

Cities have memory and interact with their neighbors

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A decision as personal as moving house or emigrating from one city to another also depends on how many people did the same last year, according to the study. Credit: SINC

Demographic changes in large cities depend on millions of individual decisions, but the population evolves depending on two factors: what 'reminds' them of their recent past and the existence of other urban areas around them.

This is the proposal supported by a Spanish-Argentinean group of researchers through algorithms, which show how American cities have a 25-year-old [memory](#) and interact with others 200 km away while in the case of the Spain these values are 15 years and 80 km.

Knowing what each inhabitant in a city will do in the coming years, with their own motivations and feelings, is a practically impossible task; but if all the individual decisions are analysed together as a set some demographic patterns appear or a 'collective coherence' which can be predicted.

These are the findings from the study that scientists from Spain and Argentina have published in the *Journal of The Royal Society Interface*. The team has developed some algorithms which reveal that what happens in a given moment in a city on a demographic level depends on what happened in previous years, as well as the presence of other large cities nearby.

"We can say that the urban systems have an inertia or memory of their past", says the lead author, Alberto Hernando, from the Lausanne Federal Institute of Technology (EPFL, Switzerland). "It may sound obvious, but this implies that a decision as personal as whether to move house or emigrate also depends on how many people did the same the year before independently, people that in reality you have never even met!"

The researchers have applied their algorithms to cities in Spain and the US. In the first case they used demographic data from the Spanish National Institute for Statistics (INE) for the period 1900-2011, and in the latter case, registers from the US Census Office between 1830 and the year 2000.

The results show that Spanish cities with more than 10,000 inhabitants

have a medium-term memory of 15 years. The amount of people that in one particular year moved to another city is highly related to the figure that did so the previous year, but that correlation tails off as time goes by and after 15 years the correlation has dropped to half.

Wars and recessions stay in the memory

However, according to the algorithms, the memory of cities in the US lasts for 25 years. It has also been verified that events such as civil war or the Great Depression in 1929 have shaped that memory, generating a kind of 'post-traumatic amnesia' which remains etched on its population for two-and-a-half more decades.

"Understanding society as a collective set of which we all form part and that behaves as a coherent entity subject to predictable rules, means that economic downturns do not only affect the individual directly harmed by the crisis, but all collective behaviour," explains Hernando.

The other result from the research is that the city's growth is also determined by the way in which its neighbours develop, and the sphere of influence varies according to the country. The typical interaction distance is 80km in Spanish cities and 200km for those in the US.

"The cities are not individual objects but form part of a more global network and their future is linked to their surrounding one," the researcher points out. "It means that to make projections for the future of a city you specifically need to know what will happen to the neighbouring cities as well".

Hernando highlights that once the mathematical theory that includes the inertias and influences on cities is developed, "we will have important information for territorial decision-making, for example, to warn of the consequences of a short-sighted decision taken for electoral or economic

reasons, given that the consequences will last several decades".

Even so, the scientists note that their study is just the starting point and that there are still many questions to answer before reaching the final formula, such as where does this memory reside? Do we all participate in it? Does it change from culture to culture? Is it a global phenomenon or only appears in certain societies? "We have no idea, not right now", they acknowledge.

More information: A. Hernando, R. Hernando, A. Plastino, E. Zambrano. "Memory-endowed US cities and their demographic interactions". *Journal of The Royal Society Interface* 12: 20141185, 2015.

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