population group is the indent affecting the pyramid starting from the 30-34 year (1977) age cohort, as the bar length starts decreasing due to lower fertility. This is a consequence of the important political, social and economic transformations happening both in Spanish and Portuguese societies from 1975 and 1974 onwards respectively (INE 2011).

The group of young people (0-14 years) is very small, since it only contains 15.22% of the basin population, due to the lower fertility mentioned above. This has meant that the young population has decreased by cohorts since 1977, thus having a direct impact on the ageing of the population and putting generational replacement at risk. However, it must be noted that cohorts ranging from 0 to 14 years have experienced a significant increase, and so we can observe that 10-14 age group is larger than the preceding one (15-19 years), which may be due to the economic kick-start in 1998, when the Spanish production model changed as a result of soil liberalization. This factor made the Spanish economy rise sharply in following years (up to 2008), drawing a large number of young immigrants, and leading, as a result, to the rejuvenation of the population. This explains the fact that the 35-39 cohort is the largest of the basin. The arrival of population of a childbearing age from other countries has led to the birth rate rising again, breaking with the previous years' trend, as can be seen in the 0-9 cohorts.

In conclusion, the pyramid corresponding to the international basin of the River Tajo population reveals an ageing population, a characteristic trait of developed societies. The causes for this ageing of the population must be sought in a very low birth rate and high life expectancy. The first cause is an outcome of changes in ways of thinking (secularization of society, transformation of family customs, incorporation of women in the work market, availability of contraceptive methods, etc.), the economic crisis which affected the developed world from 1973 onwards (oil crisis), cultural changes (longer years of study) and improvement in the population´s standard of living, all factors that, since the mid seventies, have brought about a substantial decrease in fertility.

The ageing of the population, as the dependency ratio increases, may pose, in the mid- to long term, some problems as to the viability of the current social care systems, especially when it comes to pensions, as well as medical and healthcare aspects. However, this is more an economic question than a demographic one, since, as employment increases, the dependency ratio can be lowered with the arrival of young immigrants who provide the system with higher income via their social security contributions.

An increase in ageing is foreseeable, since people ranging from 55 to 64 years (11.23% of the entire population) are the ones to reach pensionable age in the short to mid term. The problem with ageing is not so much a gradually higher number of people over 65 people, as a gradual decrease in young population. However, the increase of the birth rate over the last few years gives new hope for the rejuvenation of the population living in the basin, since generational replacement, a very necessary factor in sustaining the current standard of living, can take place.

3.4. Predictive models of population evolution (2023)

If the current the international basin of the River Tajo demographic trends persist, the population will become stagnant or with slight growth over the forthcoming years, since, in spite of the higher birth rate over the last few years, the population over 65 will continue to grow larger, because the large baby boom generations will start to reach retirement age. Nonetheless, the international basin of the River Tajo is dynamic economically, and consequently it might draw young population from other territories, which would cause rejuvenation of the population.

Life expectancy for the year 2022 is estimated at around 81.8 years for men and 87 years for women, which represents an increase of 2.5 and 1.9 years respectively from current values. At the same time, by 2022, life expectancy for 65 year-olds will have increased by up to 20 years for men and 24.1 years for women, which would cause excessive ageing of the older population. This fact will lead to a rise in the rate of mortality, due to the increasing number of older population in the higher age groups. However, it must be noted that most of the population of both Madrid and Lisbon, along with their metropolitan areas (the most populated places in the basin), stem from the rural exodus which affected both countries during the 60s and 70s, and a great deal of that human capital which moved to the cities to work in industry is likely to return to their hometowns on retiring. This fact, along with the arrival of young population to fill the posts of those who retire, will alleviate the ageing rate of the whole basin (INE 2014).

Unless the current demographic model changes, one of the possible effects is that the number of deaths will exceed births by 2023, which would mean a negative natural increase, mainly due to the lower birth rate. By age groups, the 2023 population would fall into the age brackets between 20 and 49, while population would rise across the upper part of the population pyramid. As a matter of fact, all the age groups over 50 would grow in number.

The consequences of population-ageing will pose a challenge to society in the future, since the current demographical changes are going to require some social, economic and political reforms, as dictated by the ageing process. This may account for a direct impact on the increase in healthcare budget, social benefits and disability allowance, due to the larger number of retired people and the smaller active population, since one worker for each pensioner has been estimated for 2023, which might be setting at risk the sustainability of the system (Mora, Mora, 2015).

This situation may be reversed, provided that the demographic model changes and that is why childbearing-boosting politics should be encouraged. These would bring about a decrease in the ageing rate. Nonetheless, this should come hand in hand with greater economic development, quite the opposite of the current situation; this development could cause an increase in immigration, so rejuvenating the population structure of the basin.

4. Conclusions

Altogether 12,276,941 people live in the international basin of the River Tajo, spreading over 1,119 municipalities; about 68% of them have a population under 2,000, although just 2.86% of the population live in these municipalities. On the contrary, 88.86% of the total population live in municipalities over 10,000. Thus we can conclude that the international basin of the River Tajo presents a very disperse spatial distribution of the population, which alternates population 'deserts' with average and high population concentrations in the most relevant population nuclei in the territory i.e. district market-towns and regional and provincial capitals.

The population pyramid of the international basin of the River Tajo represents an ageing population, a characteristic trait of developed societies, due to the low birth rate and rising life expectancy. If current demographical trends persist, the existing social protection system will be compromised, especially with regard to pensions, since for the year 2023 it has been estimated there will be one worker for every pensioner, which would jeopardize the sustainability of the system. Nonetheless, the international basin of the River Tajo has strong dynamics in economic terms, since it comprises two country capitals (Madrid and Lisbon), and it may consequently attract from other territories a young population searching for better working conditions, which could lead to a population rejuvenation.

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Table caption:

Table 1: Percentage of the international basin of the River Tajo municipalities grouped into 5 categories (under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants)

Population	Number of municipalities	%
Under 500	515	46.02%
501-2,000	249	22.25%
2,001-5,000	152	13.58%
5,001-10,000	75	6.70%
Over 10,000	128	11.44%
Total	1,119	100%

Source: Compiled by author from INE-ES-PT data. 2001 - 2011.

Table 2: Percentage of the international basin of the River Tajo municipalities grouped into 5 categories (under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants)

Population	Number of municipalities	%
Under 500	515	50.49%
501-2,000	249	24.41%
2,001-5,000	133	13.04%
5,001-10,000	57	5.59%
Over 10.000	66	6.47%
Total	1,020	100%

Source: Compiled by author from INE-ES-PT data. 2001-2011.

Table 3: Percentage of the international basin of the River Tajo municipalities grouped into 5 categories (under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants)

Population	Number of municipalities	%
Under 500	0	0
501-2,000	0	0
2.001-5,000	19	19.19%
5.001-10,000	18	18.18%
Over 10,000	62	62.63%
Total	99	100%

Source: Compiled by author from INE-ES-PT data. 2001-2011

Table 4: Percentage of number of inhabitants living in Spanish towns grouped into 5 categories (under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants)

Town	Population	%
Under 500	91,439	1.16%
501-2,000	260,064	3.30%
2,001-5,000	411,394	5.22%
5,001-10,000	405,863	5.15%
Over 10,000	6,710,363	85.17%
Total	7,879,123	100%

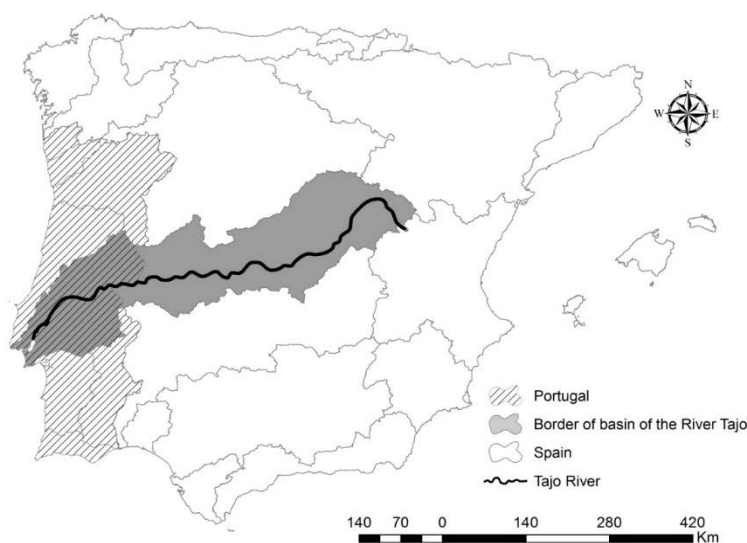Source: Compiled by author from INE-ES-PT data. 2001-2011.

Table 5: Percentage of inhabitants living in towns in Portugal grouped into 5 categories (under 500; 501 to 2000; 2001 to 5000; 5001 to 10000 and over 10000 inhabitants)

Town	Population	%
Under 500	0	0
501-2,000	0	0
2.001-5,000	71,936	1.64%
5,001-10,000	126,426	2.87%
Over 10,000	4,199,429	95.49%
Total	4,397,818	100%

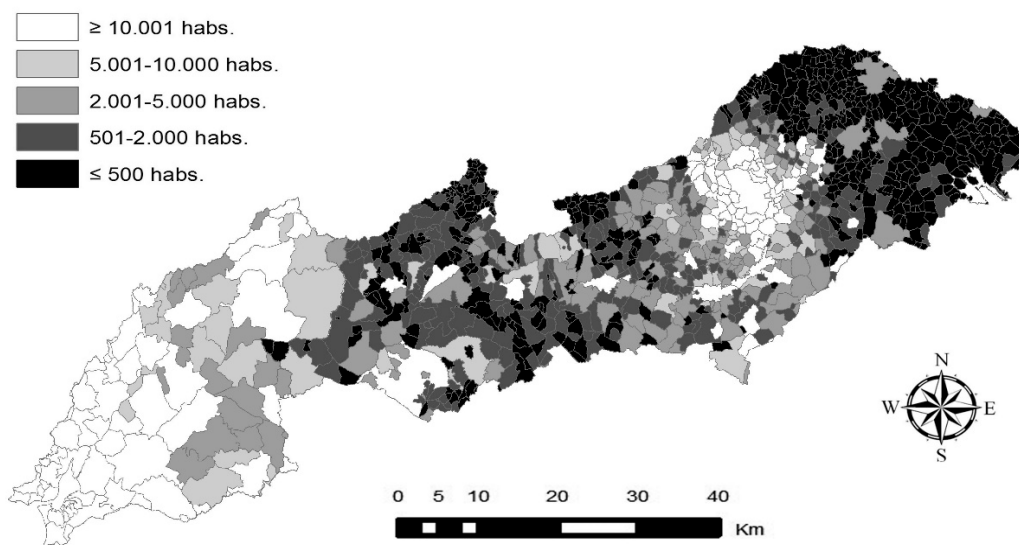Source: Compiled by author from INE-ES-PT data. 2001-2011.

Figure caption:

Fig. 1: The international basin of the River Tajo location map.
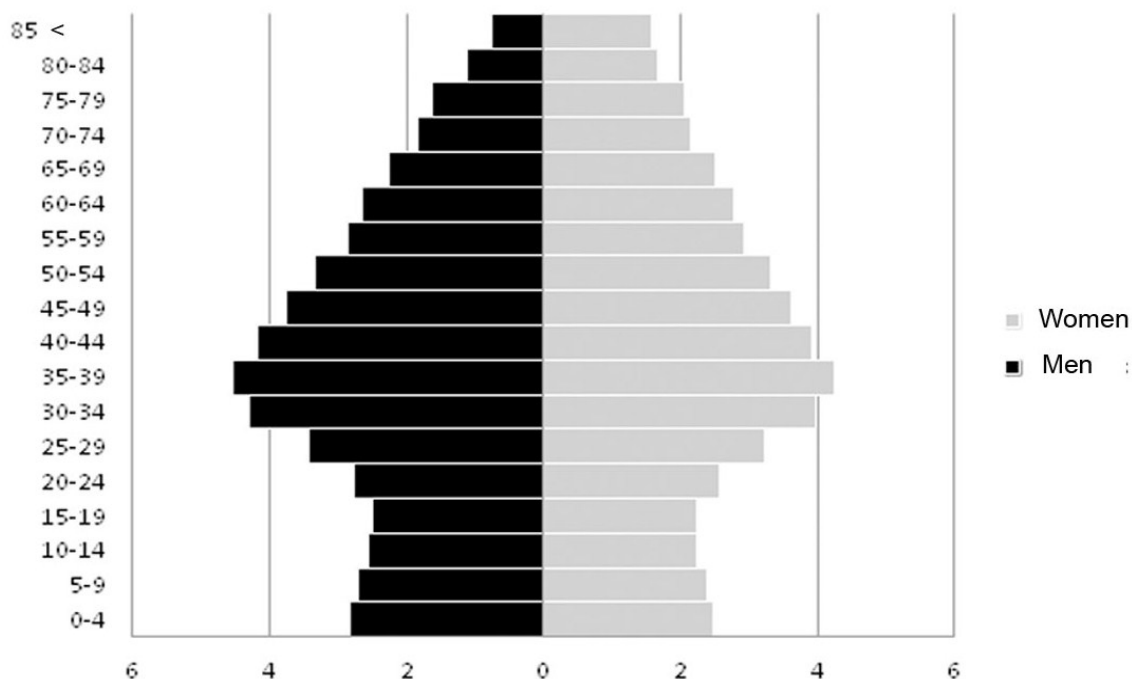

Source: Compiled by author from NCGI (National Centre for Geographic Information) data.

Fig. 2: Map representing the spatial distribution of municipalities by number of inhabitants.

Source: Compiled by author from INE-ES-PT data, 2001-2011 and NCGI (National Centre for Geographical Information) data.

Fig. 3: Population pyramid of the international basin of the River Tajo (2011)

Source: Compiled by author from INE-ES-PT data, 2001-2011.