Analysing Population Decline Trajectories in Regional Europe: A Sequence Analysis

Europe is projected to become the first continent to undergo a unique demographic transition - population decline. The latest revision of the United Nations' world population prospects review expects the continental population to be in a state of decline by 2025 (UN 2019). Population decline is not, however, expected to occur uniformly across the continent as significant differences in the rate and direction of population change are set to persist, further exacerbating regional and country demographic imbalances (Eurostat 2020, ONS 2020, UN 2019). At present, population decline has begun in 17 European territories, but is expected that a total of 33 will be in decline by 2050 (UN 2019). Depopulation at this scale is a previously unrecognised demographic phenomenon and will thus impose a wealth of novel challenges (see Bloom et al., 2010, Coleman & Rowthorn 2011).

Despite the urgency of European population decline, significant gaps in our knowledge remain. Particular research deficiencies relate to the geographic scope of studies, or lack thereof, and the overlooking of temporal processes of decline. Studies that have examined decline in comparative analyses over large geographical areas have highlighted specificities in the trajectories of decline (Haase et al., 2016, Lukic et al., 2012, Wolf & Weichman 2018). However, these studies are typically concerned with rural or urban decline exclusively. The presence of a rural/urban dichotomy within the literature has complicated efforts to conceptualise decline in national and international settings. Further gaps in our knowledge stem from the infrequent consideration of temporal processes of decline. Rather, studies tend to only consider the direction of population change between two points in time, ignoring potential fluctuations in the direction and rate of change. This study seeks to address these shortcomings by examining trajectories of population decline across the entirety of the wider European region, in a total of 43 territories. Its main contribution to research into population decline will be the production of a typology in which various pathways of decline will be investigated. Through demonstrating commonalities and differences in depopulation trajectories, this study will provide further insights into the complex processes of decline. This will be attained through the novel application of sequence analysis.

Data & Methodology

This study looks at the temporal sequence of population change in 2,036 sub-national areas in 43 European territories. Areas correspond to that of the smallest regional classification in the Eurostat territorial classification system, NUTS 3. A database was collated, using data from both Eurostat and national statistics offices, containing annual population count estimates. Due to data scarcity the period of inquiry has been restricted to this current century (2000-2018). Additional data on the population distribution by settlement type was acquired from Eurostat and national statistics agencies to construct a rural-urban typology.

The methodological procedure is composed of four stages. Briefly, the first stage involves the conversion of population count data to a categorical format required to perform sequence analysis. Annual percentage change was calculated to inform a set of five categorical states that represent various degrees and directions of population change. Trajectories of population change are represented by the chronological ordering of these states. Five states were distinguished in this study with the boundaries determined by the median and standard deviation of all rates of population change (Table 1). The second stage includes all steps relating to the application of sequence analysis, including the creation of a sequence object and the implementation of a dissimilarity metric to compare sequences of population change. This study utilises the TraMineR package in R for the implementation of sequence analysis (Gabadinho et al., 2011). The third stage involves the creation of a typology of population decline trajectories using an agglomerative hierarchical clustering procedure. Finally, the fourth stage involves the mapping of the clusters and the implementation of a rural-urban typology to further analyse cluster compositions.

State	Definition (annual % change)
Decline	≤ -0.99
Moderate Decline	> -0.99 & ≤ -0.3
Stability	> -0.3 & < 0.3
Moderate Growth	≥ 0.3 & < 0.99
Growth	≥ 0.99

Table 1 – Defined states of population change for sequence analysis.

Sequence analysis has yet to be applied in a study of population change. The benefits of using sequence analysis here are multifaceted. Firstly, it will enable entire processes of decline to be studied, providing a holistic perspective of the complex phenomenon (see Billari 2001). Secondly, its application will capture subtle differences relating to the trajectories of population decline, particularly relating to the occurrence, duration, timing and magnitude of decline.

Results & Discussion

Preliminary sequence analysis conducted on all 2,036 sub-national areas reveals that the predominant direction of population change in Europe remains oriented towards growth. However, significant variability in the sequences of population change are demonstrated in sequence index plots (not included in this summary). Of the 2,036 areas included in this study, 696 are characterised by overall population decline in the period 2000-2018. These areas of decline are the exclusive focus of subsequent analyses.

Typologies of decline

Figure 1 presents the state index plots, state distribution plots and mean time plots of 7 clusters representing different pathways to depopulation. The clusters typically describe either a singular transition from one state to another, oriented towards either the accelerating or diminishing pace of decline, or stability. Interestingly there are no clusters detailing transitions to distant states, suggesting that the process of decline is gradual, or stepwise. The clusters are described in detail below.

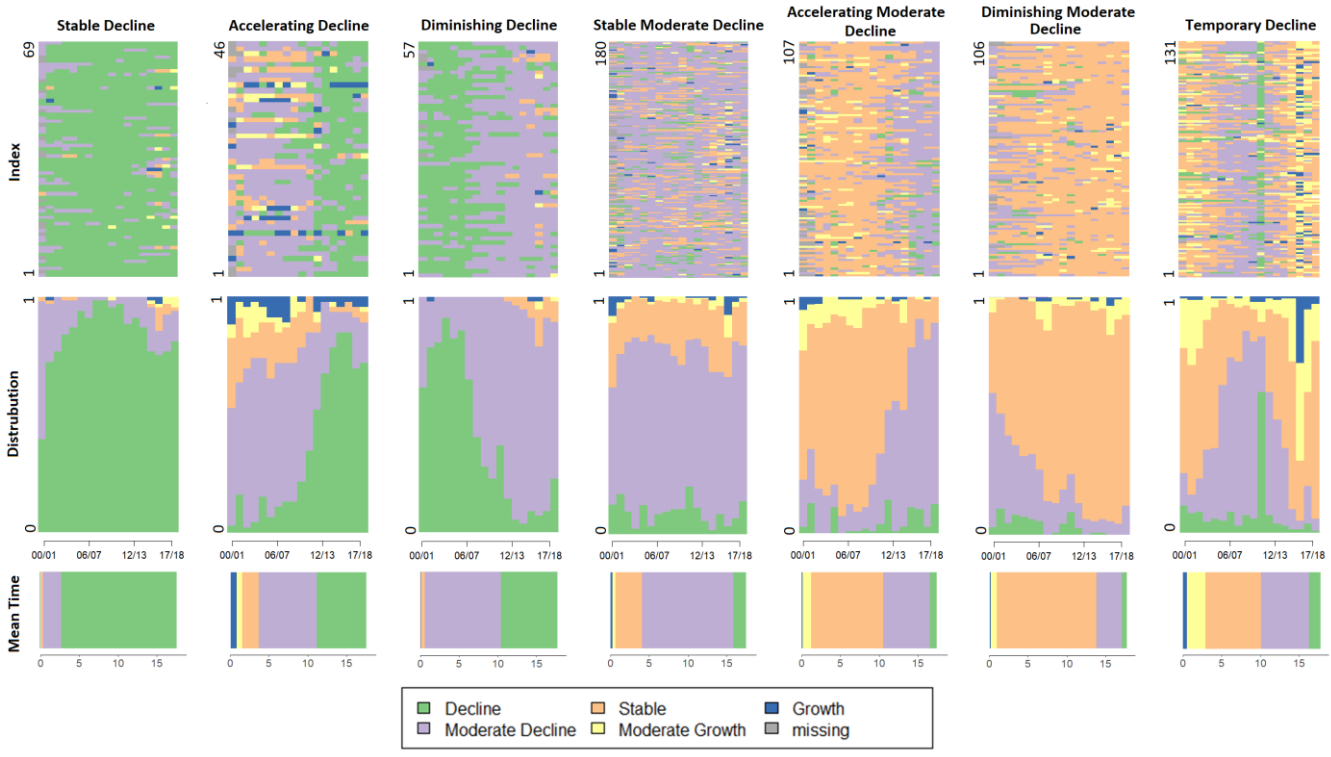

Figure 1 –State index plots (top), state distribution plots (middle) and mean time plots (bottom)

Cluster 1 – Stable Decline. Displays a pattern of sustained decline of the highest magnitude.

Cluster 2 – Accelerating Decline. Describes a trajectory of escalating population decline with areas transitioning from moderate decline to decline. This represents an increase in the pace of decline.

Cluster 3 – Diminishing Decline. Details a transition from the highest rate of decline to a moderate rate. This represents a decrease in the pace of decline though the direction population of change remains in decline.

Cluster 4 – Stable Moderate Decline. This cluster is defined by persistent moderate decline.

Cluster 5 – Accelerating Moderate Decline. Describes a trajectory of accelerating decline following an extended period of stability. Areas in this cluster represent the expansion of population decline in Europe.

Cluster 6 – Diminishing Moderate Decline. Displays a trajectory of diminishing moderate population decline to stability, signalling the end of decline.

Cluster 7 – Temporary Decline. This cluster is characterised by two transitions, and is unique in this regard. Both transitions concern stability and moderate decline, with the first describing the ascendency of moderate decline and the second detailing its withdrawal.

Mapping Cluster Memberships

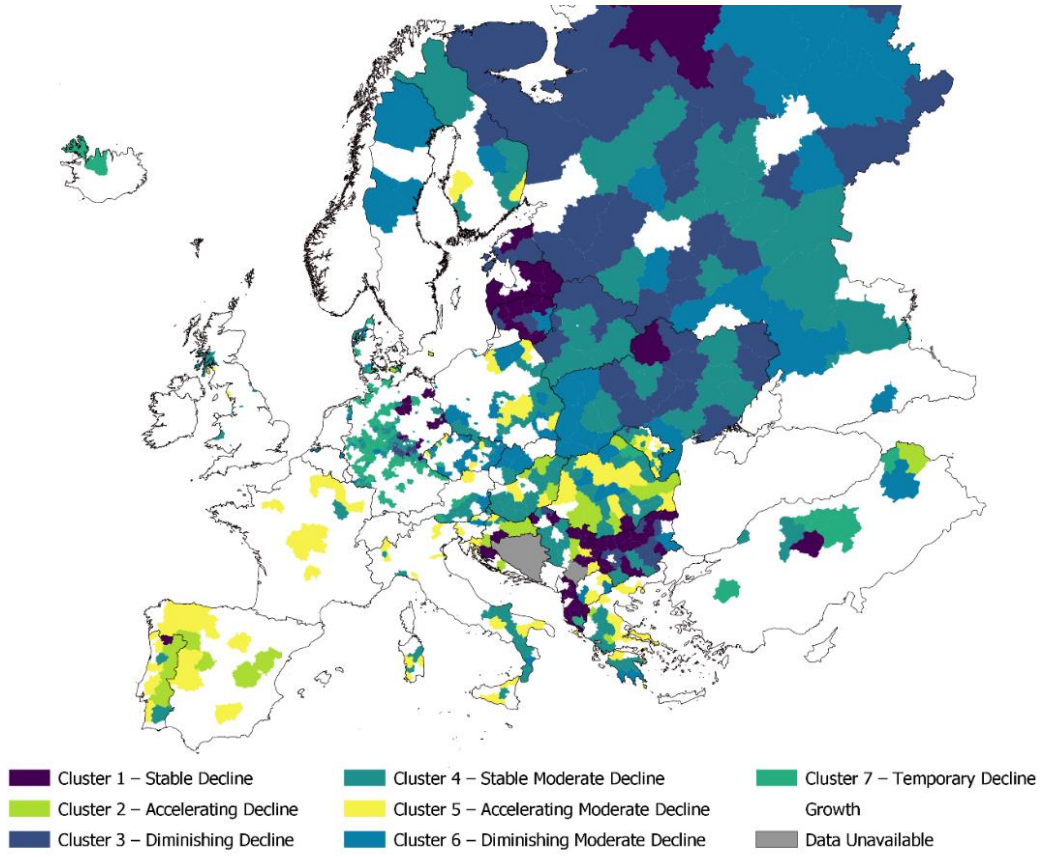

Figure 2 – Geographic Distribution of population decline trajectories

Cluster 1 – Stable Decline. Areas characterised by this depopulation trajectory are found in Eastern and Southern Europe, and in the former East Germany. Particularly concentrated in Balkan and Baltic countries – dominant in Albania, Bulgaria, Latvia and Lithuania.

Cluster 2 – Accelerating Decline. Predominantly located in Southern Europe, chiefly in the Balkan countries of Croatia and Romania. Can also be found in Western Europe, in non-coastal Portugal and Spain.

Cluster 3 – Diminishing Decline. With few exceptions, areas in this cluster are found in former Soviet Countries in Eastern Europe. Particularly in Belarus, Estonia, Russia and Ukraine. Also in Bulgaria and within the former East German state of Thuringia.

Cluster 4 – Stable Moderate Decline. This cluster is abundantly distributed across Europe but predominant in Central, Eastern and Southern Europe. Dominant trajectory of decline in Austria, Finland, Hungary, Moldova, Poland, Romania, and Serbia.

Cluster 5 – Accelerating Moderate Decline. This cluster is over-represented in Southern Europe and is the most common trajectory of decline in the countries of France, Greece, Italy, Romania, Spain, and Portugal.

Cluster 6 – Diminishing Moderate Decline. Areas with this trajectory of depopulation are mainly found in Central and Eastern Europe, and are most prevalent in Czechia, Slovakia, Sweden and the UK.

Cluster 7 – Temporary Decline. Of the 131 areas in this cluster, 101 are located in Germany, specifically in the West of Germany. This trajectory of decline is also the most common in Denmark and Turkey.

Decline by Area Classification

The final stage of the analysis offers an investigation into the distribution of decline trajectories by area classification. Using the classification established in the Eurostat Urban-Rural typology (Eurostat 2013), all 2,036 areas were sorted into three categories; urban, rural, and intermediate. In addition to this, population size was considered to further distinguish between areas. The product is a typology that enables a more rigorous analysis of population decline by considering both area classification and size.

We observe critical differences in cluster compositions. Firstly, urban areas are most prevalent in clusters detailing diminishing and temporary declines and least prevalent in clusters where decline is accelerating. This implies that the pace of urban population decline across Europe has decelerated in the past twenty years. Secondly, rural areas are dominant in trajectories that depict accelerating population decline. This has two major implications; that rural decline in Europe has accelerated since 2000 and that the observed expansion of European population decline is chiefly concentrated in rural areas. Thirdly, clusters of diminishing decline are most prevalent amongst areas with large populations (> 500,000), indicating that a deceleration in the pace of decline has taken place in areas with large populations. Finally, clusters detailing trajectories of accelerating population decline are chiefly composed of small and mid-sized areas.

Conclusion

Taken together, the analyses of this study portray a picture of heterogeneity with regards to trajectories of population decline and their geographic distribution. In an attempt to summarise, this study recognises significant regional contrasts that extend beyond simple growth/decline regimes. Generally, population decline in the East of Europe is more widespread, severe in regards to pace and magnitude, and a more long-standing feature than in the West of Europe. Further analysis shows that rural decline is considerably more common than urban decline in the European context, with decline more long-standing and fast paced than urban decline. Conversely, urban decline is shown to be largely decelerating across Europe. Similar findings are reported when looking at population decline by area size, with examples of accelerating decline abundant in areas with small and mid-sized populations and evidence pointing to a deceleration of decline in larger areas. In all, these findings reveal that the drivers of expanding European population decline are rural areas with small populations.