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A life-stage approach for decomposing spatiotemporal population changes along an urban-rural gradient: implications for regional planning

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Abstract. The study of population changes across space and time of cohorts at different life stages is relevant for regional planning, but it is often not taken into account. We focus on a case study along the urban-rural gradient of continental Spain from 2002 to 2017 at a municipal scale. Making use of longitudinal data from the municipal registers, we studied changes in total population and three birth cohorts: the cohort joining the workforce, the cohort at a mature working age, and the cohort reaching retirement during the study period. The results showed key spatiotemporal population variations. The absolute population increased in 36 percent of the municipalities, but at least one of the study cohorts showed an increase in 75 percent of the municipalities. While the cohort joining the workforce tended to concentrate in urban and suburban areas, the retirement cohort tended to move to small suburban and rural municipalities. In the next decades, the retirement of large birth cohorts in Spain will be a relevant issue for planning. This methodological approach allows us to understand life-cycle residential movements across urban, suburban, and rural areas, and better enables spatial planning decisions. The method can be applied to other study areas at different spatial and temporal scales.
Keywords: *population, birth cohort, life course, life stage, urban, suburban, rural, regional planning, spatial planning, Spain.*

Introduction

The change in population volumes across space and time is a relevant variable in relation to spatial planning for housing, services, and transportation (Singleton and Spielman 2014; Lee and others 2016; Barcus and Halfacree 2017). In the last decades, numerous areas in Western countries have shown a population decrease caused by negative natural population balance (more deaths than births) and a negative total net migration rate (taking into account both internal and international migrations) due to migrations of individuals to other areas in search of work opportunities after a decline in the labor market (Martinez-Fernandez and others 2016; Salvati 2019; Sobotka and Fürnkranz-Prskawetz 2020). At the same time, other areas have seen their population increase significantly. Thus, demographic trends vary between different areas with opposite population trajectories (Martinez-Fernandez and others 2016; Batunova and Gunko 2018; Gros-Balthazard and Talandier 2020).

The change in total population is the most common indicator used to assess population changes in a territory at different spatial scales (Martinez-Fernandez and others 2016; United Nations 2019). The change in total population in an area within a specific period depends on the sum between the natural balance (births minus deaths) and the net migration rate throughout the study period (Dax and Fischer 2018; Salvati 2019; Segers and others 2020). In the current context of globalization of the workforce, in aging societies with low fertility rates of Western countries, the net migration rate could be a significant factor when compared to the natural balance rate in total population dynamics (United Nations 2019). Total net migration rates across space and time will depend not only on internal migration flows, but also on international migration flows (Martinez-Fernandez and others 2016; Salvati 2019; Sobotka and Fürnkranz-Prskawetz 2020) and on those policies regulating them (Ueffing and others 2015). Nevertheless, the study of total population changes in different locations does not take into account certain spatiotemporal demographic changes useful for regional planning, such as specific typologies for housing and priority services for different birth cohorts with distinct size (Andrews and others 2009; Gibler and others 2009; Lee and others 2016; Barcus and Halfacree 2017).

In order to more precisely understand population changes in the territory and identify how these changes influence spatial planning, it is useful to decompose the changes in population according to different generations or birth cohorts. Each generation reacts differently to economic, labor, and social changes across time, as well as to different life events throughout life-course stages. This translates into different spatial distribution patterns of the cohorts across space and time (Plane and others 2005; Howley 2009; Bernard and others 2014; Coulter and others 2020; Tang and Feng 2015; McKee and others 2017; Sabater and others 2017; Damhuis and others 2019). The spatiotemporal evolution of a birth cohort within a given space and time depends on the sum between the number of deaths and the net migration rate specific to said cohort throughout the study period. Official data sources, such as the annual municipal registers and local area population censuses, provide reliable longitudinal data in order to analyze in detail spatiotemporal population changes by birth cohorts (Sabater and others 2017; Kooiman and others 2018).

Spain represents an interesting case study for the detailed analysis of recent changes in spatial distribution of different cohorts and the subsequent effect on spatial planning. In the whole of Spain, the net migration rate between 2002 and 2017 was of 4.5 million people, which includes labor migrations and retirement migrations, while the natural balance reached only 1 million (INE 2018). In Spain, similar to other Western countries, cohorts who have recently joined the labor force face, to a greater extent than the previous generation, economic uncertainty and diminished access to housing (McKee and others 2017; Coulter and others 2020; Cuervo and Cook 2020). For this reason, it is necessary to make the distinction between the cohort who has only recently joined the labor force and the cohort of a more mature working age in recent years. In addition, an analysis of the spatial changes in the cohort who has reached retirement age is necessary, given that previous studies in other countries indicate that this cohort tends to move to less populated areas during that phase of their life (Lee and others 2016; Sabater and others 2017).

In recent decades, countries in the south of Europe have experienced a transition from traditionally compact urban areas to polycentric and less dense suburban and urban areas (Salvati 2014; Rubiera-Morollón and others 2016). The Spanish urban-rural gradient has displayed very different demographic and socioeconomic characteristics with many rural areas experiencing an important loss in economic activity, population, and services. The population has concentrated in certain urban, suburban, and coastal areas with a more dynamic economy, while many inland rural areas and some old industrial and mining cities have suffered a demographic decline (Buciega and others 2009; Collantes and others 2014; Serra and others 2014; Molinero 2019).

The rural-urban gradient case study in continental Spain serves as the basis for this research, with the goal to identify changes in the population at a municipal scale particularly in relation to the spatial behavior of different birth cohorts across time and to detect the implications these changes have for spatial planning. The aim is to obtain an accurate view of the changes of the overall population and the population by birth cohorts at different life stages throughout a study period, in terms of number of inhabitants and number of municipalities with different typologies of change. The evolution of the following population groups is examined at a municipal level: absolute population, which is a common data point for the analysis of population evolution; the birth cohort of individuals who have only recently reached the age to join the work force during the study period (also called young, working-age cohort); the birth cohort of individuals who have remained at a mature working age during the study period (also called mature working-age cohort); and the cohort of individuals who have reached retirement age during the study period (also called retirement cohort).

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Methods

Data

Demographic data was obtained from the Spanish Continuous Municipal Register of the Spanish Statistical Office (INE), which indicates each municipality's official population by age on January 1st of each year. The INE is an official and reliable source, however the data is not always precise because in some cases migrants take time to register in their new place of residence and inform their previous local registry. The three birth cohorts for the study were obtained by combining the year of the registry and the age of the registered inhabitants.

Study area and urban-rural gradient

The area of this case study comprises continental Spain (Iberian Peninsula, Southwest Europe), yielding 47 provinces (Figure 1). In the study area, we worked with complete longitudinal population data for 7,914 of the municipalities, with a total population of 43.12 million inhabitants in 2017 (INE 2018).

Municipalities were ranked by demographic size and distance to urban centers to classify them along an urban-rural gradient. The population-size-based classification of municipalities varies from one country to another and may even vary from one official body to another within the same country. In the case of this study, the criterion used was based on the same one established by Spanish law 45/2007 for the sustainable development of the rural environment, which categorizes municipalities with more than 30,000 inhabitants as urban and with less than 30,000 inhabitants as nonurban. This law seeks to establish measures to improve the socioeconomic situation of the nonurban population and improve access to quality services. Four types of municipalities were isolated as a function of their absolute population size in 2017: urban (more than 30,000 inhabitants), large (10,000-30,000 inhabitants), medium-sized (2,000-10,000), and small (less than 2,000) (Figure 1). Municipalities thus categorized according to population size were then further classified in terms of their distance from urban municipalities (Salvati, 2014). Two categories of nonurban municipalities were used, calculated by GIS from the urban municipalities: suburban (less than 20 km) and rural (more than 20 km). By combining demographic size with distance from urban municipalities we obtained an urban-rural spatial gradient consisting of seven municipality classes.

Period of study

The period of study selected, 2002-2017, comprises 15 years during which important demographic changes took place in the study area. Between 2002 and 2017, the absolute population registered in continental Spain increased by 10.8 percent or the equivalent to 4.2 million inhabitants (INE 2018). The natural balance of the population (difference between the number of births and deaths) was positive between 2002 and 2014 and negative from 2015 (INE 2018).

Study birth cohorts and population change typologies

The percentage of change in the population in each municipality during the study period was calculated based on the following population groups: absolute population; the birth cohort of individuals born between 1973 and 1992, who reached employment age during the study period and gained access to their first occupations in the labor market (aged between 25 and 44 in 2017)-this range was selected for this concrete case study of Spain (on average, young people take longer to enter the labor market and do so with less stability in Spain than in other developed countries) (Wölfl 2013)-; the birth cohort of individuals born between 1953 and 1972, comprising individuals that have remained at a mature working age during the study period (aged between 45 and 64 in 2017); and the birth cohort of individuals born between 1943 and 1952, who reached retirement age during the study period (aged between 65 and 74 in 2017).

The number of inhabitants and their percent variation during the study period of the four population groups were calculated in each of the seven municipality classes within the urban-rural spatial gradient. Also, the number and percentage of municipalities which experienced an increase or decrease in their absolute population was analyzed, resulting in two population change typologies. In addition, the analysis included the number and percentage of municipalities of each class of the urban-rural gradient in which the population of the study birth cohorts increased or decreased during the study period, resulting in another eight population change typologies.

Results and discussion

The young, working-age cohort born in 1973-1992 and the mature working-age cohort born in 1953-1972 are similar in overall size and contain the largest birth cohorts in the study area population pyramid (Table 1 and Figure 2). The cohort born in 1973-1992 grew in size by 14.8 percent in 2002-2017 due to a notably positive migratory balance. The variation of the cohort born in 1953-1972 was

2.1 percent and of the cohort born in 1943-1952 was -5.3 percent in the study period (Table 1). The cohort born in 1973-1992 tended to move to suburban and urban areas. The cohort born in 1943-1952 tended to move to medium-sized and small suburban and small rural municipalities (Table 1 and Figure 3).

Between 2002 and 2017, 36.2 percent of the municipalities saw an increase in their absolute population. The percentage of municipalities in each class of the urban-rural gradient with a demographic increase was higher in large demographic classes with a shorter distance to urban centers. In 75 percent of the municipalities the increase was noted in at least one of the study birth cohorts (Table 2 and Figure 4).

The rural small-sized class in the urban-rural gradient shows the lowest percentage of municipalities with an increase in absolute population of a mere 14.7 percent. The large and medium-sized rural classes in the urban-rural gradient revealed the lowest percentage of municipalities in at least one of the study cohorts, at 63.2 percent and 64.3 percent, respectively. In the rural small-sized class, 71.2 percent of the municipalities displayed an increase in one of the study birth cohorts (Table 2, Figure 4).

The variance in spatial distribution of the absolute population reveals a demographic increase in the suburban areas of the main cities as well as the Spanish metropolitan areas and the Mediterranean coastal area, while large inland areas in the Iberian Peninsula lost population (Figure 5). The municipalities where the study's three birth cohorts increased are also located in urban, suburban, and coastal areas (Table 2 and Figure 6), however they are less numerous than those that had an increase in their absolute population (Table 2 and Figure 5). Certain areas with higher volumes of work opportunities show an increase in working-age cohorts and at the same time a decrease in the retirement cohort, for example areas of Madrid and Gipuzkoa.

The municipalities where the study's three birth cohorts decreased are located in areas where the working-age population decreased following a decline in agriculture (the areas of Ourense, Leon, Badajoz, Cordoba, Jaen, Ciudad Real, Albacete, Cuenca, and Toledo) or the mining sector (Asturias, Leon) and where inhabitants of the retirement cohort did not increase (Figure 6). The areas that revealed a decrease in the study's three birth cohorts are less numerous than those areas with a decrease in their absolute population (Table 2). Demographic dynamics in the latter areas trend towards an aging population, resulting in a clear negative natural balance, without being compensated by a positive net migration rate.

Among urban municipalities, 23.2 percent presented a decrease in the three study cohorts (Table 2 and Figure 4). In many cases this decrease was accompanied by an increase in the population of the cohorts in nearby suburban municipalities. However, in some old industrial cities in Alicante, Jaen, and A Coruña provinces, and old mining cities in Asturias, the cohorts decreased both in the urban municipality and in the suburban periphery (Figure 6). In these cities, the demographic and labor declines were remarkable and suburbanization growth did not occur. The detection of the different dynamics between core urban municipalities and suburban municipalities reveals more detailed data than the one obtained in previous studies that were based on wider functional urban areas (Gurrutxaga 2020).

The 1973-1992 birth cohort grew in urban and suburban areas as well as in rural municipalities located to the east of the Iberian Peninsula and was given a boost by the influx of foreign working immigrants during the study period (Collantes and others 2014) (Figure 7). This young, working-age cohort increases particularly in municipalities classified as urban and in classes of the urban-rural gradient characterized by having larger populations (Table 2 and Figure 4).

The 1953-1972 birth cohort exhibits two complementary trends. First, this mature working-age cohort, together with the young, working-age cohort, increases its population in urban municipalities as well as in rural municipalities of the urban-rural gradient that are closest to urban centers and have the largest populations. Second, this birth cohort, whether examined by itself or together with the 1943-1952 birth cohort, increases in higher percentages in municipalities of smaller classes and that are located further from urban centers (Table 2, Figure 4, and Figure 8).

The 1943-1952 birth cohort grew in the Mediterranean coastal areas and in the urban-rural gradient classes with lower populations located further away from urban centers (Table 2, Figure 4 and Figure 9). The spatial distribution of the cohort is influenced by the migration of foreigners at retirement age (Gibler and others 2009) and by return migration to the place of origin (Rodríguez and others 2002). In addition to the Mediterranean coastal area, this retirement-age cohort also settled inland in shrinking rural areas of provinces such as Lugo, Ourense, Leon, Zamora, Salamanca, Caceres, Badajoz, Ciudad Real, and Granada.

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The data obtained revealed varying residential mobility trends during different life-cycle stages depending on the birth cohort. The young, working-age cohort tends to live in urban and suburban municipalities and the tendency of the mature-age-working cohort, and in particular the retirement cohort, is to move to lesser populated areas. These trends coincide with research data presented by authors from other countries (Nefs and others 2013; Lee and others 2016, 2019; Sabater and others 2017; Moos and others 2019; Bereitschaft 2020). Numerous areas showing a decline in absolute population, often located far from urban municipalities, are attractive to the mature-age-working cohort and especially to the retirement cohort.

The general, population trends detected at the national level for the cohorts in the urban-rural gradient (Figure 3) differ in some regions and must be analyzed at regional scale to be taken into account in regional and urban planning. For instance, in the provinces of Lleida and Huesca there are numerous rural municipalities where the young, working-age cohort increases (Figure 7), due to the economic development of rural areas and job creation in recent decades (Bayona-i-Carrasco and Gil-Alonso 2012). Along the Mediterranean coast there are a number of urban municipalities in the provinces of Girona, Tarragona, Alicante, Murcia, Almería, and Malaga where the retirement cohort increases (Figure 9), due to lifestyle and retirement internal and international migrations (Parreño-Castellano and Domínguez-Mujica 2017). The presence of rural municipalities where the retirement cohort and the mature working cohort increases and the young, working cohort decreases is especially notable in provinces in the western part of the study area, such as León, Ourense, Zamora, Salamanca, Cáceres, and Badajoz, due to return migrations after working life together with the youth population moving to other regions with better job opportunities (Aldrey-Vázquez 2006; Maya-Frades and others 2011; Pérez-Díaz and Leco-Berrocal 2013; Aldrey-Vázquez and Del-Río-Franqueira 2014; González-Leonardo and López-Gay 2019). The presence of rural municipalities where the three study cohorts decrease is especially dominant in western and southern Asturias, eastern Lugo, and districts of Córdoba and Jaén (Figure 6), given that there are few local job opportunities and the provincial population is concentrated in other areas (Ocaña-Ocaña and Larrubia-Vargas 2012; Aldrey-Vázquez and Del-Río-Franqueira 2014; López-Fernández 2016).One limitation of the study that is important to note relates to the spatial distribution of the (small) cohort born after 1992, because it begins to join the labor force during the study period. In relation to the cohort born before 1943, comprised by older elderly persons, it would be relevant to understand whether their residential preferences differ from those noted in this article for the retirement-age cohort, composed by younger elderly persons, which is what other studies suggest (Gibler and others 2009; Andersson and others 2019). Similarly, it would be appropriate to increase the level of detail studied in urban municipalities and metropolitan areas by using an intramunicipal study scale (Sabater and others 2017; Moos and others 2019). In addition, the method can be applied by delimiting smaller birth cohorts (Lee and others 2019), population segments with concrete characteristics (Kooiman and others 2018; Altaher and others 2019; Gil-Alonso and Thiers-Quintana 2019), and shorter periods with specific socioeconomic dynamics (Bayona-i-Carrasco and others 2018; Gil-Alonso and Thiers-Quintana 2019; Salvati 2019; Salvati and others 2019; Gurrutxaga 2020).

Further research is needed to continue analyzing the spatial distribution dynamics of the population cohorts across time within the framework of Western countries that have rapidly aging populations. The demographic forecast of the United Nations (2019) predicts a 6.6 percent decrease of the absolute population in Spain between 2019 and 2050. Overall in Europe, the population could decrease by 5.2 percent in the same time period (United Nations 2019). If these projections are met, many municipalities will lose population overall. The future dynamics of each cohort in each municipality will depend to a large extent on the net migration rate of each cohort, which varies according to national and international migrant movements.

The residential mobility of each cohort in urban, suburban, and rural areas across countries and regions will depend not only on place attachment (Barcus and Brunn 2010; Husa and Morse 2020) and on the lifestyle preferences during their life cycle (Lee and others 2019; Moos and others 2019), but also on the varying socioeconomic constraints at different levels, such as employment opportunities (Rodríguez-Pose and Ketterer 2012; Kooiman and others 2018; Gil-Alonso and Thiers-Quintana 2019), geography of housing affordability, and cost of living and level of residential segregation between socioeconomic groups (Baker and others 2016; Moos and others 2018; Damhuis and others 2019; Tammaru and others 2020), local availability of specific housing characteristics for each life stage and household structure type (Rosenberg and Everitt 2001; Gibler and others 2009; and othersBijker and others 2012; Andersson and others 2019; Cividino and others 2020; Hartt and Hackworth 2020), telecommunications coverage and the possibility to develop home-based businesses (Salemink and others 2017; Kane and Clark 2019; Philip and Williams 2019), local and service amenities (Gosnell and Abrams 2011; Bijker and others 2012; Lee and others 2016; Elshof and others 2017), and rural accessibility to services (Camarero and Oliva 2019).

Knowing the recent residential choices of the different cohorts at diverse life-course stages provides insights into potentially emerging spatial trends in residence that could aid in long-term regional planning. Based on the life-course approach, we would expect that different cohorts, made up of different generations, might behave differently in each life stage based on their collective life experiences. Each generation could respond in different ways to structural (socioeconomic, technological, environmental) changes taking place in society in each territory (Findlay and others 2015). Variations in conditions in different locations, together with the preferences and real possibilities of residential choice at each moment, will influence spatial residential behavior of each cohort at each life stage. A key question is whether the recent trends observed in each cohort and life stage is something that we might expect for the future behavior.

The increase in the number of single-person households, which increasingly affects individuals at different life stages (Ortiz-Ospina 2019), could increase the preference for urban areas with high accessibility to services and urban amenities, taking into account the preferences shown until now by those who live alone (Cividino and others 2020). However, on the other hand, teleworking and purchases through electronic commerce have been increasing in recent years, and have accelerated notably since 2020 due to the social-distancing measures imposed by the covid-19 pandemic (Florida and others 2020). Teleworking could make rural areas more attractive to future working-age cohorts than in previous generations. In Spain, although the percentage of the employed who telework amounted to 8.3 percent in 2019, it is estimated that about 30 percent of the employed could telework (Ahghel and others 2020). Furthermore, proactive policies to attract international teleworkers have not yet been developed in Spain. If these types of policies are activated, there is a great potential for attracting teleworkers along the Spanish urban-rural gradient, taking advantage of the climatic conditions and affordable costs of living

Conclusions

The municipalities analyzed across the urban-rural gradient in continental Spain during the study period 2002-2017 follow patterns that are representative of population changes in cohorts and life stages, independently of the evolution of the absolute population. Thus, the population changes in urban, suburban, and rural municipalities are related to the residential movements of different cohorts of distinct size and at various life-cycle stages. While the young, working-age cohort tended to move to growing urban and suburban areas in Spain, the retirement cohort tended to move to medium-sized/small suburban and small rural municipalities during the study period. Numerous areas with absolute population decline, often located far from urban centers, are attractive to the retirement cohort. This has implications for adequate spatial planning in housing, transportation, and services for the elderly in rural areas, including accessibility to health facilities, nursing homes, day-care centers, and home care (Rosenberg and Everitt 2001; Andrews and others 2009; Camarero and Oliva 2019).

The general trends detected on a national scale differ in some regions and it is necessary to analyze them on a regional scale to integrate them into spatial planning. The spatiotemporal evolution of the birth cohorts is relevant both in terms of percent and absolute variation of inhabitants at the local and regional scale, given that the residential movements of the largest cohorts have a greater effect on the spatial changes in the demand for housing, transportation, and services (López-Gay and others 2013; Lee and others 2016). In this sense, the coming retirement of large cohorts in Spain must be considered as a relevant issue in regional planning. Demographic projections of the United Nations indicate a growth in the percentage of the population living in urban areas both in Spain and Europe between 2017 and 2050 (United Nations 2018). However, the largest cohorts in Spain in 2017 are from 35 to 49 years old (Figure 2) and will therefore reach retirement age in the next decades, specifically between 2033-2047. Moreover, Spain is one of the preferred residential destinations for retired people from other Western countries (Pickering and others 2019). Given the results of this study, the residential decisions of the retirement cohorts of the next decades could notably increase the elderly population volume of certain small municipalities located in suburban and rural areas of Spain.

It cannot be ruled out that in the future there will be an increase of residential movements from urban municipalities to less densely populated places by working-age cohorts in Spain. In previous studies in other countries, one of the main limitations of urban living as perceived by the inhabitants of compact cities is lack of space and overcrowding (Howley 2009). Future research should take into consideration whether the COVID-19 pandemic caused by SARS-CoV-2 coronavirus, which has driven social-distancing measures, will have an impact on the percentage of the population at different life stages that prefers less populated areas with better access to unbuilt open spaces for outdoor activities. In the context of climate change, while the threat of future pandemics exists, urban policies will need to consider creating multifunctional urban and peri-urban green spaces networks to improve habitability, enhance urban resilience, and reduce the urban heat-island effect (Samuelsson and others 2020).

Establishing a residence in less densely built areas matches the housing trends displayed by the population close to retirement age, but not with the trend of the young, working-age cohort to concentrate around urban centers. In theory, communication media and technologies will facilitate the possibility to live in areas further away from work without having to commute frequently; however, until now work and career advancement opportunities have been concentrated in concrete urban and suburban areas, and it is there where most of the young, working-age cohort establish their residence. Further research will be necessary to establish whether future generations will continue the trend of living in these urban areas with a more dynamic labor market (Sabater and others 2017; Kooiman and others 2018; Kashnitsky and others 2020) and more varied urban amenities (Lee and others 2019) or whether this trend will lessen during the next decades thanks to a more geographically balanced labor market (Iammarino and others 2019) and a more balanced economic development between and within regions (Rauhut and Humer 2020). Studies that integrate the multivariate analysis of those causal factors of demographic variations in space and time (Kabisch and Haase 2011; Salvati and others 2019) will be necessary to detect those concrete variables that most influence the specific spatial trends of each cohort at each life stage.

The results of the spatiotemporal evolution of the cohorts must be checked against the infrastructures available in the territory so that existing gaps may be addressed. The spatial planning of housing, services, and transportation for the population should be integrated into comprehensive regional planning along the urban-rural gradient of Spain together with suitable criteria on natural risks, water availability, cultural landscapes, and nature conservation (Barbero-Sierra and others 2013; Olcina and others 2016; Morote and others 2017; Valladares and others 2017).

The methodological approach described in this article can be used by researchers, planners, and policy makers for the anticipation of the demand for specific typologies of housing, services, green open spaces, and infrastructure (Andrews and others 2009; Lee and others 2016; Andersson and others 2019; Damhuis and others 2019; Philip and Williams 2019; Segers and others 2010). This approach is also helpful for the design of employment, governance, taxation, welfare, environmental, and heritage policies both in urban (Nefs and others 2013; Martinez-Fernandez and others 2016; Van Hoof and others 2018; Gros-Balthazard and Talandier 2020; Hartt and Hackworth 2020) and rural areas (Haartsen and Venhorst 2010; Dax and Fischer 2018).

It is therefore relevant to integrate the population dynamics of different birth cohorts with distinct size and at different life stages within the framework of comprehensive regional planning. The methodological approach used in this article enriches the vision of spatiotemporal population changes across urban, suburban, and rural areas. This method can be applied to other study areas at different spatial and temporal scales.

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Table 1. Number of inhabitants of the total population and the study birth cohorts in each class of municipalities along the urban-rural gradient in 2017, further indicating population change (percent) from 2002 to 2017.

Population group	**Population in 2017 (percent population change in 2002-2017)**							
	Classes of municipalities along the urban-rural gradient							**Total**
	Urban	**Suburban**			**Rural**			
		Large	**Medium**	**Small**	**Large**	**Medium**	**Small**	
Total population	26,085,163 (10.0)	7,521,258 (26.4)	1,432,643 (24.4)	806,196 (14.1)	3,989,880 (5.7)	1,535,576 (-2.5)	1,749,980 (-13.8)	43,120,696 (10.8)
1973-1992 birth cohort	7,525,110 (13.4)	2,207,116 (29.8)	407,056 (33.8)	213,844 (30.2)	1,095,808 (5.3)	391,902 (-0.3)	392,108 (-6.5)	12,232,944 (14.8)
1953-1972 birth cohort	7,247,638 (-0.8)	2,081,229 (11.1)	400,874 (16.2)	236,429 (15.8)	1,120,621 (0.9)	437,168 (0.8)	521,636 (0.2)	12,045,595 (2.1)
1943-1952 birth cohort	1,343,415 (-8.8)	350,756 (1.4)	69,289 (5.9)	44,457 (8.7)	198,883 (-4.0)	84,476 (-0.7)	110,816 (2.9)	2,202,092 (-5.3)

Data from Spanish Municipal Register.

Table 2. Number and percentage of municipalities of each class of the urban-rural gradient according to whether i) their total population grew or not, and ii) the studied birth-cohorts grew or not (2002-2017).

Population change typology		**Number of municipalities (percent in each class)**							
		Classes of municipalities along the urban-rural gradient							**Total**
		Urban	**Suburban**			**Rural**			
			Large	**Medium**	**Small**	**Large**	**Medium**	**Small**	
By total population	Total population growth	195 (87.1)	534 (88.4)	333 (75.9)	688 (55.9)	240 (63.5)	211 (39.2)	663 (14.7)	2,864 (36.2)
	Total population decline	29 (12.9)	70 (11.6)	106 (24.1)	542 (44.1)	138 (36.5)	327 (60.8)	3,838 (85.3)	5,050 (63.8)
	Total number of municipalities	*224*	*604*	*439*	*1,230*	*378*	*538*	*4,501*	*7,914*
By birth cohorts in study	Growth of the three cohorts	38 (17.0)	262 (43.4)	208 (47.4)	476 (38.7)	58 (15.3)	87 (16.2)	665 (14.8)	1,794 (22.7)
	1973-1992 birth cohort growth	55 (24.6)	53 (8.8)	23 (5.2)	74 (6.0)	55 (14.6)	43 (8.0)	297 (6.6)	600 (7.6)
	1953-1972 birth cohort growth	3 (1.3)	16 (2.6)	23 (5.2)	80 (6.5)	16 (4.2)	32 (5.9)	410 (9.1)	580 (7.3)
	1973-1992 and 1953-1972 growth	74 (33.0)	184 (30.5)	93 (21.2)	241 (19.6)	88 (23.3)	69 (12.8)	466 (10.4)	1,215 (15.4)
	1973-1992 and 1943-1952 growth	2 (0.9)	2 (0.3)	2 (0.5)	40 (3.3)	3 (0.8)	4 (0.7)	194 (4.3)	247 (3.1)
	1953-1972 and 1943-1952 growth	0 (0.0)	5 (0.8)	16 (3.6)	84 (6.8)	11 (2.9)	38 (7.1)	502 (11.1)	656 (8.3)
	1943-1952 birth cohort growth	0 (0.0)	3 (0.5)	6 (1.4)	82 (6.7)	12 (3.2)	67 (12.5)	671 (14.9)	841 (10.6)
	Growth of at least one birth cohort	172 (76.8)	525 (86.9)	371 (84.5)	1,077 (87.6)	243 (64.2)	340 (63.2)	3,205 (71.2)	5,933 (75.0)
	Decline of the three birth cohorts	52 (23.2)	79 (13.1)	68 (15.5)	153 (12.4)	135 (35.7)	198 (36.8)	1,296 (28.8)	1,981 (25.0)
	Total number of municipalities	*224*	*604*	*439*	*1,230*	*378*	*538*	*4,501*	*7,914*

Data from the Spanish Municipal Register.

Figure 1. Map of the study area.

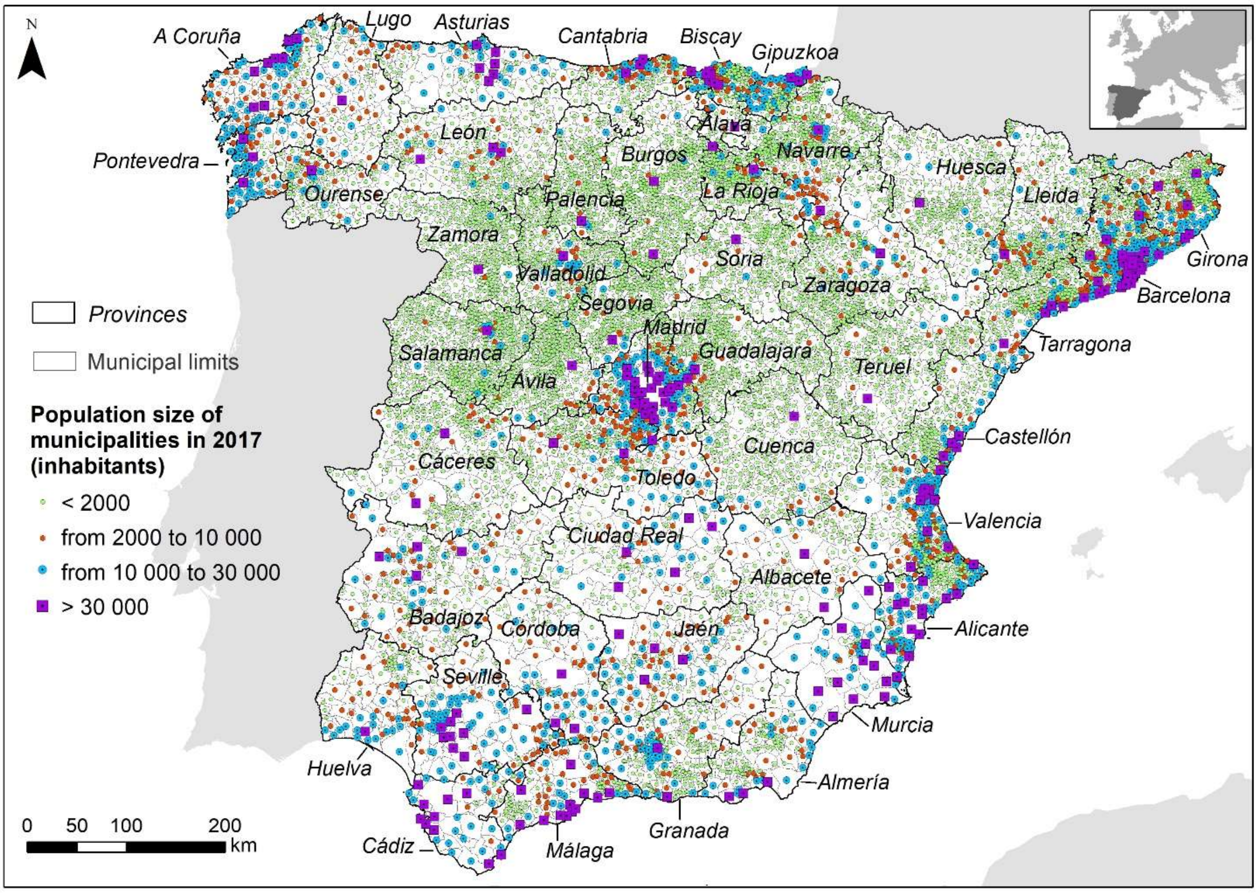


Figure 2. Population pyramid of the study area in 2017. The cohort born in 1973-1992 was 25-44, the cohort born in 1953-1972 was 45-64 and the cohort born in 1943-1952 was 65-74 years old in 2017.

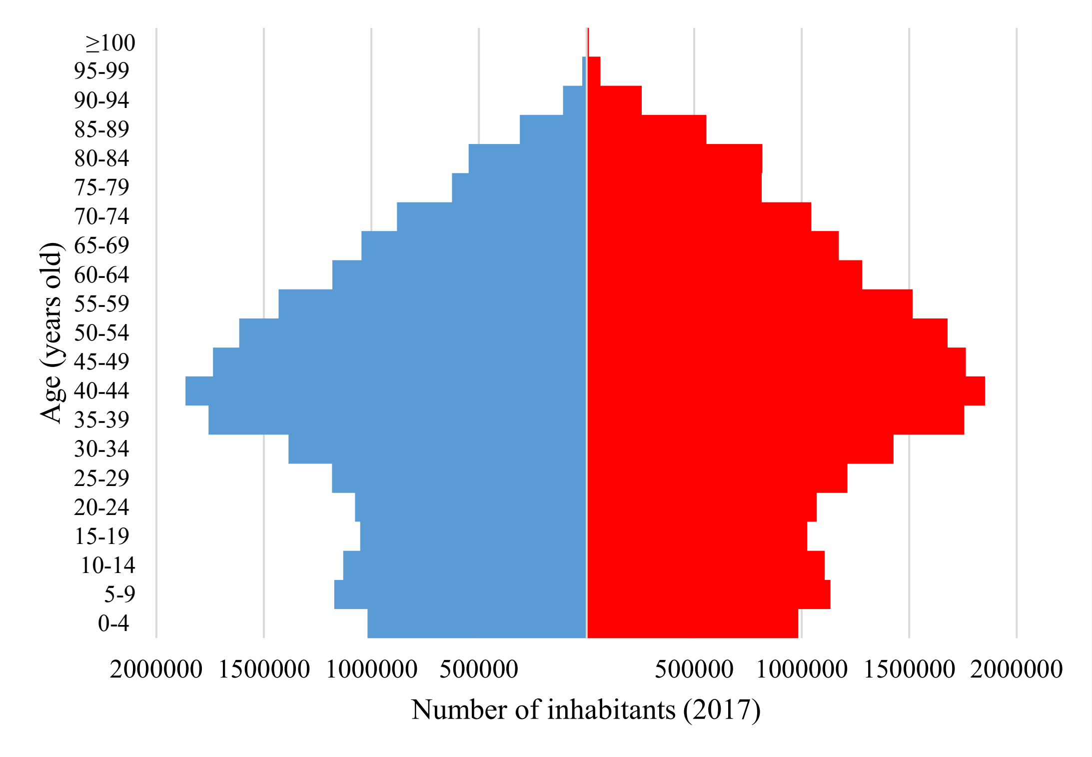


Figure 3. Percent population change of the total population and the study birth cohorts in each class of municipalities along the urban-rural gradient from 2002 to 2017.

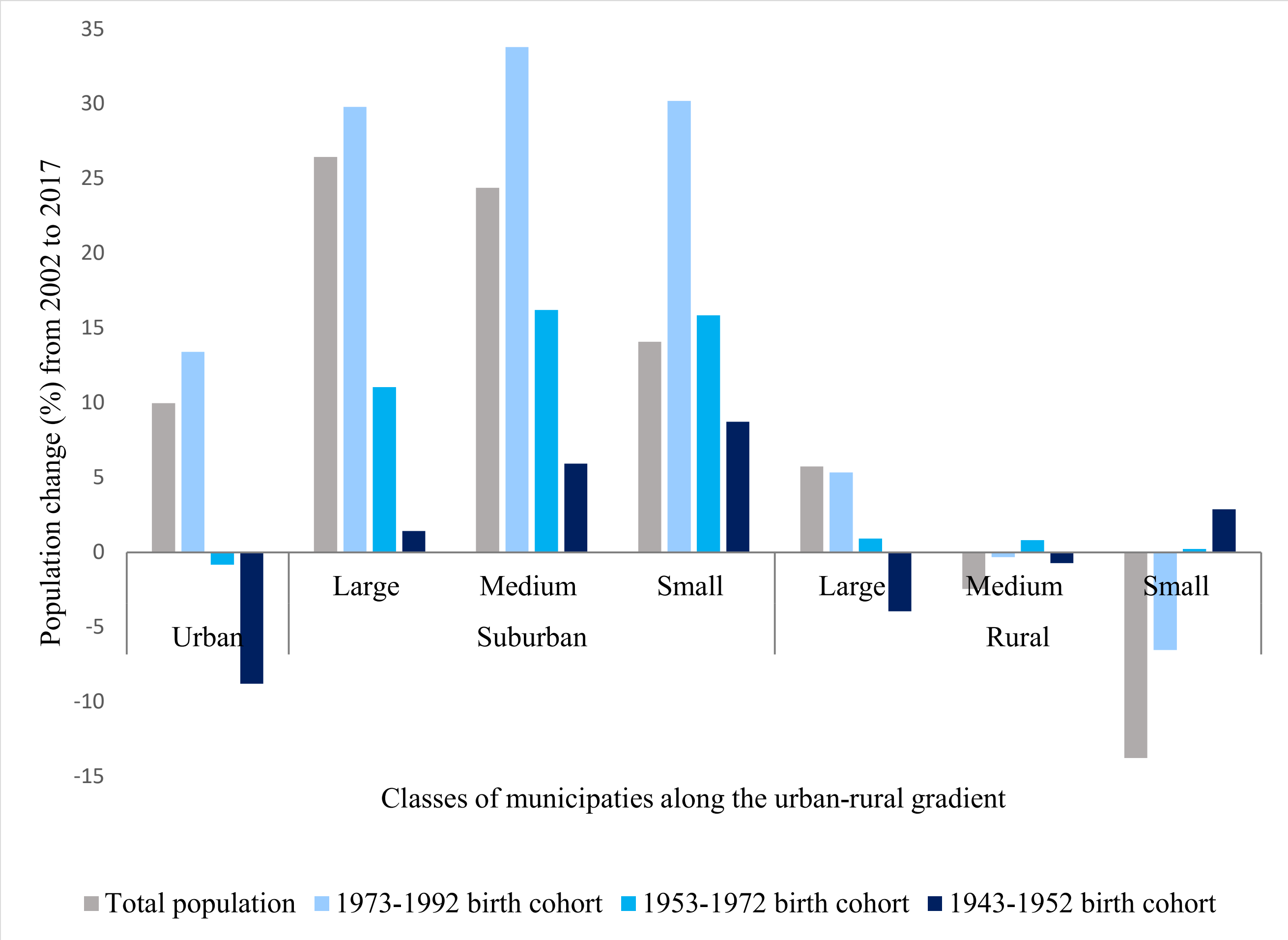
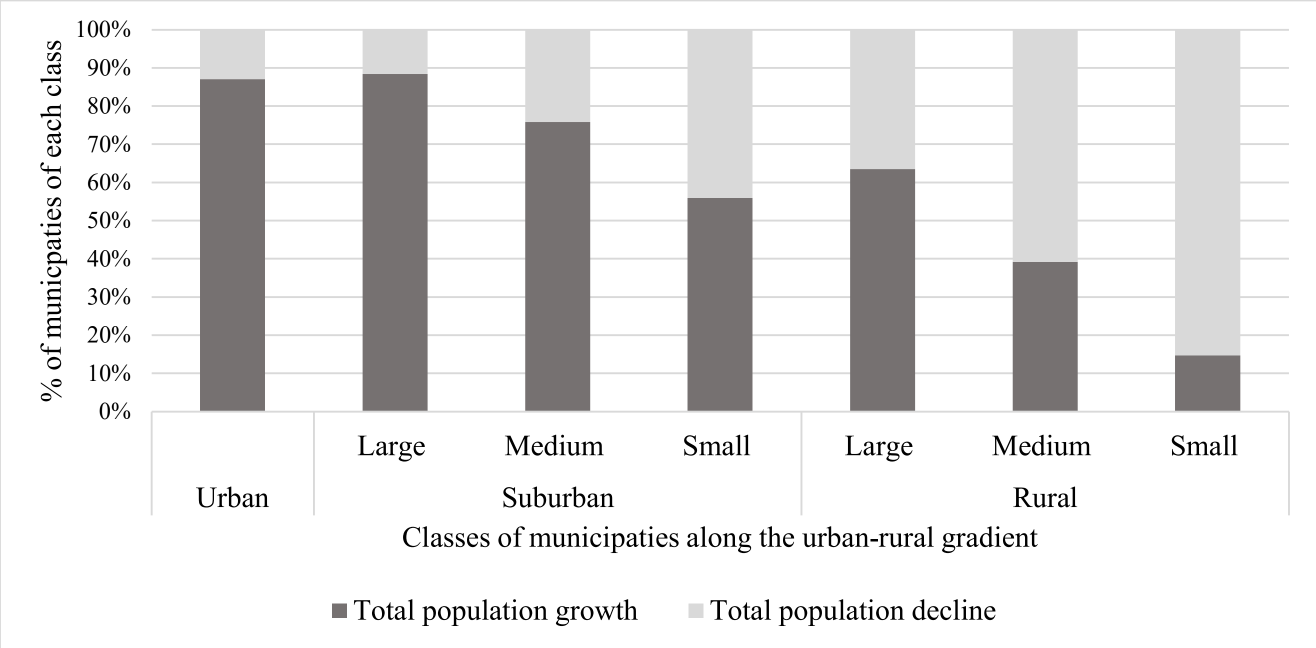


Figure 4. Percentage (%) of municipalities of each class of the urban-rural gradient according to whether i) their total population grew or not and ii) the studied birth cohorts grew or not (2002-2017).



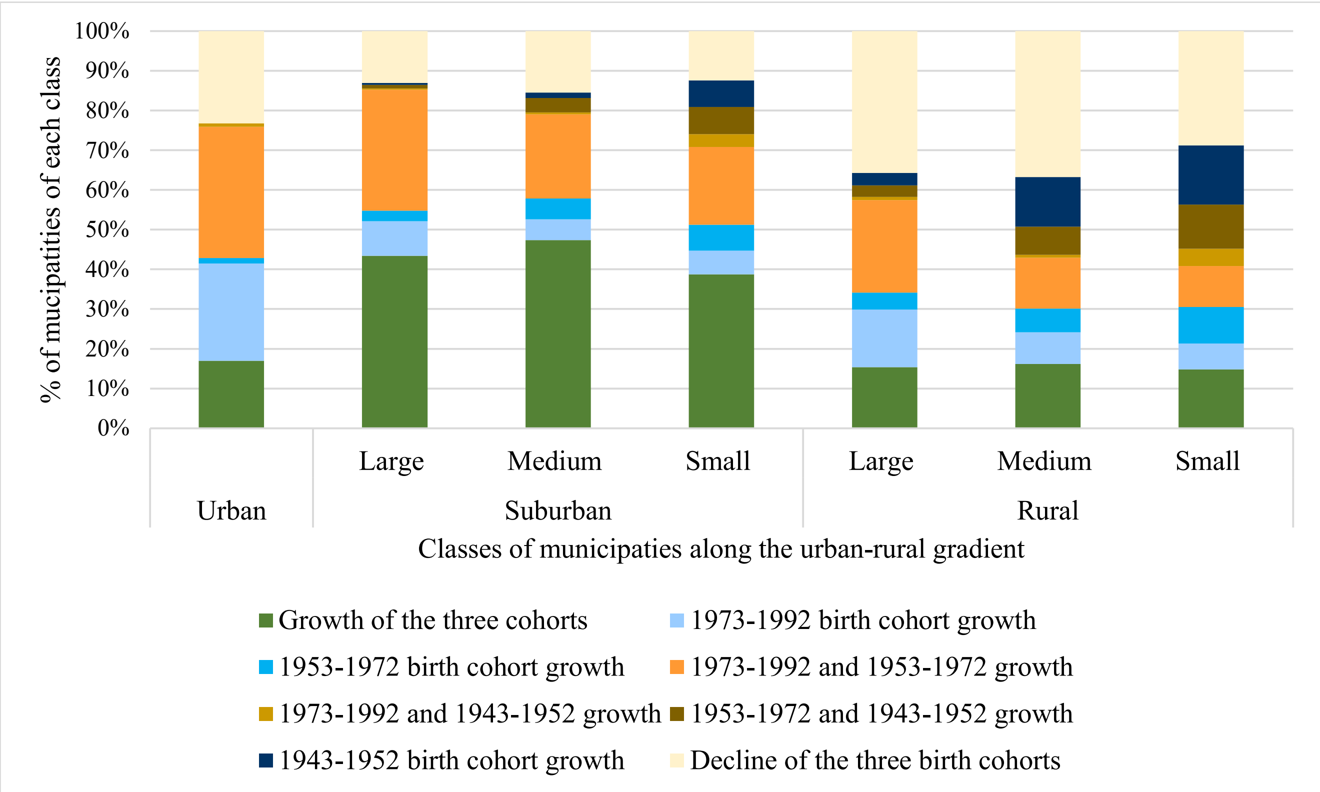


Figure 5. Map of the total population change (%) in each municipality (2002-2017).

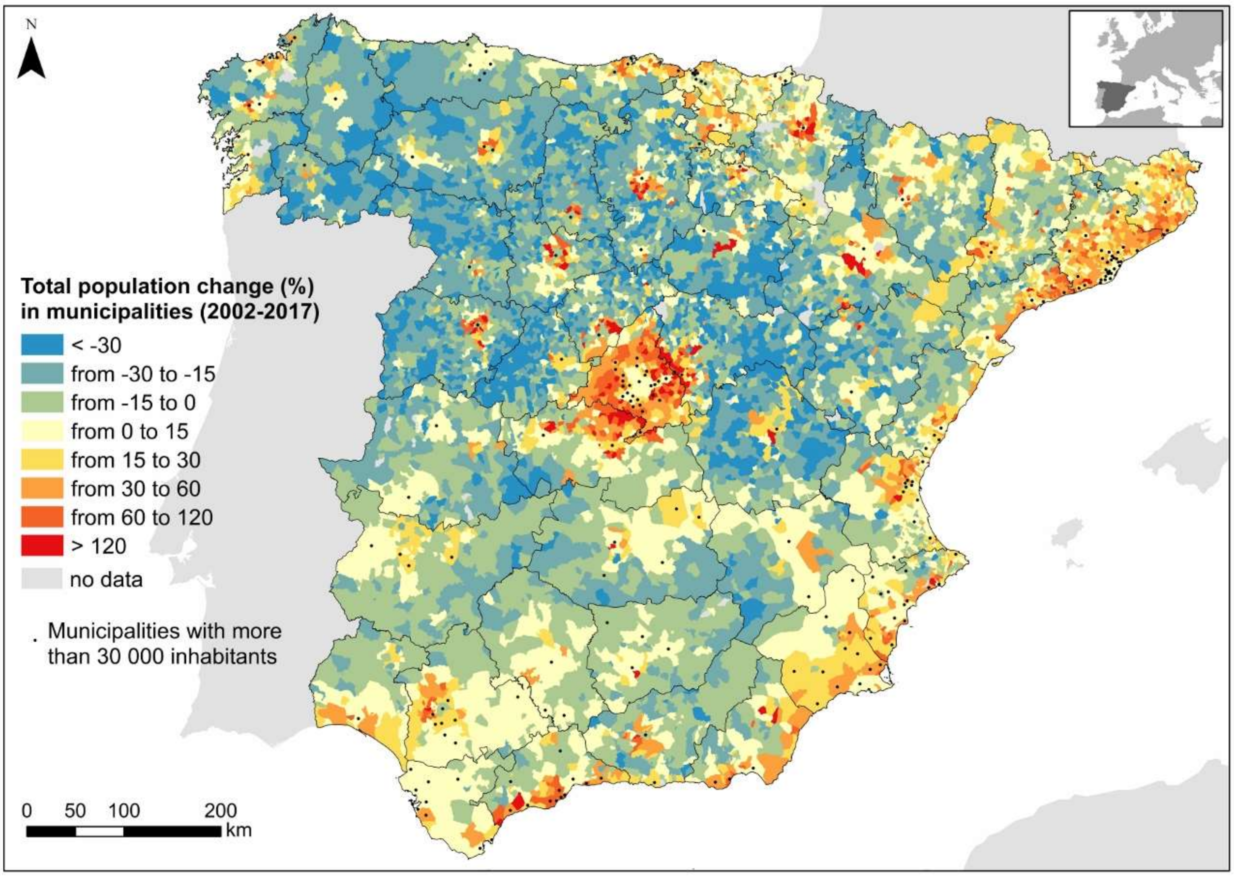


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Figure 6. Map of population change typology of each municipality according to whether the studied birth-cohorts grew or not in 2002-2017.

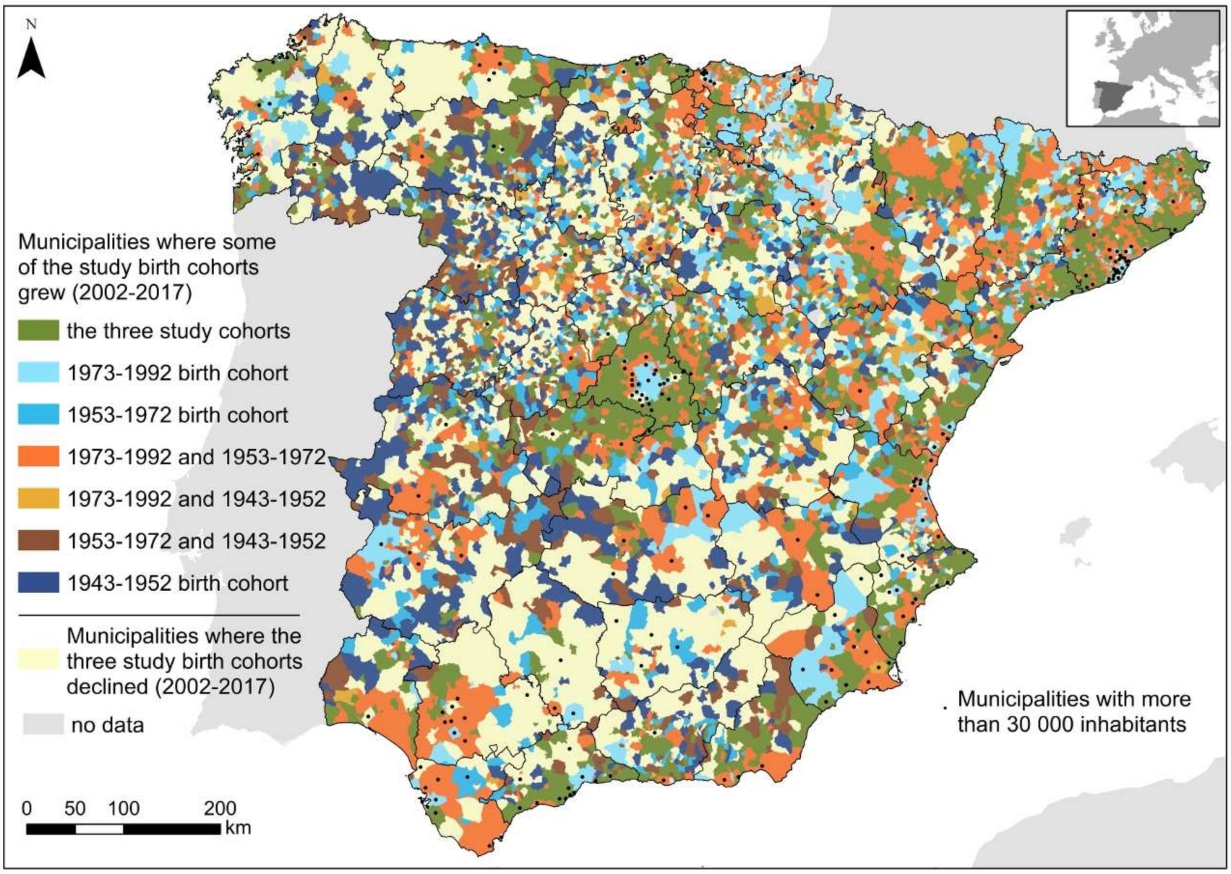

Figure 7. Map of the population change (%) of the 1973-1992 birth cohort in each municipality (2002-2017).

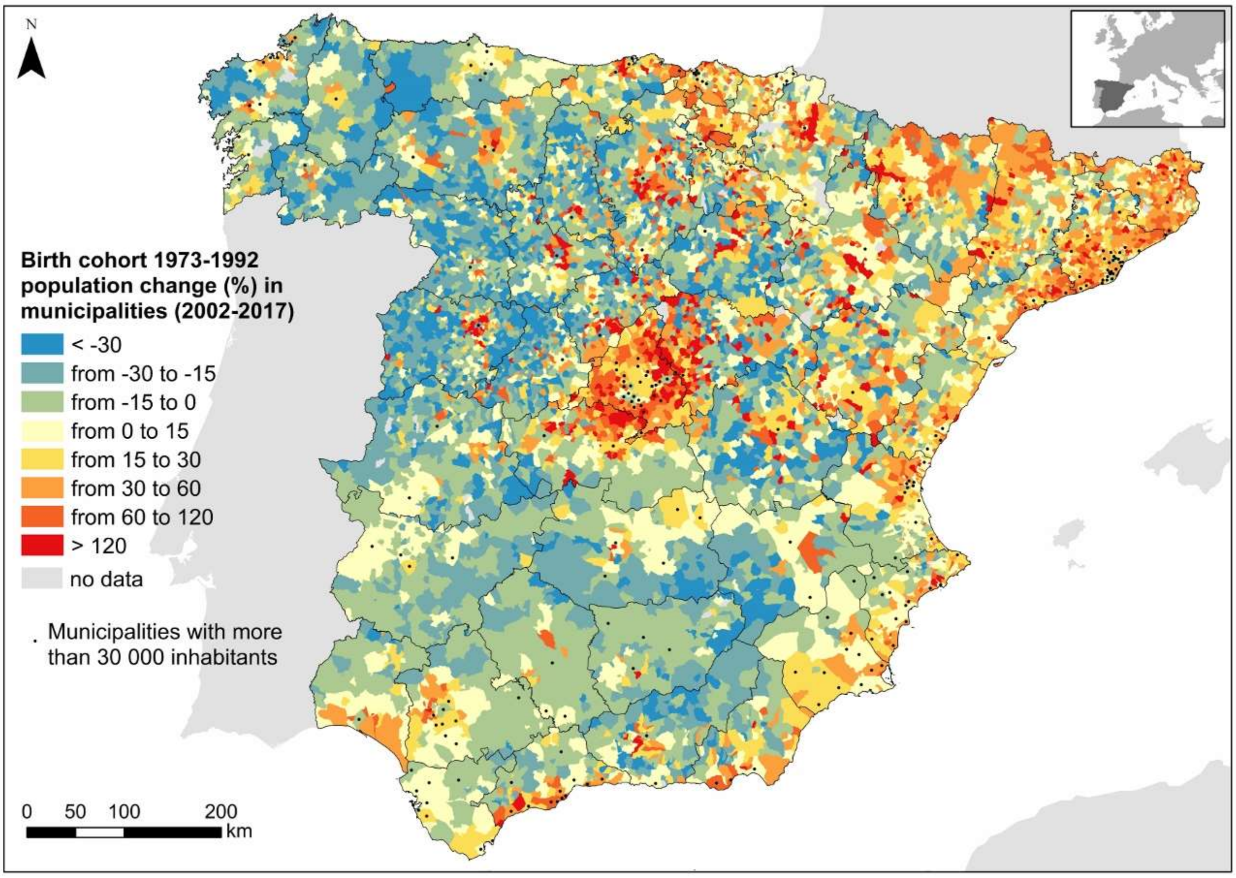

Figure 8. Map of the population change (%) of the 1953-1972 birth cohort in each municipality (2002-2017).

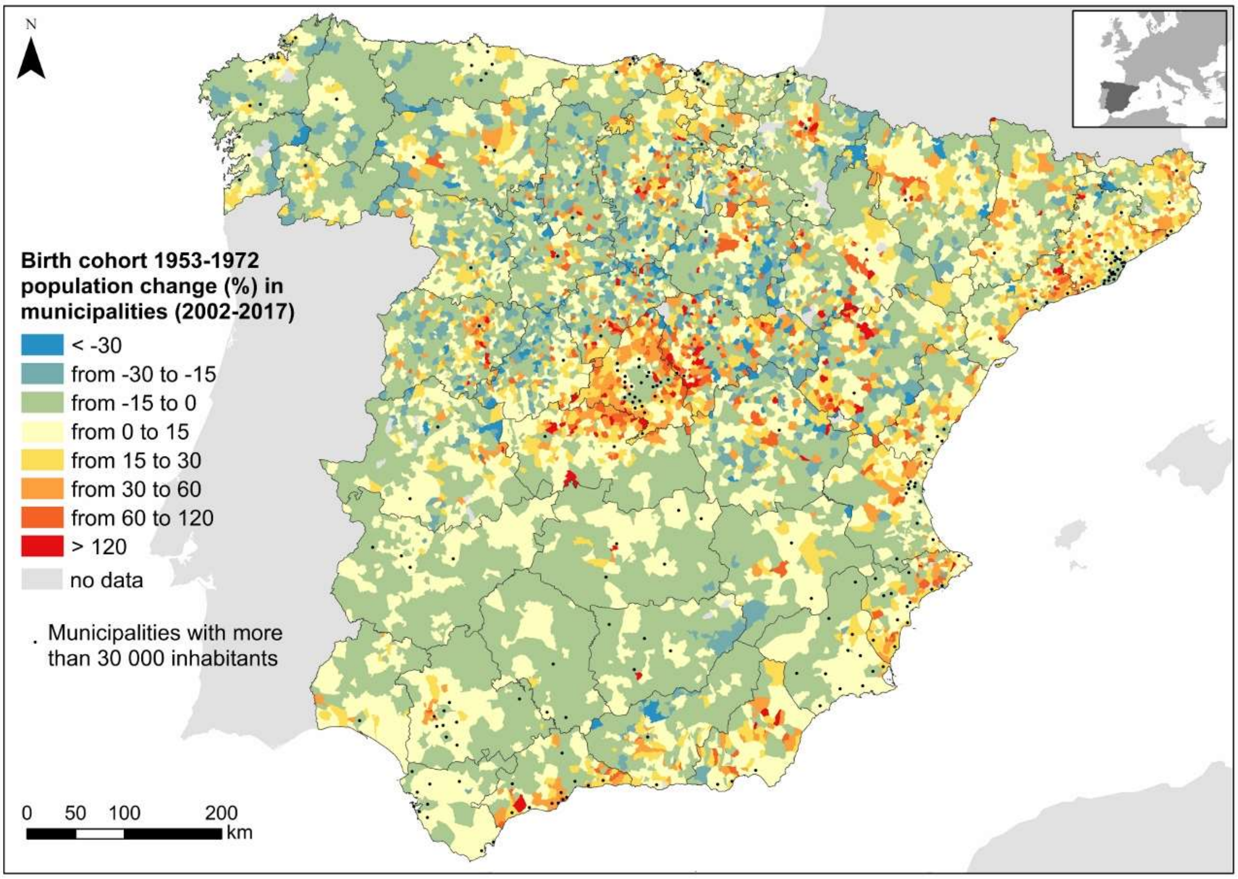

Figure 9. Map of the population change (%) of the 1943-1952 birth cohort in each municipality (2002-2017).