

- *Demographic change – Micro-macro links – Spatial analysis – GIS*

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## **Towards an Integrated Understanding of Demographic Change and its Spatio-Temporal Dimensions: Concepts, Data Needs and Case Studies**

*Eine integrierte Analyse des demographischen Wandels und seiner raum-  
zeitlichen Dimensionen: Konzepte, Datenerfordernisse und Fallbeispiele*

With 12 Figures

Demographic change is a macro-phenomenon, driven by decisions and events at the individual level. However, individual-level events are often influenced by the spatial socioeconomic context in which the actors are embedded. This context usually changes slowly over time which suggests that the present circumstances depend to a large extent on past developments. In this paper, we outline how a GIS-based empirical research approach can deepen our understanding of the spatio-temporal dimensions of demographic change. This approach can benefit from the concepts and methods of at least three disciplines: demography, geography and historical sciences. In addition, we describe the recent improvements in the (geo-)data infrastructure, with the goal of overcoming data limitations that have so far restricted research in this field. Three case studies illustrate the potential of such an approach.

### **1. Demographic Change – an Old Phenomenon with Continued Relevance**

In many countries across the globe, demographic changes are attracting attention, both in scholarly circles and among the broader public. In developing countries, an era with very high fertility levels is on the verge of coming to an

end, raising questions about the future demographic and socioeconomic development of these regions (*Bongaarts* 2003). In Europe, fertility remains at comparatively low levels, although there are some signs that the era of lowest-low fertility may be coming to an end (*Goldstein et al.* 2009). The now global implications of population ageing occupy researchers and policy-

makers alike, as these trends will have dramatic consequences for family structures and functions, as well as for welfare and policy systems (Myers and Agree 1994, Anderson and Hussey 2000). Many of the critical changes in individual behaviours and group demographic patterns that have recently been observed in Europe are often interpreted as causally linked with, and structurally part of, centuries-long processes of fundamental demographic changes (Chesnais 1992, Lee 2003, Laslett 1991).

In German-speaking countries, the main focus of the debate on demographic change is on three consequences of recent demographic developments which are summed up in the phrase: “weniger, älter, bunter” (fewer, older, more diverse) (see, e.g., Schönig 2003). A closer look at the research conducted by German-speaking geographers on demographic change reveals that most of the recent studies have been focused on phenomena that operate at the aggregate level, e.g., the ageing and shrinking of regions and cities and possible coping strategies (e.g., Friedrich and Schultz 2007, Naegele 2008). The temporal focus of these studies has generally been on the last two decades, while the geographic focus has been on eastern Germany (e.g., Herfert and Lentz 2007) and on the declining old-industrialised areas<sup>1</sup> of western Germany (see also Kemper 2006).

Some more general studies do, however, exist. These include, for example, the volume on population of the National Atlas of Germany (Gans and Kemper 2001), the section on demography in the Alpenatlas (Tappeiner et al. 2008), and work by Mai et al. (2007) on spatial aspects of internal migration and ageing in Germany. Also relevant are activities within the framework of the ESPON 2013 program, namely the DEMIFER project which examines how demographic processes affect European regions and cities (ESPO/NIDI 2009). Yet these are the exceptions.

With this article, we advocate for an integrated approach for studying demographic change that can benefit from the conceptual considerations of at least three disciplines: demography, geography and historical sciences. Our paper consists of three parts. In the first part, we explain how a GIS-based empirical research approach at the intersection of demography, geography and historical sciences can improve our understanding of demographic change and its spatio-temporal dimensions. For this field to develop, it is crucial that comparative data are available across long time spans and preferably at small spatial scales, if not at the individual level. Another precondition is an extensive geo-data infrastructure which provides information about the administrative/statistical division of countries and respective changes over time. With regard to these data requirements, researchers can benefit from recent developments, as there are currently a number of projects that seek to overcome existing gaps in the data infrastructure. In the second part of our paper, we provide an overview of these developments. In the third section, we briefly present three empirical case studies in order to illustrate the potential of such an integrated research approach.

## 2. Studying Demographic Change and its Spatio-Temporal Dimensions

### 2.1 Conceptual considerations

Demographic developments at the macro-level are the result of events at the individual level over which actors have more or less control. These events include decisions to stay in an area or to move somewhere else, decisions about whether to live alone or to share a household with others (kin or non-kin), decisions about whether to reproduce or to remain childless and decisions about whether to marry or divorce. Actors can also influence their health status to

some extent by choosing to engage in risk-averse or risk-prone behaviours (smoking, etc.). Over time, individuals eventually age, attain or lose capital (human, social, financial, natural) and ultimately die. As a result of these decisions and events, aggregate populations can change in many different dimensions: overall size, household characteristics, importance of kin and non-kin, inter- and intra-generational relationships, age distribution, marital status, health status etc.

In recent decades demographers have increasingly focused their attention on processes occurring at the individual level (*Courgeau* and *Lelièvre* 1997, *Courgeau* 2003, *Courgeau* 2007), thereby improving our understanding of some fundamental aspects of life-course dynamics and demographic change. This shift to individual-level analysis was also motivated by the work of *Robinson* (1950) on the ecological fallacy problem, which illustrated that relationships observed at the aggregated group level do not naturally hold if the groups are disaggregated into individuals and the analysis is repeated. But this focus on the individual level does not imply that the spatio-temporal context in which decisions and events occur does not play a role. *Lesthaeghe's* work on long-term fertility changes showed, for example, that childbearing behaviour is influenced to a large extent by the social context in which an individual is embedded (*Lesthaeghe* 1980), which is in turn patterned along spatial regularities (*Coale* and *Watkins* 1986, *Lesthaeghe* and *Neels* 2002).

More generally, it has also been shown that, in addition to an ecological fallacy, an individual fallacy can occur (e.g., *Subramanian* et al. 2009). This relates to the problem that associations at the individual level might only be detected correctly if the hierarchical relationships in which the individuals are embedded have been accounted for. The effect of individual-level unemployment on fertility decisions

might, for example, be different in areas with high unemployment than in regions with more favourable economic conditions. In the former setting, people who are employed might refrain from having a(nother) child due to the fear of losing their job soon; while in the latter context, there might be distinct differences between employed and unemployed persons. The extent to which the labour-market situation of parents plays a role in the decision-making process might also largely depend on the welfare state context in which they are embedded.

Furthermore, micro-macro links between demographic developments at the individual and the aggregate population levels are also important. Research on healthy life expectancy without long-term disabilities, for example, provides evidence that, at the individual level, the gains are bigger than the overall increase in life expectancy. This suggests that further increases in life expectancy will not increase the percentage of the lifespan during which an individual requires care (*Christensen* et al. 2008). However, despite this trend at the individual level, there can still be an increased need for care at the aggregate level if the number of people in higher age categories is rising. There is also some evidence that livelihood opportunities for individuals depend to some extent on the size of their cohort relative to the preceding and following cohorts (*de la Croix* et al. 2009).

In recent years, there has been renewed interest in demography in the spatial context in which demographic events occur (see, e.g., *Voss* 2007, *Wachter* 2005, *Weeks* 2004, *Kulu* and *Boyle* 2009). This development is also supported by advancements in statistical techniques in the field of multi-level modelling which make it possible to adequately nest individuals in their context. This tendency towards a spatial turn in demography offers opportunities for geographers who are trained to be aware of the spatial dimensions of socioeconomic phenomena.

Even more evident than the spatial dimension is the fact that demographic change has also always had a temporal dimension (e.g., *Laslett* 1969, *Lee* 2003). Thus, some processes show a long continuity in their trend direction. This is, for example, the case with changes in record life expectancy which has been increasing in a strikingly linear manner over the last centuries (*Oeppen* and *Vaupel* 2002). In this development, the vanguard population has changed frequently across continents: from Europe (Norway) to Oceania (New Zealand), back to Europe (Nordic countries) and finally to East Asia (Japan). The authors argue that a diffusion of best practices might be driving this process. It would be interesting to see whether a spatial analysis based on sub-national data of several countries would support this hypothesis. Other demographic change processes, such as fertility developments, are, on the other hand, often characterised by periods with little change that are sometimes interrupted by periods with rapid shifts. Such (dis-)continuities can be observed not only across time, but also across space. Political and cultural borders are often also borders with regard to the level or diffusion of certain demographic phenomena (e.g., *Claval* 1974, *Decroly* and *Grasland* 1993, *Bocquet-Appel* and *Jakobi* 1996). These spatial (dis-)continuities can intensify or diminish over time.

A big advantage of studying population development is that comparative data are available for relatively long time periods. This also makes it possible, at least to some extent, to study indirectly non-demographic phenomena for which little or no data are available. Economic and ecological crises usually also affect population developments, as they affect livelihood opportunities (see also *Sen* 1998). In addition, the relatively good quality of demographic data makes them ideal for general studies of processes with a spatial dimension (see, e.g., *Goldstein* and *Klüsener* 2010 on fertility decline and spatial diffusion).

## 2.2 Potentials and challenges of an integrated empirical research approach

We believe that an empirical approach which integrates theoretical considerations and methods from demography, geography and historical sciences can improve our understanding of how demographic change occurs, both at the individual and the macro levels, and how it is embedded in space and time. In this regard, it is important to point out that research at the intersection of time, space and population has had a long tradition in the field of (human) geography. It was actually one of the central topics of the field when geography was established as a separate discipline in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries (see, e.g., *Ratzel* 1891, *Vidal de la Blache* 1922, and theoretical considerations by *Hettner* 1947). However, over the 20<sup>th</sup> century, the close links that existed between these three disciplines were weakened as a result of increased specialisation and of time lags in the onset of the quantitative revolution. In the field of geography, the latter was hampered by the fact that geographic models often require high computation power, which was, until recently, only available to a limited extent. But the spatial turn in demography and historical sciences, as well as improvements in the access to computation power supporting a further quantification of the field of human geography, offer opportunities to renew the links between the disciplines.

Demographers can contribute their in-depth knowledge on the individual dimension of demographic change to such an integrated empirical research approach. This includes changes in how people organise their life course and how they are embedded in their social network, which consists of family links and other social relations (e.g., *Bernardi* et al. 2007). In addition, demographers can bring in their knowledge on existing micro-macro links between individual demographic behaviours and demographic phenomena at the aggregate level (e.g., *Billari* and *Prskawetz* 2003). Furthermore, they can also

offer predictions on how life expectancy and fertility will develop in the future, and contribute their vast expertise in quantitative modelling.

Historians can bring in their methodological approach, which looks for continuities and discontinuities, and their detailed knowledge of how the livelihood opportunities of people in specific regions have changed over time (*Bengtsson and Saito 2004, Allen et al. 2005*). With regard to data, they can contribute the large numbers of historical datasets that are already available, either in form of micro-censuses or family cards reconstituted from parish registers of vital events. Past temporal and spatial changes in patterns of co-residence can be investigated (*Laslett 1969, Wall 1995, 2001, Szoltysek 2008a, 2008b*), with the latter making it possible to trace changes in demographic behaviour, both at the individual and the family level (*Knodel 1988*).

Geographers can contribute their awareness of the spatial dimension of social processes and political institutions (e.g., *Reuber 2005*) and their analytical frameworks, which differentiate structures and processes by the geographic scale at which they are operating (e.g., global, national, regional). Methodologically, geographers can contribute their extensive knowledge of the field of GIS and spatial modelling (e.g., *Anselin et al. 2004, Haining 2003*).

With regard to the potential geographical focus area for such research, we believe that the European continent is ideal for two reasons: first, because of the diverse cultural and political landscape of Europe; and, second, because the European states were among the first to establish statistical offices that collect demographic data in a standardised manner. These factors make it possible to study demographic developments over long time spans in Europe.

Among the challenges in pursuing such an integrated research approach are the current gaps in

the concepts, and especially the methods, used in demography, geography and historical sciences. At least in Western Europe, mainstream human geography is currently focused on qualitative rather than on quantitative research. Only a small number of scholars are conducting research applying advanced statistical methods (event history, agent-based modelling) to analyse individual-level data. This is despite the fact that *Hägerstrand* (1966, 1970) advocated at a very early stage for a quantitative geography which utilised individual-level data. In Germany, this kind of research is also limited to some extent by problems with data availability. In contrast to some Nordic countries, the Netherlands, and Belgium, no population registers are available for Germany. The existing individual-level datasets are often too small for conducting research below the level of the states (*Bundesländer*), but spatial aspects often become relevant only at a smaller scale (district or local level).

In historical sciences, the situation is very similar to that of geography. For a long time, only a small circle of scholars were capable of analysing individual-level data using advanced statistical and modelling techniques. However, there have been changes over the last two decades, as some historical disciplines have been merging with social sciences and economics, leaning towards quantification and strong statistical reasoning (*North 1997, Wetherell 1999*). As this shift has been accompanied by the discovery of large amounts of quantitative historical data, it eventually also spurred an interest in historical GIS. The application of GIS in historical analysis has developed and greatly expanded the opportunities for historical analyses of subjects and processes in their spatial contexts. The use of GIS has allowed historians to devise dynamic views of past developments, thus enhancing our understanding of a variety of historical phenomena, as these phenomena can be analysed using both qualitative and quantitative approaches (*Gregory and Healey 2007, Knowles 2008, Bodenhamer et al. 2010*). It is also important to note that,

among the historical sub-disciplines, historical demography is, apart from economic history, the most quantitative of the research fields.

As attempts have also been made to accommodate more qualitative and interpretive approaches in mainstream demography over the past decade (*Greenhalgh 1995, Kertzer 1997, Kertzer and Fricke 1997*), a truly interdisciplinary dialogue between demography, historical science (like for anthropology) and geography is becoming increasingly possible. For the further development of such an integrated field, it would clearly be beneficial to intensify the dialogue between these three disciplines, on both conceptual and methodological issues. The potential for this intensified dialogue clearly exists, as has been illustrated by the work of *Giddens (1984)* and *Werlen (1997)*. Methodologically, such an effort can benefit from recent advancements in the field of spatio-temporal modelling (*Cressie and Wikle 2011*).

### 3. Data Needs for Long-Term Studies of Demographic Change

As was noted above, when studying human populations, researchers can profit from the fact that demographic data are available for quite long time periods. This is particularly true for Europe, where the collection of standardised demographic data has a long history. However, this does not mean that the data have been digitised and harmonised. Moreover, geo-data on the administrative division of states and on the respective changes over time are only available for a limited number of countries. These limitations restrict empirical research in this interdisciplinary research field.

But in recent decades, a number of large infrastructure projects have improved the access to long time series of data. These projects include IPUMS International (*Ruggles et al. 2003*), which currently provides standardised individual-level data from more than 150 censuses in over 50 countries,

covering the period 1960 until today. Under the umbrella of this project, external researchers have also standardised their individual-level datasets and made them available for scientific use. Another important initiative is the North Atlantic Population Project (NAPP), which aims to digitise, harmonise and distribute all existing census data from Canada, Germany, Great Britain, Iceland, Norway, Sweden and the United States from the 19<sup>th</sup> century until today (*Roberts et al. 2003*).

In Germany, legal data use restrictions hamper the availability of individual-level data. But over the last decade, substantial improvements have been achieved, mainly thanks to the initiatives of the German Data Forum (*Rat für Sozial- und Wirtschaftsdaten*). In an attempt to improve the access of scientists to social and economic data, it initiated the establishment of several research data centres (*Forschungsdatenzentren*), both at statistical offices, as well as at other administrative offices that routinely process individual-level data. This includes a research data centre at the German Pension Fund, which provides both longitudinal and cross-sectional micro-datasets for researchers. These data have recently been partially linked with data from the employment office. Via their research data centres, the statistical offices offer access to individual-level datasets of the West German censuses of 1987 and 1970 and complete birth, death, marriage, divorce and migration registers, going back in part until 1990. One more important recent improvement is that it is now possible to use the German annual micro-census for analyses at the district level, which makes this dataset very interesting for studying demographic structures and processes across space.

Another research frontier is the creation of a geo-data infrastructure which allows to display the spatial dimension in demographic structures and processes. In recent years, historic GIS databases have been created for several countries, providing information on the administrative division and its development over time. GIS databases have, for

example, been established for Great Britain, the US and Belgium (see *Gregory and Healey 2007: 640* for an overview), while the HGIS Germany database was built for Germany at the *Regierungsbezirk* level (*Kunz and Zipf 2008*). The Max Planck Institute for Demographic Research (MPIDR) is, in cooperation with the Chair for Geodesy and Geoinformatics at the University of Rostock, also contributing to this endeavour by setting up the MPIDR Population History GIS Collection. This project aims to fill existing gaps in the geo-data infrastructure by producing coherent GIS libraries containing information on the administrative division of Europe, Germany and other selected countries and territories at different points in history. For Europe, shape files of the European states and their administrative regional division have been produced for the following time cuts: 1870, 1900, 1930, 1960, 1990 and 2007. These files usually cover the first sub-national administrative level. For Germany, with its frequent administrative border changes, a time series has been produced from 1815 until today. Whenever possible, changes down to the district level are covered. This geo-data should become freely available for scientific use in the near future.

In addition, the MPIDR is working on setting up coherent datasets containing official census and population change data for several European countries. In creating these datasets, we digitise and harmonise both aggregate and individual-level data. Other activities include the Population and Policy Database project, which gathers coherent information on policies with relevance to demographic behaviours and their development over time (e.g., family, health and naturalisation policies). This database aims to support research on interdependencies between demographic change and political structures and processes. Overall, the recent improvements in the data infrastructure are opening up new opportunities for fundamental research on the spatio-temporal aspects of demographic change.

#### 4. Research Examples

In the following section, we will present research examples to illustrate the benefits of the integrated research approach laid out above. In addition, we will demonstrate the potential of the new data infrastructure that is currently being constructed by the MPIDR and others. The first two examples deal with the persistence of spatial patterns of demographic behaviour, with a particular focus on demographic dividing lines. The latter often coincide with current or former political, economic or cultural borders. These divisions can persist over time, as illustrated by the examples of the east-west divides observed in non-marital fertility in Germany and in patterns of household organisation in (historical) Poland. The third example deals with spatial aspects of population ageing in Germany, contrasting the period 1990 to 2008 with developments in the period 1871 to 1910. These developments exhibit several similarities which suggests that these processes are subject to general principles that are rather constant over time, provided there are no major political constraints limiting the movement of people.

##### *4.1 The long-standing east-west demographic divide in Germany*

Research into demographic divides along geographic lines has a long tradition in demography. *Hajnal (1965)* described the existence of a historic west-east divide in European marriage patterns (see second example). Another dividing line has been proposed by *Reher (1998)*, who makes a distinction between societies with strong family ties in southern Europe and those with weak ties in northern Europe. This hypothesis is also supported by *Albertini et al.'s (2007)* work on intergenerational transfers. *Lesthaeghe (1977)*, also *Lesthaeghe and Neels 2002*) demonstrated that the language border in Belgium between the Flemish-speaking part in the north and the French-speaking part in the south has a long history as a demographic dividing line.

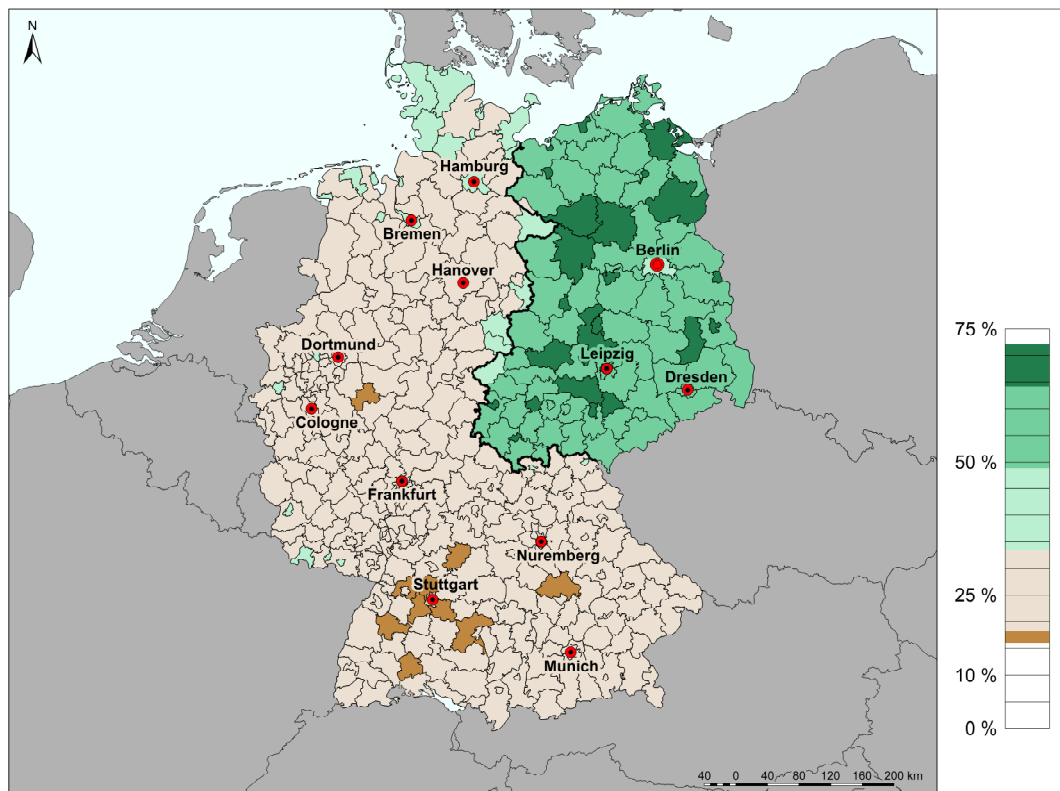


Fig. 1 Share of non-marital births in all births, 2008 (Source: German Federal Statistical Office; base map: © Bundesamt für Kartographie und Geodäsie 2009) / Anteil der nichtehelichen Geburten an allen Geburten 2008

Another important demographic divide is the border between the former GDR and western Germany. This dividing line has been the focus of a number of scientific publications since German reunification in 1990 (e.g., Höhn and Dorbritz 1995, Konietzka and Kreyenfeld 2002, Salles 2006). Several studies have looked at regional differences in the share of non-marital births, which was much higher in eastern than in western Germany prior to reunification. Some authors expected this divide to disappear (e.g., Höhn and Dorbritz 1995) as West German legal norms took effect in eastern Germany. However, the divide did not diminish, but rather increased further. Figure 1 shows the current non-marital birth ratios for all German districts.

It is relevant to note that the authors of the above-mentioned studies usually implicitly or explicitly assumed that the origins of this divide lie in the different political and socio-economic developments in East and West Germany in the period 1945-1990. However, an analysis of the historic development of this divide reveals that at least parts of the German-German border have had a longer history as demographic dividing line. This is illustrated in Figures 2-4 which display maps of demographic indicators for Prussian districts in the 1870s. The maps are based on a standardised dataset with 407 time-constant districts for the period 1875-1910 (see Galloway et al. 1994 for details).



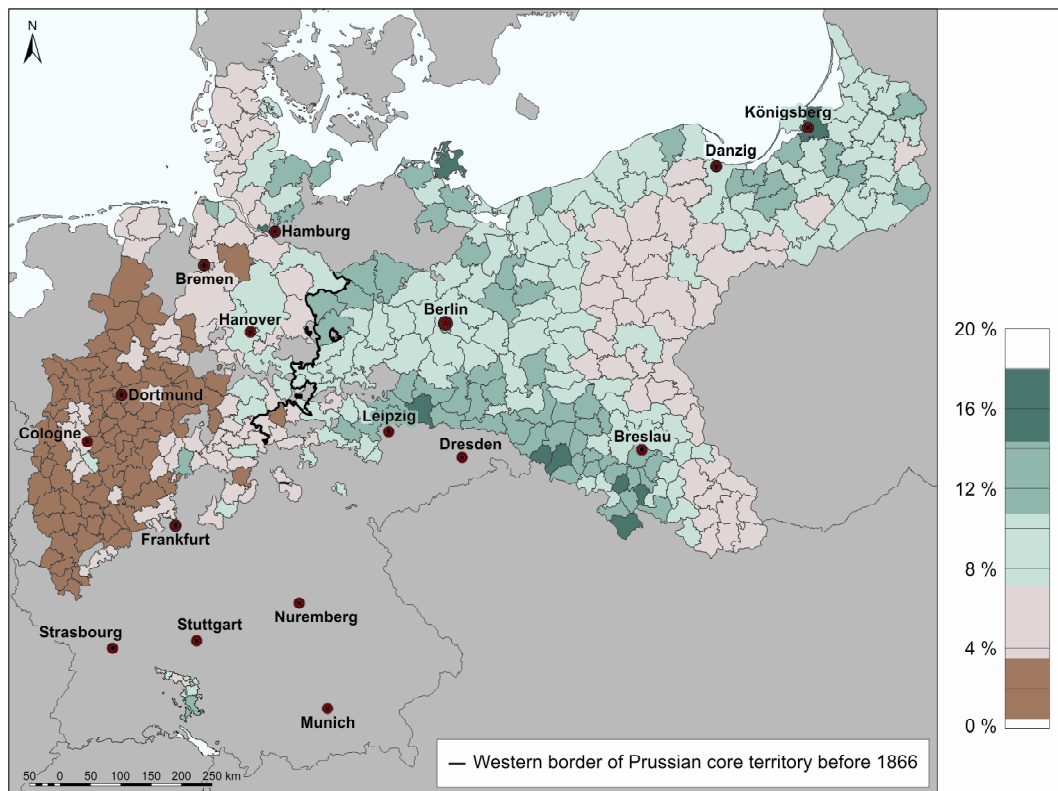


Fig. 2 Share of non-marital births in all births, 1875 (Source: Prussian Statistical Office, own calculations; Base Maps MPIDR and CGG 2011, based on *Hubatsch* 1975; HGIS Germany) / Anteil der nichtehelichen Geburten an allen Geburten 1875

For categorisation purposes, we chose the standard deviation scheme. With the exception of the highest and the lowest categories, this generates intervals of equal distance, which, in our case, are preferable to quantiles, as our distributions deviate substantially from a normal distribution. In contrast to a simple equal-interval distribution, the standard deviation categorisation has the advantage that it is centred on the mean and is less sensitive to extreme outliers. Values above the mean are in green shades, while values below the mean are in brown shades. This categorisation scheme will also be used in the demographic maps of the second and third examples.

*Figure 2* shows the share of non-marital births in the Prussian districts in 1875. The levels were substantially lower than today's levels. However, even then a clear east-west gradient was visible in those territories of Prussia which also belong to present-day Germany. Even more evident is the divide in the share of divorced women in the female population above age 15 (*Fig. 3*). Interestingly, an east-west divide was found during that period not only for indicators related to fertility and nuptiality, but also for mortality-related indicators, such as marital infant mortality (see *Fig. 4*).

For the share of non-marital births and infant mortality rates, we also have data for the whole

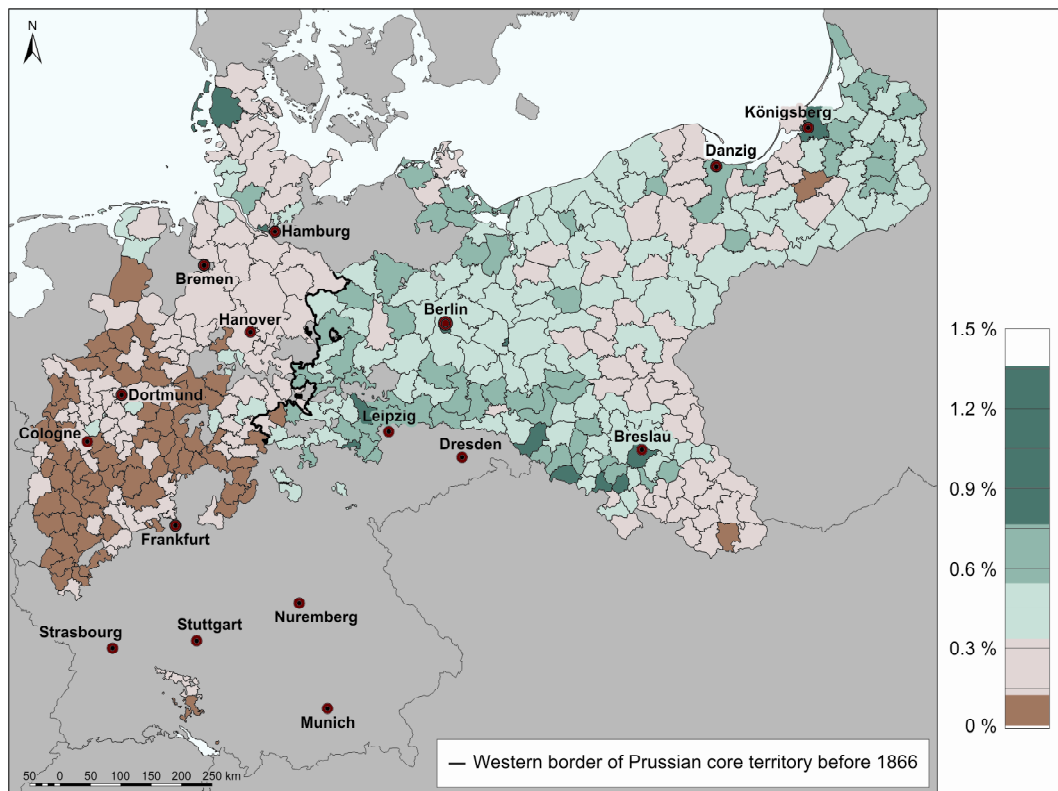


Fig. 3 Share of divorced in female population aged 15 and above, 1871 (Source: Prussian Statistical Office, own calculations; Base Maps MPIDR and CGG 2011, based on *Hubatsch 1975*; HGIS Germany) *Anteil geschiedener Personen an der Gesamtzahl der Frauen über 15 Jahren im Jahr 1871*

German Empire. These data indicate that the east-west dividing line was not identical to the line which later became the German-German border. The indicator values of Bavaria, for example, were more comparable to the values of regions in today's eastern Germany than with western German regions. The same is true for the state of Braunschweig. But these exceptions do not challenge the general finding that, as early as in the late 19<sup>th</sup> century, there was a clear east-west gradient visible in a number of demographic indicators.

Research on factors that contributed to the emergence of the divide is currently underway

(*Klüsener and Goldstein 2012, Gehrman and Scholz 2010*). Thus, we can only present preliminary results, with a focus on the divide in shares of non-marital births. In general, it is important to note that large sections of the borderline between the core Prussian territories in the east and the territories in the west have long been state borders. Some sections can be traced back to the Middle Ages. The line did not lose its function as a state border until the mid-1860s, when, as a result of the Austro-Prussian War, Prussia annexed several northern and central German regions (see *Fig. 5*). The old western border of the Prussian core territory prior to 1866 is highlighted in *Figures 2-6*.

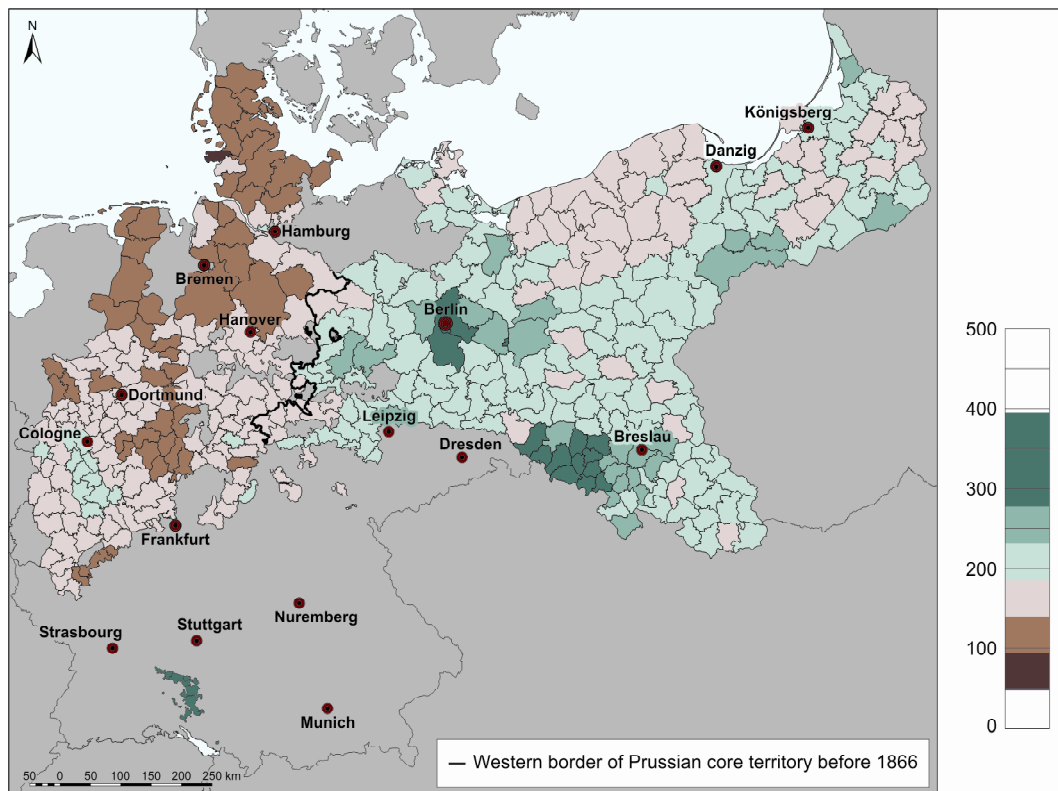


Fig. 4 Marital infant mortality, 1875 (Prussian Statistical Office, own calculations; Base Maps MPIDR and CGG 2011, based on *Hubatsch* 1975; HGIS Germany) / *Sterblichkeit ehelich geborener Säuglinge 1875*

With regard to the nuptiality and fertility indicators, we believe that three factors are likely to have played a role in creating the divide: differences in religiosity, differences in economic organisation and differences in the legal framework. When considering the role played by religion, it is important to stress that the border was not, for the most part, a dividing line between different denominations. On both sides of the border, the people were predominantly Protestant (*Fig. 6*). But statistics collected by the Protestant church on participation in religious activities suggest that the population of the regions that later formed the GDR had become more secularised than western Germany as early as the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Evi-

dence for this was found by *Hölscher* 2001 who provided timeline data with a fine level of geographic detail on the number of communion participations per 1,000 Protestants and the number of church leavers per 1,000 church members in the first exit waves of the 20<sup>th</sup> century (see also *Klüsener* and *Goldstein* 2012). With respect to economic activities, clear east-west differences also existed in Germany. Most of the Prussian areas in today's eastern Germany were part of East Elbia, which was dominated by large estates and a large share of dependent agricultural labourers. Seasonal migration of agricultural workers was widespread and increased with the sugar beet boom in the late 19<sup>th</sup> century (*Moch* 2003: 122). Over the summer, these labourers lived far from

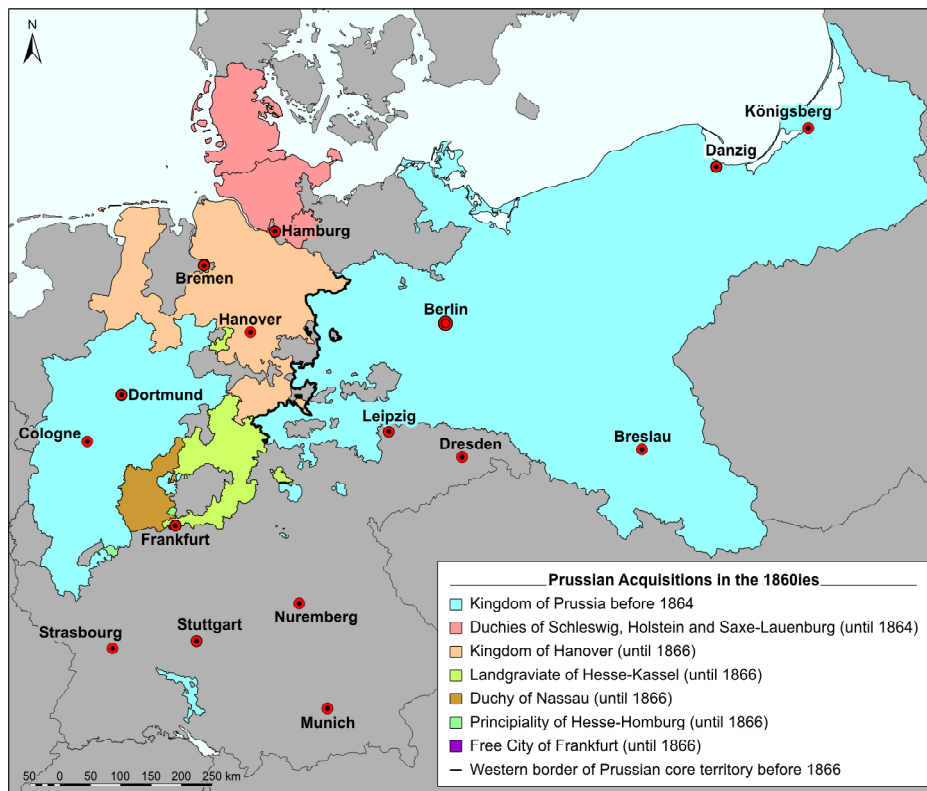


Fig. 5 Prussian acquisitions in the 1860s (Base Maps MPIDR and CGG 2011, based on Hubatsch 1975; HGIS Germany) / *Preußische Territorialgewinne in den 1860er Jahren*

home in mass dormitories, where there was little social control. This pattern of migration might have contributed to a higher risk of pregnancy among non-married women. In addition, the legal position of non-married mothers differed widely in Germany prior to the harmonisation of the civil law systems in 1900. Protections for these women were rather weak in the western German territories, particularly in those areas where civil law was based on the French *code civil*. The latter forbade any judicial inquiries into the father of a non-marital child. The Prussian civil code, on the other hand, stated that the father of a non-marital child had to support child and mother. This was mostly motivated by a concern for the child and its development, as Prussia needed

healthy soldiers. It is likely that this law also had an effect on non-marital birth trends.

This example demonstrates that distinct demographic differences between western and eastern Germany existed long before the division of Germany into two countries after World War II. From this case study we can derive two conclusions. First, the long history of the divide in non-marital births, which is influenced by cultural norms, means that it is very unlikely that this difference will disappear in the near future, despite a convergence of legal conditions in Germany after 1990. It also suggests that the role of the GDR in shaping distinct demographic patterns has been somewhat overstated in the literature. It appears that the period in which

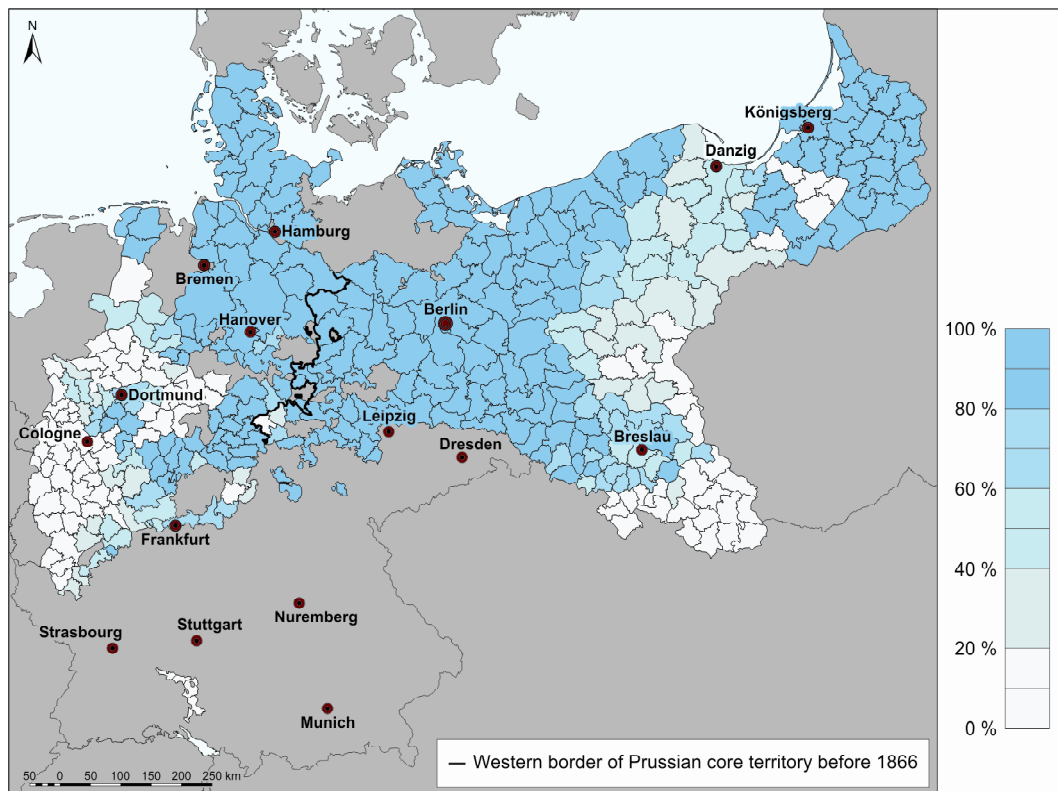


Fig. 6 Share of protestants in total population, 1880 (Source: Prussian Statistical Office, own calculations)  
*Anteil der Protestanten an der Gesamtbevölkerung 1880*

Germany was divided into two states with two different ideological systems served to deepen already existing differences in demographic behaviour, rather than to create new ones.

#### 4.2 Persistence of the past: household structure and composition in (historical) Poland

A substantial number of 20<sup>th</sup>-century scholars were concerned with the spatial divisions of European family systems. At least since the 1970s, scholars have been led to believe that both historical and contemporary family systems have not been distributed in a spatially random pattern, and that it is possible to brand ma-

ajor areas of Europe as having a particular type of system. Apparently ignoring the very real possibility that the geography of European family systems could be “complex and puzzling” (Laslett 1977: 14 ff., also Kertzer 1991), the typical perspective of Western scholars on Eastern Europe was that the region was dominated by complex family organisation patterns and familistic societal values (Laslett 1983, Wall 1995, 2001, Todd 1985, Therborn 2004, Berend 2003). For a long time, the spatial characteristics of Eastern European family systems were determined through bold interpretative inferences from single case studies (Czap 1982), which were then regularly cited as representative of larger spatial units, or even of whole regions.

*John Hajnal* and *Peter Laslett* were the most influential in popularising the viewpoint that there was a unique set of north-west European marriage and household patterns (*Hajnal* 1965, 1982, *Laslett* 1977), which distinguished “the west and the north of Europe from the east and the south” (*Laslett* 1971: 94). Eastern Europe has been commonly understood to represent the greatest intra-European departure from the “English standard” and from Western Europe as a whole. However, the authors’ geographic accounts were very non-systematic. *Hajnal* proposed a demarcation line from Saint Petersburg to Trieste, dividing the continent into two zones of sharply contrasting family systems. To the west and north of this line was the zone of nuclear family households, where marriage was late and far from universal. To the east and south of this line, the multi-generational complex family was ubiquitous, marriage was universal, and marriages took place at an early age (*Hajnal* 1982: 452f.). When taken literally, the “line” splits the historical Polish territories into two largely unequal parts. The eastern regions of the historical Poland-Lithuania were supposed to have marriage characteristics of “non-European civilisations” (*Hajnal* 1965: 104), and family complexity that diverges from “Western European standards”.

In a similar spirit, *Laslett* used data from several single location points in preindustrial Europe (although none from Poland) as illustrative of regions of Europe which seem to have had distinct family and household forms (these “domestic group tendencies” were West, West/Central or Middle, Eastern and Mediterranean; see *Laslett* 1983: 516, 526f.). The domestic group constituencies in Poland, as well as in other East-Central European regions, were placed in an intermediate category that was, however, closer to the West than to the Mediterranean or the East, with large parts of historical Poland being placed within the Eastern zone of familial tendencies.

Some scholars have attributed these supposed differences in household structure to underlying cultural differences, arguing that Slavic populations were more “collectivist” than other European societies (*Macfarlane* 1981, *Czap* 1982, 1983). It has also been proposed that, since the late Middle Ages, the dividing line between the Western and Eastern Churches was located in the area of the Hajnal line. Others have emphasised the role of economic factors, arguing that the complex households in Eastern Europe arose from peasants’ survival strategies within the coercive system of serfdom (*Czap* 1982, 1983, *Alderson* and *Sanderson* 1991). In fact, the agrarian constitutions and the historical settlement patterns developed very differently in the western and eastern regions of Poland. Whereas a strong manorial system was introduced in the western part of Poland starting in the Middle Ages, the development of this system on the eastern fringes was much slower, and its full acceptance was delayed in part by prevailing demographic and ecological constraints (*Szoltysek* 2008a, *Szoltysek* and *Zuber* 2009). Recently, *Kaser* and *Mitterauer* posited clear functional relationships between different elements of Eastern Europe’s socio-economic and cultural characteristics, which came together in Central Europe to create a significant “zone of cultural transition” between Western and Eastern European family and household formation patterns, systems of kinship and patterns of inheritance (*Mitterauer* 1999, *Kaser* 2002).

Research on interwar Poland has also noted the divergence of broad demographic patterns among the population in the eastern part of the country (e.g., *Fogelson* 1938, *Obrębski* 2007). This was usually seen as a more general package of features in which the specific characteristics of the family system were linked to a high-pressure demographic environment of excessive fertility and high mortality, rural poverty, persistence of anti-modern values and other obstacles to the penetration of capitalism and its individualist values (e.g., *Fogelson* 1938, *Obrębski* 2007).

Despite the prevailing view among historians that Poland represents, at least historically, an intermediate case between Western and Eastern Europe, it is interesting to note that relatively few researchers have looked at the role of spatial differences when analysing contemporary family formation processes in Poland. Most of the existing studies on the topic have been conducted at the national level, ignoring inter-regional variations in household behaviour in Poland (space), and without giving enough consideration to developments preceding the 1960s (time) (Schwarz 1988, Kuijsten 1996, Kotowska 1999). A common framework for this research was the progressive decline in cohabitation among two or three generations, which was explained using a mixture of the classic modernisation theory and the Second Demographic Transition theory which posits an individualisation of preferences and shifts in cultural and social norms (Lesthaeghe and Surkyn 2002). This narrow focus on developments in recent decades is likely to be incomplete, particularly if only developments after World War II are taken into account, without the inclusion of spatial variations.

In the following, we will present recently digitised historical data, which allow us to take a much more detailed look at the historical development of spatial household patterns in Poland. In order to test the hypotheses of Hajnal and Laslett and to improve access to historical regional data on Poland, the CEURFAMFORM Database has been constructed. It provides household-family variables for as many territories of historical Poland-Lithuania as possible. The database has been built around the remnants of historical micro-censuses from Poland and Silesia (regions 1-7), Belarus (regions 11N and 11S) and Ukraine (regions 8 and 10) (Fig. 7)<sup>2</sup>. Currently, it consists of 240 micro-censuses, conducted between 1766 and 1799, which cover more than 1,000 villages with almost 27,000 households and a total population of 155,000 individuals. Most of these data are spatially dispersed. Fortunately, however, these

“samples” have been quite evenly spatially distributed over major historical regions of the country (Szołtysek 2008a, Szołtysek and Biskup 2008).

Our analysis of this material showed that the typical family system of the Polish-Lithuanian Commonwealth at the end of the 18<sup>th</sup> century had several distinct characteristics. Most importantly, a clear pattern of progression was seen relative to the figures for Western (Poland proper), Eastern 1 (eastern Poland, central Belarus and Ukrainian northern ethnic territories) and Eastern 3 (southern Belarus) (Fig. 7)<sup>3</sup>. Almost all of the indexes indicated that household complexity increased consistently, moving from west to east. In the Western region, families were predominantly simple (over 78 % of all households), domestic groups were of a moderate size, and these groups did not contain large numbers of co-residing kin. In this region, marriage was rather late for males (age 27), but occurred at a moderately low age for women (age 21.5). In two eastern clusters, a larger number of complex households was found, and the share of multiple-family households was much bigger than in the Western region (33.2 % in Eastern 1 and 54.2 % in Eastern 3, compared to 8.8 % in the West). The age at marriage also declined when moving to the east (24 for males and 19 for females) (Szołtysek 2008a, 2008b). This research demonstrates that, at a high level of aggregation, Hajnal’s polarised model of different family systems may hold true in the eastern part of the continent.

Because only small amounts of historical material have survived, tracing the continuities and/or discontinuities of patterns observed in the late 18<sup>th</sup> century with those of later periods (particularly in the 19<sup>th</sup> century) is very difficult. The demise of Poland after 1795 and the country’s changing borders from 1918 through 1945 add to the problem. For much of the 19<sup>th</sup> century, tracking down developments in household structures and family behaviours in Polish historical territories requires combining data from differ-

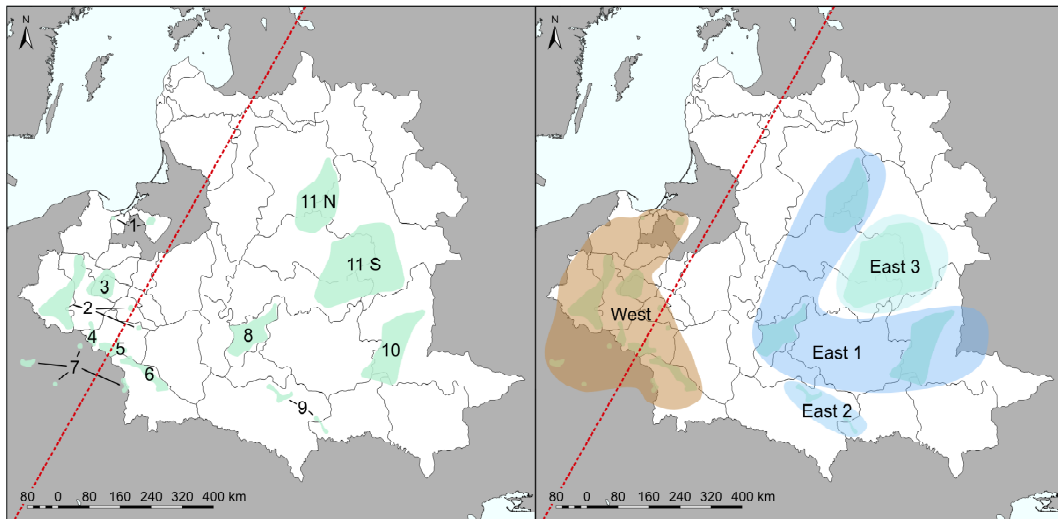


Fig. 7 Spatial sample distribution (Poland-Lithuania before 1772) and supposed division of family systems in East-Central Europe; family systems in Poland-Lithuania, 1790 (Source: CEURFAMFORM; Base map: MPIDR and CGG 2011, partly based on © Eurogeographics for the administrative boundaries 2011) / *Räumliche Verteilung der Stichproben (Polen-Litauen vor 1772) und angenommene Teilung der Familiensysteme im östlichen Zentraleuropa; Familiensysteme in Polen-Litauen 1790*

ent national statistics (German, Austrian and Russian) and is therefore particularly difficult although not entirely impossible<sup>4</sup>. Unfortunately, the first national census of Poland from 1921 contained only the crudest data on household co-residence and is therefore of no use in the present context (Rothenbacher 2002: 568 ff.). More detailed estimates are not available prior to the second Polish census of 1931.

Despite the gap of more than a century between the historical “samples” discussed above and the material from the 1930s, there appear to be surprising spatial continuities in patterns of co-residence. A province-level map of the Second Polish Republic shows (Fig. 8) that the east-west divide between regions with lower and higher complexity of co-residence patterns persisted as recently as in the early 1930s. As was the case in the late 18<sup>th</sup> century, the western and central provinces of rural Poland in 1931 had the lowest proportions of multiple-family households, with the percentages

being only slightly larger than they were 140 years earlier (the proportion of multiple-family households in the Western cluster in the 1790s was 8.83 %, while during the interwar period, it was usually below 11 %) (Szoltysek 2009)<sup>5</sup>.

This general continuity of spatial patterns of co-residence in Poland does not, however, imply that the family system was stable in the eastern parts of the country for more than a century. Despite a persistent division of Poland into western-lower complexity areas and eastern-higher complexity areas, the share of multiple-family households among the latter in 1931 was significantly lower than at the end of the 18<sup>th</sup> century. Whereas in the latter period, multiple-family households in the areas located to the east of Hajnal’s line accounted for almost 39 % of all units, they made up no more than 18 % of all of the households at the province level in 1931. County-level data add more variability to the pattern described above, but do



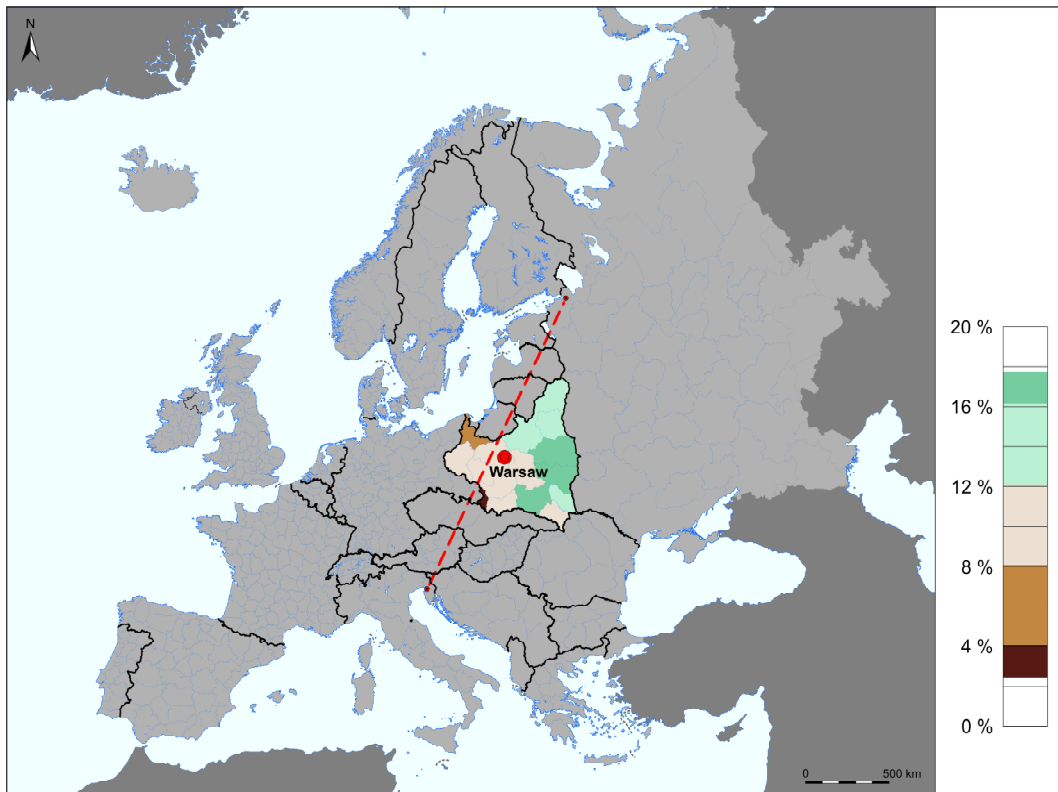


Fig. 8 Multiple-family households in rural areas of Poland, 1931; Hajnal line (Source: Polish Census 1931, own calculations. Base Map: MPIDR and CGG 2011, partly based on © EuroGeographics for the administrative boundaries 2011) / *Mehrfamilienhaushalte in ländlichen Regionen Polens 1931, Hajnal-Linie*

not alter the general picture. In fact, the progressive decline in the complexity of family systems in eastern Poland during the first decades of the 20<sup>th</sup> century was reported by several authors (e.g., Siebert 1998, Obrebski 2007). Compared to the changes that took place between the 18<sup>th</sup> and the mid-20<sup>th</sup> centuries, the developments after World War II appear to have been much less dramatic. Kotowska (1999: 16), for example, gives figures of 77.8 % for one-family households in Poland in 1970 and 73.3 % in 1995.

Overall, the example shows that the large-scale digitisation and geo-coding of historical demo-

graphic datasets in Eastern (Central) Europe can serve at least three important purposes. First, it allows us to test the grand theories of European family systems, which had – at least for this part of Europe – been based on rather thin empirical evidence. Second, they permit us to take a longer view of changes in regional household formation patterns. These seem to be quite persistent over time, suggesting that path dependencies might still play a role today in areas that were once part of Polish-Lithuania. Third, the long-term perspective allows us to investigate to what extent recent changes in household patterns can be considered severe relative to developments in earlier periods.

### 4.3 Spatial aspects of population ageing in Germany (1871-1910 vs. 1991-2008)

In recent decades, the populations of almost all European regions have experienced a substantial ageing process (Grant et al. 2004). However, across space, the intensity of this process differs widely. Many regions in north-west Europe are ageing at a rather slow pace, partly because of relatively high fertility levels and/or partly due to a positive migration balance. Other regions, particularly in Eastern Europe, are experiencing a much more rapid ageing process. These trends raise the question of how both nations and regions can successfully cope with the challenges that stem from these developments. In addressing this issue, it would be helpful to have a clear understanding of the factors that are driving this process, and of the spatial and temporal dimensions of the problem.

So far, however, there has been a lack of systematic research on this topic (see also *Martí-Henneberg* 2005). Official regional population predictions are often still based on relatively crude assumptions about future fertility, mortality and migration trends, which are, in turn, usually based on past developments in the respective regions. We believe that the use of GIS models – which are based on spatially sensitive theories from fields such as economics, social geography or demography and which take into account processes operating at different geographical scales (global, national, regional) – could improve our ability to make future population projections at different spatial scales. We also believe that taking a long-term view with a fine level of geographic detail could enrich our understanding of the processes at work. We will briefly lay out our approach in the following example which contrasts spatial aspects of population ageing in Germany over the last 20 years with developments in the period between 1871 and 1910.

Since 1989, east-west differences have dominated the geography of population ageing in Germa-

ny. The population of eastern Germany has aged much more rapidly than the population of western Germany. This gap is largely attributable to the slower economic development in the former GDR relative to the western German states, which has created incentives for young eastern Germans to move to western Germany to seek better job opportunities (Wolff 2006, Mai 2007).

However, with economic conditions improving in eastern Germany, can we expect to see the emergence of a new spatial migration and population ageing pattern? In answering this question, it might be helpful to look at a period prior to the founding of the GDR, when the socioeconomic geography of Germany was not influenced by the legacy of a communist state. Thus, we contrast the developments of the last 20 years (Figs. 11 and 12) with trends observed in Prussia in the period from 1871 until 1910 (Figs. 9 and 10). Unfortunately, we cannot present data for the whole German Empire, as we still need to digitise the information for the other member states. But as Prussia included more than half of the territory of the German Empire at that time, covering most of the northern and central part of today's western Germany and substantial parts of eastern Germany, we believe that such a comparison is meaningful. Both periods were eras of rapid globalisation, with relatively few limitations placed on freedom of movement. In addition, in neither period was Germany involved in large-scale warfare activities which are likely to have a substantial effect both on the age structure and the spatial distribution of the population.

Our variable of interest is the old-age dependency ratio, which we defined as the number of elderly people per 1,000 inhabitants of economically active ages. Due to data limitations, we were forced to use slightly different age categories for the two periods studied. For the period 1871 until 1910, we treated the population aged 15 to 60 as economically active and the population above age 60 as the elderly population. Meanwhile, for the period 1990-2008, the elderly were

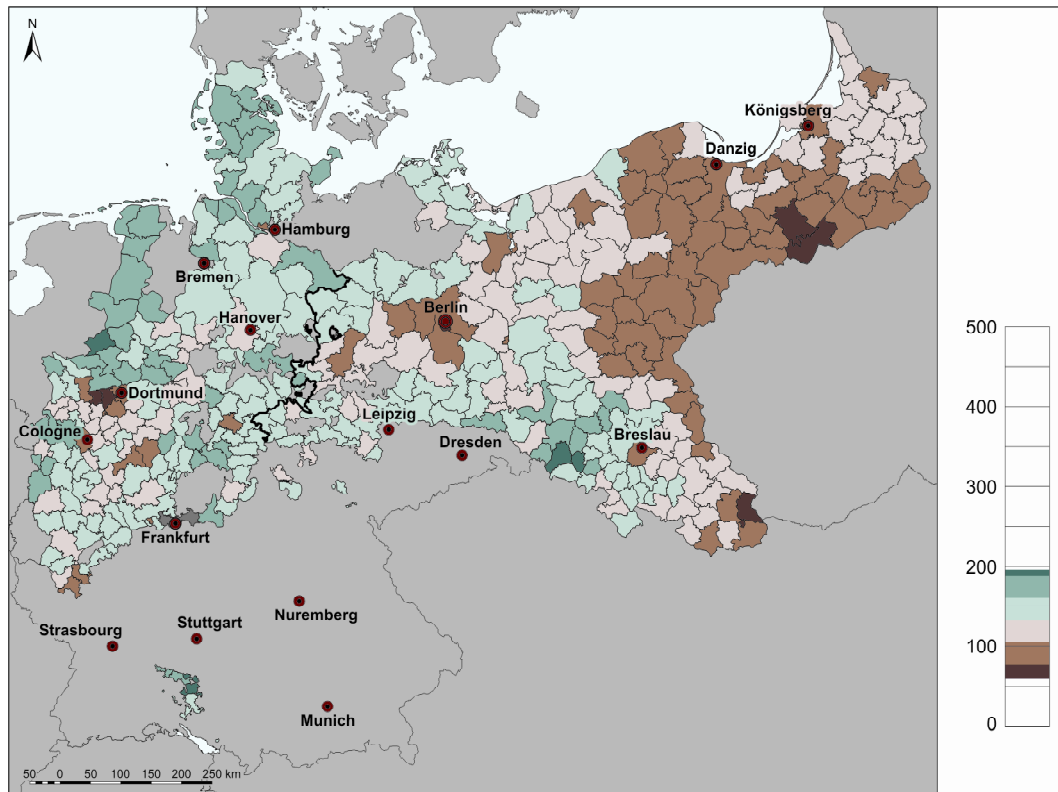


Fig. 9 Old-age dependency ratio (Pop. > 60/Pop. 15-60), 1871 (Source: Prussian Statistical Office, own calculations. Base Maps MPIDR and CGG 2011, based on *Hubatsch* 1975; HGIS Germany) *Altersquotient (Bev. > 60 / Bev. 15-60) 1871*

defined as those over age 65. This is in part also adjusting for improvements in life expectancy at age 60, which changed for men from 15.0 years in 1871/1880 to 19.8 years in 2001/2003 and for women from 15.9 to 23.9 years (*Imhof* 1994, German Federal Statistical Office).

The comparison of spatial aspects of population ageing in the two periods of interest reveals some striking similarities, both in the initial conditions and in the development. If we first look at the starting conditions in the two time periods, we see in both cases a large cluster of districts with relatively low old-age dependency ratios in the northeast. In 1870, these regions were the provinces of East

and West Prussia as well as Posen (*Fig. 9*); in 1990, the cluster was centred on Brandenburg and Mecklenburg-Western Pomerania (*Fig. 11*).

If we look at the overall development in these two time periods, we find that the trends in the old-age dependency ratio are much greater in the recent period than in the late 19<sup>th</sup> century (see legends in *Figs. 9-12*), even though the former covers a time period less than half as long as the latter. But if we focus on changes in the relative position of the regions within Prussia/Germany, we can see that, in both periods, the eastern regions experienced higher increases in old-age dependency ratio than the western regions.

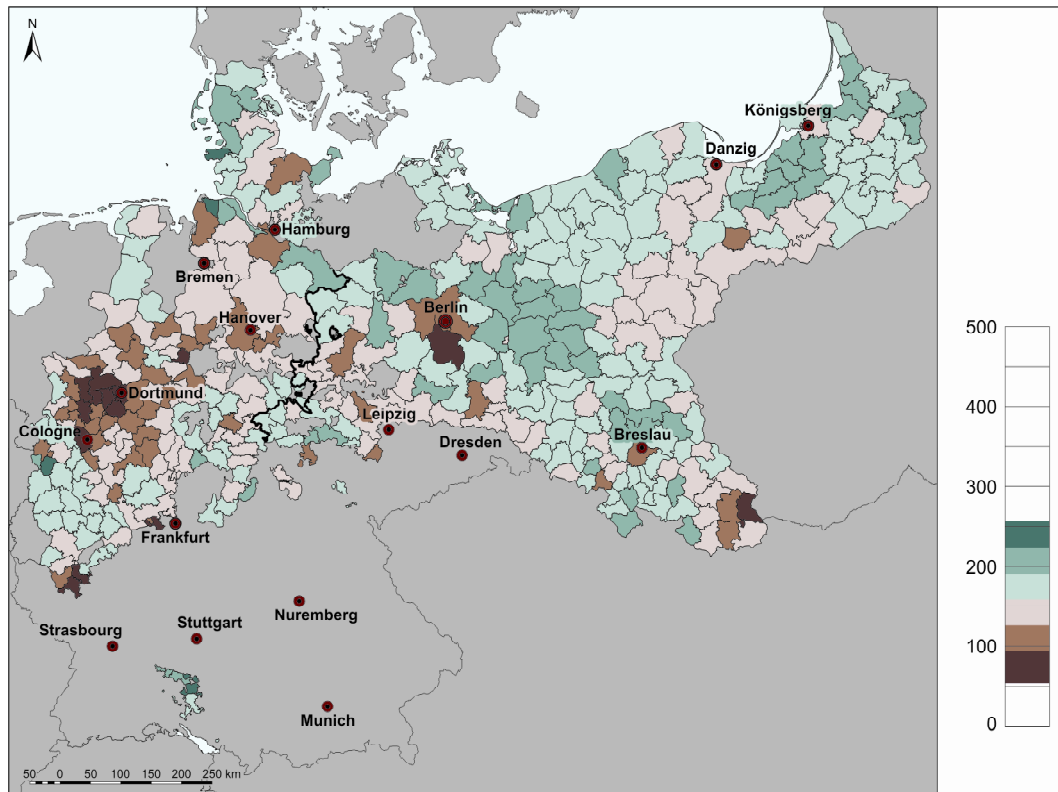


Fig. 10 Old-age dependency ratio (Pop. > 60 / Pop. 15-60), 1910 (Source: Prussian Statistical Office, own calculations. Base Maps MPIDR and CGG 2011, based on *Hubatsch* 1975; HGIS Germany)  
*Altersquotient (Bev. > 60 / Bev. 15-60) 1910*

In addition to these broad resemblances, we can also see similarities on a smaller scale. In both periods, for example, the areas of the state of Brandenburg located farthest from Berlin were ageing rapidly, while the areas close to Berlin were ageing at a much slower pace (see *Figs. 9-12*). This gap is mainly attributable to the processes of age-selective migration between Berlin and its surrounding areas in the context of urbanisation and suburbanisation processes.

In the period of 1871-1910, Berlin and the Ruhr area in particular benefited from in-migration from the east (*Kirsten et al.* 1966). This migration was driven by economic developments and

was especially high in periods of economic growth (*Langewiesche* 1977: 9). In addition, in the period after 1991, Berlin and its surrounding areas benefited from in-migration, making the old-age dependency ratios in these areas lower than the ratios of other eastern German areas (see *Fig. 12*). The Ruhr region, on the other hand, is today among the old-industrialised areas of western Germany suffering from structural economic problems which have not benefited substantially from in-migration flows over the last two decades. As a result, the region has a comparatively high old-age dependency ratio. Similar developments can also be observed in the old-industrialised areas around Salzgitter, south of

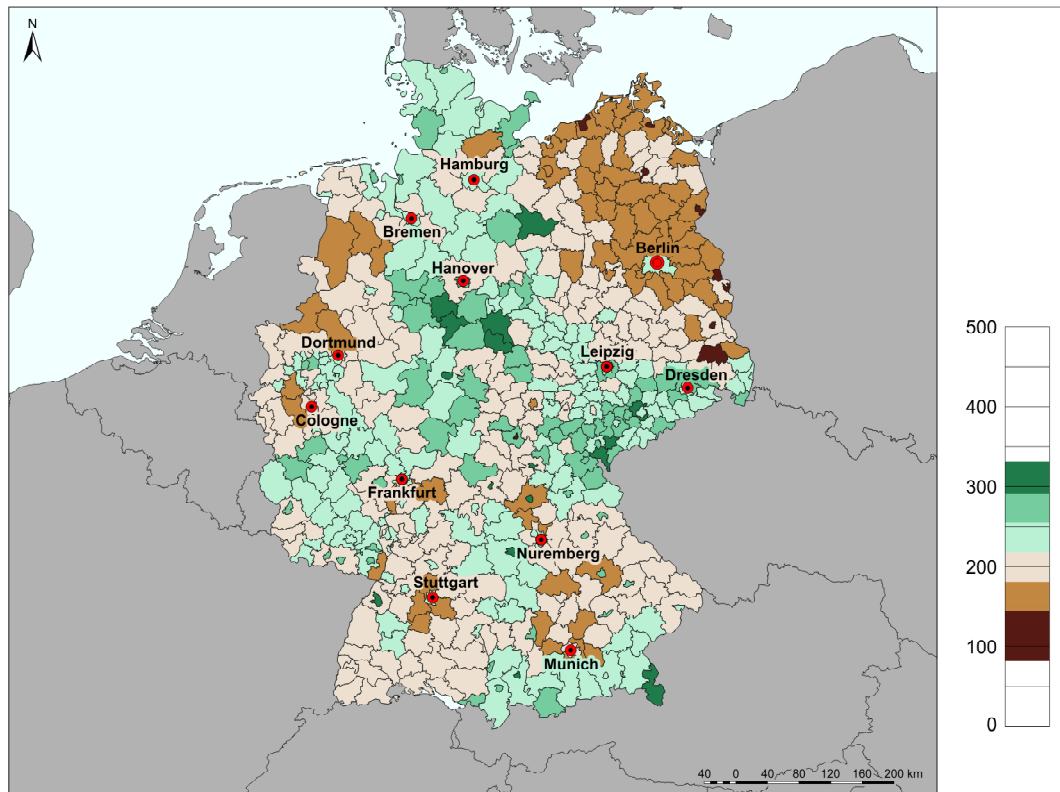


Fig. 11 Old-age dependency ratio (Pop. > 65 / Pop. 15-65), 1990 (Source: German Federal Statistical Office, own calculations. Base Map: MPIDR/CGG 2011, partly based on © Bundesamt für Kartographie und Geodäsie 2009) / Altersquotient (Bev. > 65/ Bev. 15-65) 1990

Hanover, or in the city of Bremen. By contrast, the prosperous areas in southern Germany and along the Rhine and the Ems corridor in western Germany saw the smallest increases in old-age dependency ratios. In some areas, such as the Ems region in northwestern Germany, the low old-age dependency ratio is also the result of relatively high fertility rates.

Apart from Berlin, the only other area in eastern Germany with modest old-age dependency ratios is western Mecklenburg. This region benefits from its proximity to Hamburg, making it attractive for commuters working in Hamburg (Kühntopf and Tivig 2007: 24). These rather low

dependency ratios may also to some extent represent a holdover of the high fertility rates prevalent in the northern part of the GDR (Weber 1991: 241). A big cluster with high old-age dependency ratios stretches from Saxony and Saxony-Anhalt into the southeastern part of the western German state of Lower Saxony. This includes declining old-industrialised areas, such as Magdeburg-Halle-Gera (Herfert 2007), as well as the comparatively prosperous regions around Leipzig and Dresden. However, the current high old-age dependency ratios in Saxony (Fig. 12) are not solely the result of out-migration after 1991, as Saxony experienced lower out-migration rates in the period 1991-2004 than Thuringia, Saxony-

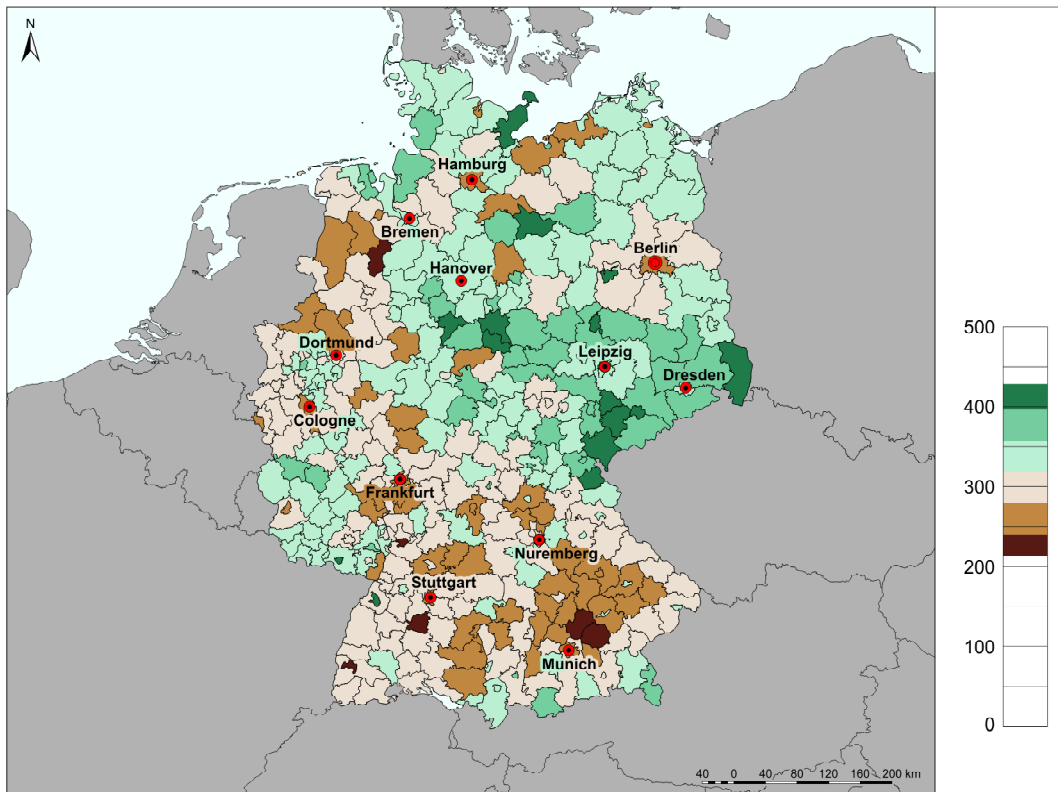


Fig. 12 Old-age dependency ratio (Pop. > 65 / Pop. 15-65), 2008 (Source: German Federal Statistical Office, own calculations. Base Map: © Bundesamt für Kartographie und Geodäsie 2009)  
*Altersquotient (Bev. > 65 / Bev. 15-65) 2008*

Anhalt or Mecklenburg-Western Pomerania (Mai 2007: 257). It appears that the long history of low fertility rates in Saxony, both in GDR times (see Weber 1991) and in earlier periods (Knodel 1974), have resulted in the current high old-age dependency ratios in this area.

In general, we can conclude that in the two periods many similarities can be observed with respect to spatial aspects of population ageing. This is particularly true for the east-west disparities in the development of the old-age dependency ratio. In order to identify the general factors driving these trends, in future research we intend to investigate the extent to which it is possible to

model the observed processes using a GIS-based model. Economic explanations for the observed pattern might be based on the work of Myrdal (1957), Buttlar et al. (1977) and Krugman (1991) who developed concepts and models that enable us to explain why spatial disparities in economic development and livelihood opportunities are likely to increase, rather than decrease, over time, even under free-market conditions. This phenomenon may, for example, be caused by spillover effects in the centres of economic activity and selective migration of highly qualified persons into those regions (see also Greenwood 1975). Explanations of why in Germany this polarisation tends to exhibit a west-east gra-

dient might be derived from discussions related to spatial aspects of European and global integration processes. *Brunet* (1989) has pointed out that substantial parts of western Germany belong to the so-called European Backbone. This is an arc stretching from southeastern England across the Benelux countries and the Rhine area to the regions north and south of the Alps which is characterised by a high level of economic development, as well as population density. This arc already existed in 1870 and has since grown in significance (*Martí-Henneberg* 2005). It may be assumed that spillover effects in these highly developed areas tend to reinforce an already existing west-east gradient in economic development in Germany.

But pure economic theories would probably fall short in explaining the observed spatial pattern of population ageing. Migratory decisions, which today are the main cause of spatial disparities in population ageing in Germany, are not just an effect of differences in job opportunities between the current place of residence and a potential migration destination. Social capital considerations, such as the embeddedness in social kin and non-kin networks, both at the place of residence as well as at the potential migration destinations, also play an important role (see, e.g., *Massey* et al. 1993, *Haug* 2000). These factors would also need to be taken into consideration as they may enable us to explain why it is that, despite persisting spatial disparities in economic development in Germany, we do not currently see massive internal migration flows from economic disadvantaged areas to more prosperous ones.

## 5. Conclusion and Outlook

In this article, we called for closer cooperation between demographers, geographers and historians studying aspects of demographic change. The recent spatial turns in demography and historical sciences – together with advancements in histor-

ical data infrastructure projects, GIS technology and spatio-temporal modelling – offer plenty of opportunities for innovative empirical research in an integrated research field. Our research examples have shown that research focusing on a single aspect of demographic change – such as changes in the life course trajectories in national-level samples, spatial variation at single cross-sections or broad long-term changes in historical perspectives – are likely to give an incomplete picture.

The first example of the German east-west divide in marriage and fertility behaviours revealed that the divide is much older than is usually assumed in demographic studies. This implies that any explanation that only refers to developments after 1945 is likely to be incomplete. The second example illustrated that, while there is a high level of awareness among historians of the spatial differences in household formation strategies in Poland, this spatial awareness has been largely absent in recent demographic studies on changes in family formation strategies in Poland. The observed spatial pattern also calls into question whether Poland should be treated as having a particular type of family system, without careful investigation of historically dependent features of multiple sub-populations in their spatial contexts. The third case study on spatial aspects of population ageing in Germany demonstrated that an east-west gradient in regional population ageing can be observed not just over the last 20 years, but also in the period 1871-1910. These results suggest that, in addition to the legacy of the GDR, the rather peripheral spatial position of eastern Germany in relation to the centres of economic activity in Europe seems to have had an effect on these trends. The findings also lend support to the assumption that the population will continue to age more rapidly in the eastern than in the western parts of the country. However, regional development policies might provide instruments for improving (at least) the integration of eastern German metropolitan areas into the global economic system (for general comments, see, e.g., *Vandermotten* 2006).

We should point out that some of the research results presented here are preliminary in nature and require further validation. We also did not use in our examples all of the analytical potential that GIS technology currently offers (see, e.g., *Haining* 2003 for a detailed account). Before we can move on to more sophisticated modelling, we need to work on improving the (geo-)data infrastructure. With regard to the latter, we also showed that joint endeavours at the intersection of demography, geography and history are much less constrained by data limitations today than they were even a decade ago. For this research field to develop further, it is also necessary to intensify the exchange of concepts and particularly of quantitative methodological approaches between the three disciplines.

### Notes

<sup>1</sup> “Old-industrialised area” is a direct translation of the German term “*altindustrialisierter Raum*” which refers to regions that were among the first in Germany to undergo a process of industrialisation in sectors such as mining, shipbuilding and textile and porcelain production. Because these areas have long been dominated by economic monostructures, local stakeholders have been relatively inflexible in reacting to new economic challenges. As a result, in recent decades many of these areas have experienced structural economic crises with high levels of unemployment.

<sup>2</sup> Regions 11N, 11S, and 10 are almost entirely outside of Poland’s present-day eastern border; region 8 is currently split between Poland and Ukraine. However, the family and household structure features in these regions can be considered similar to the Belarussian and Ukrainian subpopulations located farther to the west, but for whom historical data were not available.

<sup>3</sup> These groupings emerged from formal clustering procedures. Because of a small number of cases, cluster East 2 is treated as not fully representative and is not discussed here.

<sup>4</sup> Currently, data collection activities are being carried out at the Laboratory of Historical Demography at the MPIDR that should fill this gap in the future.

<sup>5</sup> In 1931, more than 80 % of all family households in Poland were single-family households.

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*Summary: Towards an Integrated Understanding of Demographic Change and its Spatio-Temporal Dimensions: Concepts, Data Needs and Case Studies*

This paper outlines how a GIS-based empirical research approach at the intersection of demography, geography and historical sciences can improve our understanding of the spatial and temporal dimensions of demographic change processes. The recent spatial turns in demography and historical sciences offer new opportunities for interdisciplinary research in this field. Furthermore, we provide an account of recent improvements in (geo-)data infrastructure which seek to overcome the data

limitations that have so far restricted research in this field. Three case examples illustrate the potential of this approach. They show that research focusing on a single aspect of demographic change – such as changes in the life course trajectories in national level samples, small-scale spatial variation at single cross-sections, or long-term historical changes on a large geographic scale – is likely to give an incomplete picture of the past and present factors driving these trends. The first case study deals with the east-west spatial divide in non-marital fertility in Germany, the second with regional variations in household structures in Poland and the third with long-standing spatial disparities in population ageing in Germany.

*Zusammenfassung: Eine integrierte Analyse des demographischen Wandels und seiner raumzeitlichen Dimensionen: Konzepte, Datenerfordernisse und Fallbeispiele*

Der Artikel legt dar, wie ein GIS-basierter empirischer Forschungsansatz an der Schnittstelle zwischen Demographie, Geographie und Geschichtswissenschaften dazu beitragen kann, unser Wissen über die räumlichen und zeitlichen Dimensionen von demographischen Wandlungsprozessen zu vertiefen. Der momentan in der Demographie und den Geschichtswissenschaften zu beobachtende *Spatial Turn* eröffnet neue Möglichkeiten für interdisziplinäre Forschung in diesem Feld. Außerdem geben wir einen Überblick über neueste Entwicklungen bei (Geo-)Dateninfrastrukturprojekten, die dazu beitragen, bisher bestehende Datenmängel in diesem Forschungsfeld zu beheben. Anhand von Fallstudien zeigen wir auf, dass die alleinige Untersuchung einzelner Aspekte des demographischen Wandels – wie etwa die Erforschung von Veränderungen in individuellen Lebensverläufen mit lediglich für die nationale Ebene repräsentativen Daten oder die Betrachtung kleinräumiger geographischer Variationen zu einem einzigen Zeitpunkt bzw. langfristiger historischer Veränderungen auf grober geographischer Maßstabsebene – Gefahr läuft, wichtige Ursachen der beobachteten Prozesse nicht zu erfassen. Die erste Fallstudie beschäftigt sich mit den räumlichen Ost-West-Disparitäten bei den nicht-ehelichen Geburten in Deutschland, die zweite mit

räumlichen Unterschieden bei Haushaltsstrukturen in Polen, während die dritte sich mit langfristigen Kontinuitäten bei den räumlichen Mustern der regionalen Bevölkerungsalterung in Deutschland auseinandersetzt.

*Résumé: Une analyse intégrée du changement démographique et de ses dimensions spatiales et temporelles: des concepts, des exigences en matière de données et des études de cas*

Ce document souligne comment une approche empirique de recherche basée sur le SIG à l'intersection des sciences démographiques, géographiques et historiques peut améliorer notre compréhension des dimensions spatiales et temporelles des processus de changement démographique. Les récents tournants spatiaux dans les sciences démographiques et historiques offrent des nouvelles opportunités pour la recherche interdisciplinaire dans ce domaine. Par ailleurs, nous donnons un aperçu des développements les plus récents en matière d'infrastructure des données (géographiques) qui ont pour objet de supprimer les limites en matière de données qui ont jusqu'à présent restreint la recherche dans ce domaine. Trois études de cas illustrent les potentiels de cette approche. Elles montrent que la recherche qui se concentre sur un seul aspect du changement

démographique – tel que les changements apportés aux trajectoires de la vie individuelle avec uniquement des données représentant le niveau national ou la prise en compte des variations géographiques à petite échelle ou les changements historiques à long terme sur une grande échelle géographique – risque de donner une idée incomplète des causes essentielles des processus observés. La première étude de cas traite de la disparité spatiale est-ouest en matière de naissances hors mariage en Allemagne, la seconde des différences spatiales au niveau de la structure des foyers en Pologne tandis que la troisième cible le vieillissement de la population avec des continuités à long terme en ce qui concerne les modèles spatiaux en Allemagne.

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