Demographic ageing in Mediterranean: spatial convergence?

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Theoretical framework

Convergence is a temporal process whereby the disparities between individuals[1] decrease over time. Divergence, on the other hand, implies an increase in disparities between individuals. In 2001, Chris Wilson identified a global convergence of fertility since 1950. This can be attributed to a decline in fertility in developing countries, with rates growing closer to that of developed countries, thus reducing global disparities. The concept of convergence is well suited to social sciences. Indeed, human societies transform over time, through their population structure, fertility, mortality, social structures, education, economy, growth, etc. These changes in social phenomena involve a process of convergence and/or divergence, since these processes are the very basis of social change.

In the late 1980s, econometrics was the first social science discipline to propose ways of measuring the convergence process (Baumol, 1986). In the 1990s, these methods were developed and gained in complexity (Barro, 1991 ; Barro et Sala-i-Martin, 1992 ; Quah, 1997). Spatial econometrics employs these methods to account explicitly for space in the models (Rey, 2001 ; Rey et Le Gallo, 2006). Initially, the methods to objectify the convergence process remained in the field of econometrics and spatial econometrics, and were only later transferred to demographics or population geography. In fact, some demographers did not begin to use these ways of measuring convergence until the second half of the 2000s (Dorius, 2008 ; Lanzieri, 2010 ; Arokiasamy et Goli, 2012).

Yet the concept of convergence is appropriate for demographic studies. Typically, demographic transition is explicitly a process of convergence (Wilson, 2001). This is a phenomenon in which fertility and mortality converge from high to low levels. The combination of these two indicators automatically produced one of the most important demographic challenges of the 21st century: the ageing of the population (Chesnais, 1986). In other words, the population is converging from a young structure to an older one. The explicit convergence of demographic transition implies a convergence of the population's ageing process.

However, demography is a spatial social science (Voss, 2007). This means that demographic phenomena are not randomly distributed in space. The decline in fertility has often been modelled as a spatial diffusion, particularly in India (Guilmoto et Rajan, 2001). It is therefore interesting to integrate the field of spatial analysis into demographic studies in general (Weeks, 2004). In this case, the convergence process is not only a temporal, but also a space-time process.

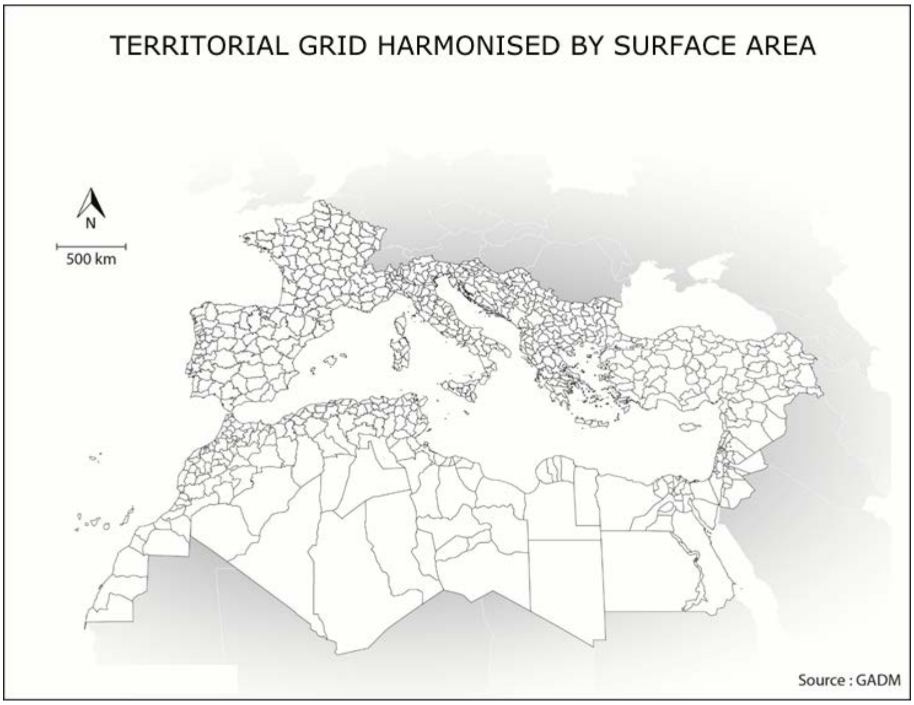
[1] We use the term "individual" in the sense of "statistical individual". Our approach is not individual-centric, in order to avoid confusion with the "individual" in the sense of a "natural person". This can therefore be a country, a territory, a region, a couple or another object of study in a broad sense.

This work aims to study the convergence of demographic ageing, by explicitly integrating the spatial dimension and by using original methods, little used in demography. To this end, we chose the Mediterranean, an ideal geographical area for a study of demographic convergence. Indeed, from a demographic standpoint, the Mediterranean is characterised by a dichotomy between the southern and northern shore, with higher fertility and mortality rates on the former, and an older population on the latter. Nevertheless, fertility has declined fastest in developing countries (Wilson, 2011), where populations have consequently aged more rapidly (Pison, 2008, 2009). In years to come, this will cause a convergence of demographic ageing from the southern towards the northern shore of the Mediterranean, justifying the relevance of this geographical region as a study area (Troisi, 2013). To do so will require us to carry out population projections. Finally, in light of the regional disparities, which may exist within the same country, a sub-national scale will be used for this study.

Empirical approach

To study the convergence of demographic ageing on an international scale in the Mediterranean, we had to face several methodological challenges.

First, we created a sub-national grid for the entire Mediterranean. Each country possesses numerous administrative levels. However, for the purposes of a sub-national study, it was appropriate to select only one per country. Given the impact of the territorial grid on the results of a cartographic or statistical analysis, this step should not be underestimated (Openshaw, 1984). To limit the effects of scale, we constructed a sub-national grid harmonised by surface area, that is, by choosing administrative levels of a similar average size (Map 1). Using this method, we limited disparities in the size of the grid, while maintaining a fine-scale analysis.



Map 1: Territorial grid in the Mediterranean

Next, for population projections, we chose the component method over a 50-year period (2015-2065). This required a certain amount of data: structure by sex and age, fertility by sex and age, mortality by sex and age, and immigration and emigration by sex and age. We therefore needed this data for each previously created sub-national area of the Mediterranean territorial grid. However, there is no central data office – akin to Eurostat for the European Union – for the Mediterranean area. We therefore collected this data from each national statistical office (civil registry, population estimates, censuses), but also from specific surveys (Demographic Health Surveys [DHS], national fertility surveys, etc.) and international organisations (see table 1 for data sources).

	Abbreviation	Signification	URL
Organisation internationale	DHS	Demographic and Health Surveys	http://dhsprogram.com/
	ONU	Organisation des Nations Unies	http://www.un.org/
	WPP 2015	World Population Prospects 2015	https://esa.un.org/unpd/wpp/
	EUROSTAT		http://ec.europa.eu/eurostat/fr/home
Albanie	INSTAT	Instituti I Statistikave	http://www.instat.gov.al/
Algérie	ONS	Office National des Statistiques	http://www.ons.dz/
Bosnie-Herzégovine	RZSRS	Republika Srpska Institute of Statistics	http://www.rzs.rs.ba/
	FZS	Federal Office of Statistics	http://www.fzs.ba
	BHAS	Bosna i Hercegovina Agencija za Statistiku	http://www.bhas.ba/
Bulgarie	NSI	National Statistical Institute	http://www.nsi.bg/
Chypre	SSC	Statistical Service of Cyprus	http://www.mof.gov.cy
Croatie	CBS1	Croatian Bureau of Statistics (Croatie)	http://www.dzs.hr/
Égypte	CAPMAS	Central Agency for Public Mobilization and Statistics	http://www.capmas.gov.eg/
Espagne	INE	Instituto Nacional de Estadistica	http://www.ine.es/
France	INSEE	Institut National de la Statistique et des Etudes Economiques	http://www.insee.fr/
Grèce	HSS	Hellenic Statistical Authority	http://www.statistics.gr/
Israel	CBS2	Central Bureau of Statistics (Israël)	http://www.cbs.gov.il/
Italie	ISTAT	Istituto Nazionale di Statistica	http://www.istat.it/
Jordanie	DOS	Department of Statistics	http://web.dos.gov.jo/
	JFFHS	Jordan Fertility and Family Health Survery	
Kosovo	ASK	Agjencia e Statistikave Të Kosovës	http://ask.rks-gov.net/
Liban	MOPH	Ministry Of Public Health	http://www.moph.gov.lb/
	CAS	Central Administration of Statistics	http://www.cas.gov.lb/
Libye	BSC	Bureau of Statistics and Census Libya	http://www.bsc.ly/
Macédoine	SSO	State Statistical Office	http://www.stat.gov.mk/
Malte	NSO	National Statistics Office	https://nso.gov.mt/
Maroc	HCP	Haut-Commissariat au Plan	http://www.hcp.ma/
Montenegro	MONSTAT	Statistical Office of Montenegro	http://www.monstat.org/
Palestine	PCBS	Palestinian Central Bureau of Statistics	http://www.pcbs.gov.ps/
Portugal	INE	Instituto Nacional de Estatistica	https://www.ine.pt/
Serbie	SORS1	Statistical Office of the Republic of Serbia	http://webrzs.stat.gov.rs/
Slovénie	SORS2	Statistical Office of the Republic of Slovenia	http://www.stat.si/
Syrie	CBS3	Central Bureau of Statistics (Syrie)	http://www.cbssyr.sy/
Tunisie	INS	Institut National de la Statistique	http://www.ins.tn/
		Ministère de la santé	http://www.santetunisie.rns.tn/
Turquie	TURKSTAT	Turkish Statistical Institute	http://www.turkstat.gov.tr/

Table 1: Source of data

This collection process yielded a highly heterogeneous set of data, as some countries have highly detailed data available, whereas in others, it is imperfect or summary. We then used demographic methods of indirect estimation to overcome these problems: indirect standardization (Henry, 1984), estimating life expectancy at birth using the mortality tables from the United Nations Model Life Tables, and the *Population Analysis Software* developed by the US Census Bureau (Arriaga, Johnson et Jamison, 1994a, 1994b). This finally produced a consistent set of data across all the Mediterranean sub-national territories, allowing us to calculate life expectancy at birth by sex, and an overall fertility rate by sub-national territory.

We then made projections using the component method, opting for a closed population[2]. For the future development of fertility and mortality, we employed projections from the United Nations' *World Population Prospects 2015*. We adapted the UN's various development variants to our data (sub-national territories follow the same trend as the country to which they belong) to construct four prospective scenarios over a period of 50 years (2015-2065). The first shows the median change for all countries (median scenario). The second simulates a demographic transition model, whose fertility rate has changed, coming closest to two children per woman. The third scenario simulates a slow demographic transition in which the fertility rate is the slowest to approach two children per woman. Finally, in the fourth scenario, the change in fertility rates follows the United Nations' median trajectory, with the exception of countries with a recent increase in fertility (Egypt, Algeria, Tunisia and Jordan). For the change in mortality, we chose the UN's median change. With these four prospective scenarios, we obtained the age structure of each sub-national territory for all dates between 2015 and 2065. This allowed us to calculate the degree of ageing (persons aged over 65) for each territory and date.

Using this data, the methods of econometrics and spatial econometrics[3] were applied to measure the convergence of demographic ageing. First, the σ-convergence used three different dispersion indicators to measure the overall change in disparities over time (Barro et Sala-i-Martin, 1991). For a local exploration of convergence, we used local σ-convergence, which measures local changes in statistical dispersion (Bourdin, 2015). We then analysed the change in statistical distribution over time. We modelled individuals' trajectories using this statistical distribution with Markov chains (Quah, 1993). Rarely used in demography, this modelling analyses the trajectories of ageing in specific territories: which of these are young in 2015 and become elderly in 2065? Do some areas grow younger? It also qualifies the underlying process, that is, whether these trajectories lead to convergence or divergence on the whole. Mapping the transition matrix of Markov chains allowed us to identify the convergence spatial clubs, that is, adjacent territories with the same ageing trajectory. Finally, we used spatial Markov chains to determine if space plays a significant role in territorial trajectories (Le Gallo, 2004 ; Rey, 2001). This method conditions the classical transition matrix of Markov chains through the state of each individual's environment. In other words, is a territory with older neighbouring territories more likely to age than a territory surrounded by younger territories?

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[2] Overall, migration data is poorly recorded by Mediterranean statistical offices. Some countries do not provide any statistics available for this phenomenon. We have therefore chosen to exclude migration from the projections.

[3] For statistical developments of the methods used in this study, please consult the synthesis offered by Doignon (2016).

Results

The application of these methods to ageing in the Mediterranean between 2015 and 2065 produced interesting results. First, statistical distribution has changed over time: the gap is narrowing between the youngest and oldest territories (Figure 1). The measure of σ-convergence shows an overall decrease in disparity over time. In all scenarios, disparities in demographic ageing are lower in 2065 than in 2015.

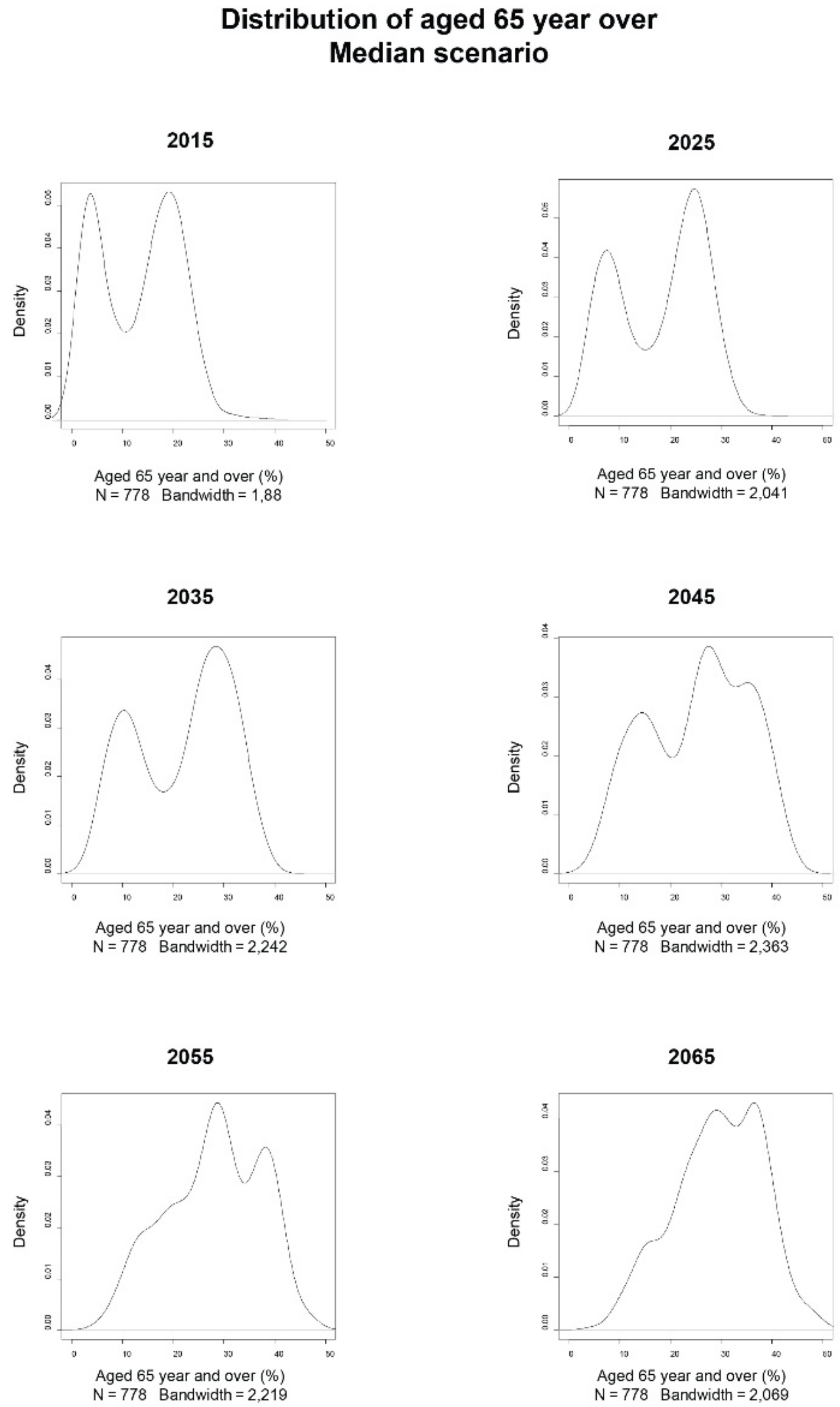


Figure 1: Distribution of aged 65 and over between 2015-2065

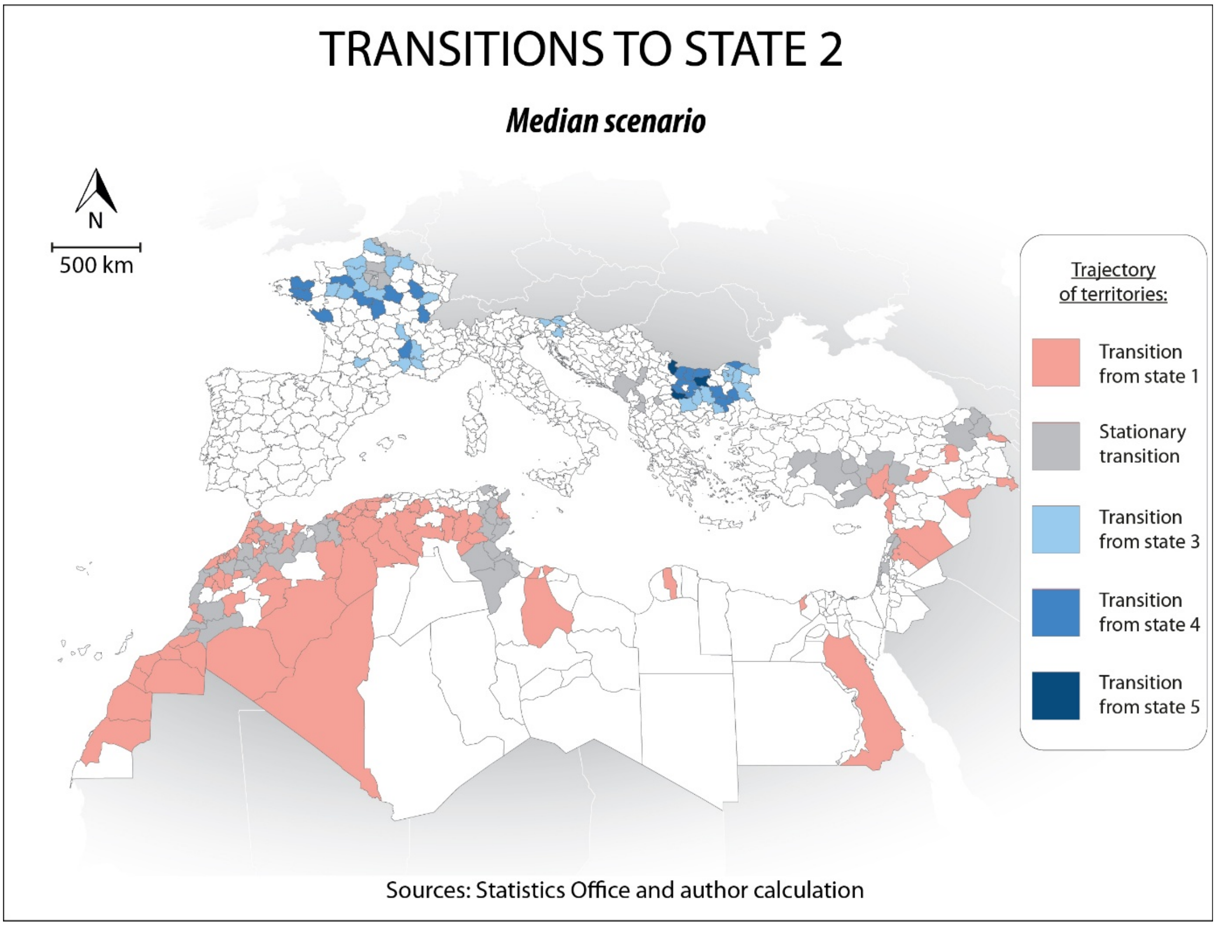
Modelling through Markov chains, including the transition matrix, shows that the trajectories of Mediterranean territories varied considerably between 2015 and 2065 (Table 2)[4]. Of course, territories that are young in 2015 age rapidly to converge and catch up with older ones. But contrary to what had been expected, we are far from a situation in which all territories age relentlessly. Though most younger territories age, some grow younger.

		State *2065*				
		1	2	3	4	5
State 2015	1	0,92	0,08	0	0	0
	2	0,02	0,90	0,08	0	0
	3	0	0,04	0,84	0,12	0
	4	0	0	0,08	0,78	0,14
	5	0	0	0	0,08	0,92

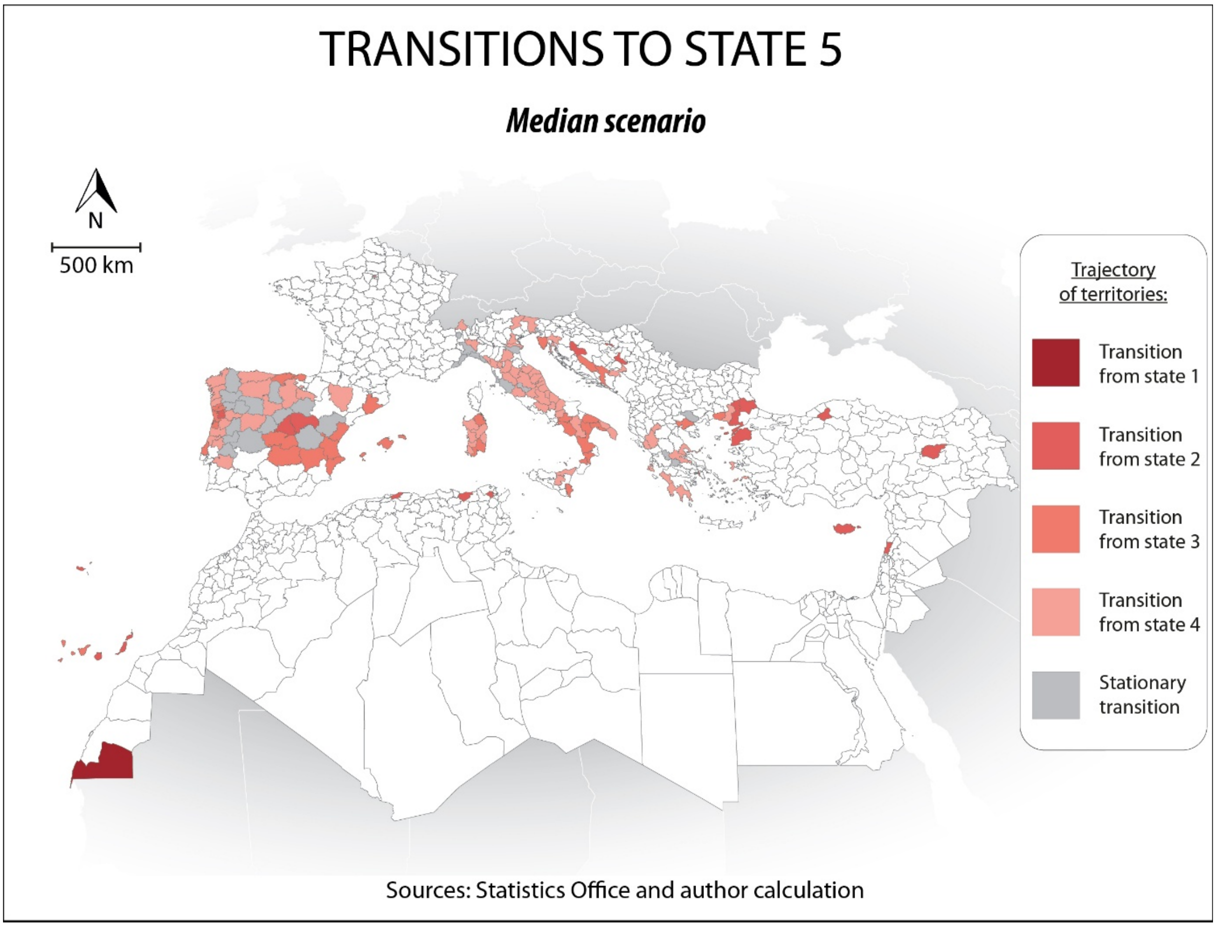
Table 2: Markov matrice (2015-2065), Median scenario

Mapping the transition matrix highlights convergence spatial clubs. Territories with the same trajectory are not randomly distributed in space (Maps 2 and 3, showing territories converging towards, respectively, a young state [state 1] and a highly aged state [state 5]). The Iberian peninsula is a convergence club, as are northern France, part of Italy and a large part of Bulgaria. The territories on the southern shore of the Mediterranean that age very rapidly are often urban spaces. Space thus plays a key role in the convergence of demographic ageing.

[4] For this method, we normalised the raw data by the Mediterranean average of the portion of over 65-year-olds. This indicated the general trend of ageing in the Mediterranean area.
The states in the Markov matrix in table 2 represent a specific portion of the distribution. State 1 comprises the youngest territories. Conversely, state 5 contains the territories with the highest rates.


TRANSITIONS TO STATE 2
Median scenario
N
500 km
Trajectory of territories:
Transition from state 1
Stationary transition
Transition from state 3
Transition from state 4
Transition from state 5
Sources: Statistics Office and author calculation

Map 2

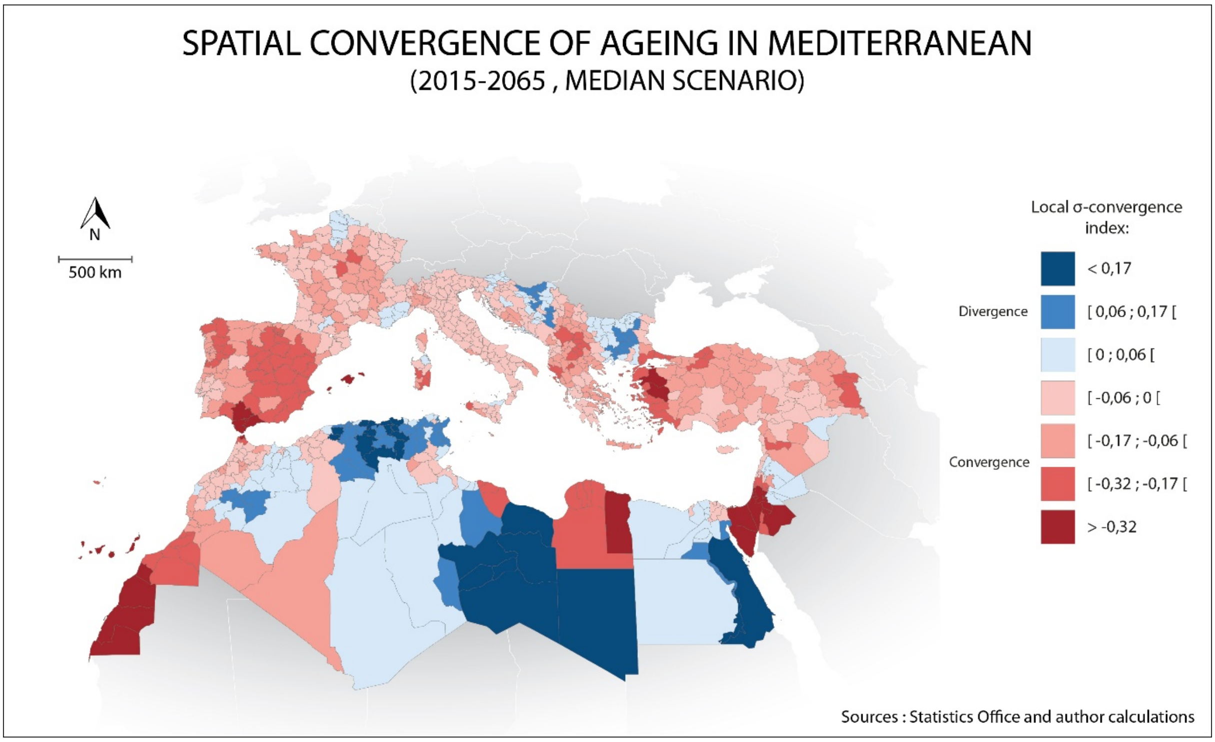


Map 3

Therefore, in our analysis, we incorporated space explicitly with the local σ-convergence. It adds considerable nuance to earlier teachings on σ-convergence, which identified a global convergence of Mediterranean territories over time. Local σ-convergence shows areas of spatial convergence, but also of spatial divergence (Map 4). This signifies that local disparities in some areas increase over time, particularly in Bulgaria and North Africa. These dynamics of spatial divergence altered the spatial structure of population ageing in the Mediterranean in 2015. The opposition between the northern and southern shores becomes much less marked in 2065.

Finally, with spatial Markov chains, we used statistical tests to prove[5] that space plays a significant role in individuals' trajectories. The convergence process is thus heavily influenced by the spatial dimension.

[5] This includes spatial stationarity tests.



Map 4

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