PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2022

Weather and Climate Vulnerability in Italian Demographic History

Introduction

The aim of the project is to identify the most vulnerable individuals and sociodemographic groups to the impact of weather shocks in the past. We consider the effects of sudden fluctuations in meteorological series such as temperatures, rainfall, humidity, and wind registrations as well as the impacts of catastrophic climatic events such as floods, heatwaves, and snow excesses. Using micro and macro historical sources, the project studies the historical interval from the last decades of the eighteenth century to the first half of the twentieth century in two Italian regions, Friuli and Emilia. In recent years, driven by global warming, the connections among climate, extreme weather events, and demographic variables have attracted growing interest. In this research context, particular attention was paid to short-to-medium term reactions. In historical demography, the first studies on this topic concerned the long-term relationships between climate and population (e.g., Le Roy Ladurie 1967). Short-term issues have been addressed only since the 1980s, with Lee's contribution to England (1981) assessing the relationship between temperature and rainfall (as well as grain prices) and fertility, mortality, and marriages. Some recent historical analyses relied on the use of individual data, allowing for a further qualitative leap in this research topic. There are not many studies of this type. However, we have a good number of articles on North-Eastern Italy (Derosas 2009; Dalla Zuanna & Rosina 2011; Scalone & Samoggia 2018; Fornasin & Rizzi under review) and Northern Sweden (Schumann et al. 2019; Karlsson et al. 2021). In these studies, attention was focused on the relationship between neonatal mortality and low temperatures. In these terms, knowledge concerning the impact of climate shocks is still limited in a peculiar framework and must be expanded, including other demographic outcomes, geographical settings, and social groups. In this project, for the most prolonged period from the early decades of the nineteenth century to the first decades of the twentieth century, most statistical analyses will combine individual longitudinal data and daily weather records, adopting specific modeling strategies for micro-demographic data. To include the second half of the eighteenth century, we adopt a regression approach for count data, as only monthly demographic series are available. We aim to fill the gap concerning the short-term weather impact on the historical demographic system before and during the demographic transition. Respect to previous historical research, this project expands the knowledge regarding the short-term impact of weather shocks on the demographic system not only focusing on mortality, but including other demographic outcomes such as fertility, marriages and migrations. In these terms, the project compares the demographic effects of the weather shocks in different geographical settings, using similar data and same methods.

Background

In recent years, driven by global warming, the connections among climate, extreme weather events, and demographic behaviors have attracted growing interest among scholars. In this research context, particular attention was paid to short-to-medium term reactions. In Europe, for example, numerous contemporary studies have reported on overmortality among the elderly caused by heatwaves in the summer of 2003 (e.g., Conti et al. 2005). In addition, other studies have focused on the impact of climate on migration or, albeit at a much lower frequency, on fertility (e.g. Lam & Miron 1996; Manfredini 2009), child health (Muttarak 2019). Historical demographers only partially follow these research perspectives. The first studies on this topic concerned the long-term relationships between climate and population (e.g., Le Roy Ladurie 1967). This theme met great success later when several scholars identified different climatic phases such as the medieval optimum population or the little ice age of the modern age, showing specific demographic adaptation processes (e.g. Collet & Schuh 2018). These works used long-term climatic reconstructions (Lamb 1982).

Short-term issues have been addressed only since the 1980s, with Lee's pioneering contribution to England (1981). Lee noted the relationships established at 3- to 5-year intervals between temperature and rainfall (as well as grain prices) and fertility, mortality, and marriages. This seminal study was followed by numerous other works from London (Galloway 1985), France (Richards 1983), Italy (Breschi & Gonano 2000), and Sweden (Bengtsson & Reher 1998). A number of comparative studies have also been conducted (Galloway 1994). Although the models, as well as the meteorological information (usually monthly averages of events), used in these research studies are entirely similar, the details of the demographic data are different. For example, in Galloway's (1985) study, the deaths were distinguished by age group, allowing the author to detect the strong impact of cold winters on the number of deaths in the younger and older age groups. Increases in summer temperatures significantly increased the number of deaths among the middle and old age groups. Decreased spring rainfall was related to the significant increase in the number of deaths in most age groups. An alternative approach considers the role of meteorological variables in connection with the seasonality of demographic phenomena such as mortality (e.g. Breschi & Livi-Bacci 1997). These studies also found excessively high winter neonatal mortality rates. Local meteorological measurements were often collected daily in these short-term analyses and then aggregated into annual, seasonal, or monthly averages. Other research studies based on time series also investigated the indirect effects of meteorological conditions on demographic conjuncture. For example, there are many studies on the spread of epidemics (e.g., Xoplaki et al. 2000), and even more numerous are those on agricultural production (e.g. Alfani 2010). In addition, some studies have paid particular attention to the consequences of exceptional events that caused sudden changes in the global climate, such as volcanic eruptions (Post 1977; Stothers 2000). The research studies mentioned used aggregate data. Some recent historical analyses relied on the use of individual data, allowing for a further qualitative leap in this research topic. There are not many studies of this type. However, we have a good number of research articles on North-Eastern Italy (Derosas 2009; Dalla Zuanna & Rosina 2011; Scalone & Samoggia 2018; Fornasin & Rizzi under review) and Northern Sweden (Schumann et al. 2019; Karlsson et al. 2021). In these studies, attention was focused on the specific relationship between neonatal mortality and low temperatures. The potential to expand this research field is therefore remarkable. For example, Ekamper et al. (2009) showed how the effects of extreme temperature waves were not only due to cold weather and concerned not only infants. Research studies that have investigated the connections between demographic and meteorological variables not related to temperature are still scarce. An exception is provided by Åström et al. (2016), who investigated the association of temperature and precipitation with total mortality from infectious and cardiovascular diseases in Ministero dell'Università e della Ricerca MUR - BANDO 2022 northern Sweden. These studies often used meteorological data collected daily or sub-daily. These research studies are still at an early stage. Recent studies based on individual data, especially concerning developing countries, have highlighted a wide range of relationships between meteorological and demographic variables, mainly mortality, which has rarely or has not been investigated for historical populations. In fact, these studies focused not only on temperature but also on humidity, rainfall, drought and daylight (e.g. Beltran et al. 2013; Andalon et al. 2016).

Objectives

The aim of the project is to identify the most vulnerable individuals and sociodemographic groups to the impact of climate shocks and extreme weather events in the past. We will consider the effects of sudden fluctuations in meteorological series such as temperatures, rain fall, humidity, and wind registrations as well as the impacts of catastrophic climatic events such as floods, heat waves, and snow excesses from other historical sources. Using historical sources, the present project will focus on the period from the last decades of the eighteenth century to the first half of the twentieth century, and will consider two Italian regions, Friuli and Emilia. The time interval spans from a typical preindustrial and pretransitional period to the onset of demographic transition and industrialization for both the two regions. Considering the short-term impacts of extreme weather events, we define vulnerable individuals as those who experienced the effects of sudden meteorological fluctuations with more intensity than others in terms of increased mortality, reduced fertility, migration and marriage behaviors. In addition, we also aim to provide profiles that describe the most vulnerable historical groups according to their demographic characteristics (age, sex, and marital condition), socioeconomic status, and geographical settings distinguishing rural and urban areas, and mountains and flatland regions. A second objective of the project is to provide a framework of the main mechanisms through which sudden meteorological fluctuations impact the most vulnerable individuals in historical periods. Since meteorological shocks could affect health status and demographic behaviors, directly modifying human physiological functions or indirectly acting through the effects on agricultural production, food supplies, and worsening hygienic and environmental conditions, this project will highlight how individuals, families, and socioeconomic groups acted to protect the most vulnerable ones in the past. Going into the specifics of the work, first, we aim to detect the effects of meteorological and weather fluctuations on mortality, reproductive, marriage and migration propensity, distinguishing by age groups, sociodemographic conditions, and geographical areas. On the basis of the available historical data, we will mainly focus on individuals of different ages such as infants, children, and the elderly. Indeed, the impact of weather fluctuations can vary between age groups, affecting mortality risks due to different causes of death and illnesses. First, we will focus on infant mortality distinguishing neonatal and post-neonatal mortality and then different post-neonatal age groups such as 1–4, 5–8, and 9–12 months, as infant survivorship varies during and after weaning when exogenous causes of death related to environmental and weather determinants prevail. Similarly, we will also consider the impact of climate shocks on child mortality between 1 and 5 years of age. In addition, we will analyze the effects of weather fluctuations on the mortality risks of older age groups in connection with the progressive physiological weakening due to senescence. However, to fully explore the weather impact on the death risks, we will consider other possible age groups between children and old ages. Potential sex differences will be systematically detected. The consequences of climate shocks can show gradients according to different socio-demographic groups due to dissimilar material conditions such as heating systems, living in isolated houses, more (or less) adequate clothes to warm or cold meteorological conditions, sanitary structures, and water facilities not contaminated by bacterial growth during the warmest days. According to the available historical information, we will classify the individuals by their fathers' and household heads' occupations, considering children and older people, respectively. Using the HISCO (Historical International Standard Classification of Occupations) and the HISCLASS (Historical International Social Class Scheme) classifications, we assume that socioeconomic status can be a representative proxy of individual material conditions. We could also rely directly on specific house quality and heating system information in some cases. Finally, household structures can matter, as families could protect their members from weather and climate difficulties. Children or the elderly in multiple households could benefit from the knowledge of older women and relatives (e.g., better techniques to protect individuals from heatstroke, hypothermia, and airborne and waterborne diseases). Meanwhile, very large families increase the contagiousness of airborne infections inside the households.

Source and Data

Demographic Data

We will use demographic sources at both the individual and aggregate levels to reconstruct the main variables related to mortality, fertility, marriage and migration. First, we will use individual information from parish and civil registrations. The religious sources include parish registers of baptisms, marriages, and burials, and Status Animarum (a census-like nominative list reporting the main individual demographic characteristics in each year), covering most of the nineteenth century for two rural parishes in the Bologna area (Scalone & Samoggia 2018) and the rural village of Madregolo in the Duchy of Parma (Manfredini 1997). The civil sources are population registers (“anagrafe”) and vital registrations (“movimento di stato civile”) at the individual levels for Udine's areas in the nineteenth century (Fornasin & Rizzi under review) and the village of Granarolo bordering Bologna in the first half of the twentieth century (Scalone et al. 2017). In previous research projects, we collected and imputed all individual information from historical demographic sources. In addition, we longitudinally reconstructed all individual biographies and family histories for all geographical areas in question. Thus, historical databases are already available to provide the answer to the research questions of the present project. From a previous project on the population history of the Bologna area, we obtained monthly counts of marriages, childbirths, and infant deaths at the parish level. These aggregate data refer to the last decades of the eighteenth century, distinguishing between rural and urban parishes.

Meteorological Data

This analysis can rely on a long series of meteorological records already collected in previous projects on climate history. In the case of Bologna and the Emilian villages, from the middle of the eighteenth century until the end of the study period, the meteorological registers from the astronomic observatory of the University of Bologna provide the daily climate observations, recording the minimum, mean, and maximum temperatures; rainfalls; snowfall; and humidity levels for each day during the study period. The astronomic observatory was located in the southeastern part of the town, not far from the communities under examination. As the rural parishes in the hinterland of Bologna were primarily situated in the belt surrounding the town, the observatory's registrations represent the ideal climate source to study the impact of the meteorological fluctuations on Bologna's population. In addition, these daily climate records are available in the dataset of the Global Historical Climatology Network (Menne et al. 2012), which provided data series that were further controlled and harmonized to prevent possible measurement issues. The meteorological data sources for Udine in the period considered are particularly rich owing to the exceptional data collection work of the meteorologist Girolamo Venerio, who collected data on atmospheric pressures, temperatures, rainfalls, and wind directions at different hours of each day. He collected information of this kind for more than 40 years, starting on January 1, 1802. This series stopped on the day Girolamo Venerio died on March 4, 1843 (Cittadella 2016). A not-so-detailed series, unlike that of Venerio, covers the second half of the eighteenth century on the basis of the observations of Giulio Asquini. Other series covered the rest of the nineteenth century.

Methods

For the most prolonged period from the early decades of the nineteenth century to the first fourth decades of the twentieth century, most statistical analyses will combine individual longitudinal data and daily climate records, adopting specific modeling strategies for micro-demographic data. To include the second half of the eighteenth century, we will also adopt a multivariate regression approach for count data, as only monthly demographic series are available.

Modeling Individual Data

Following the approach proposed by Derosas (2009), Dalla Zuanna & Rosina (2011), and Scalone & Samoggia (2018), we will investigate the impact of meteorological variables on mortality risks, nuptiality, fertility and migration propensity by adopting an event history approach. Historical and contemporary demographic studies have relied widely on event history analysis using both discrete-time and continuous-time perspective approaches in the last decade. From this point of view, we will also model the effects of daily climate measures on demographic outcomes. Each climate measure will refer to the day of the considered demographic event (death, childbirth, and marriage) and previous days to estimate the lagged and cumulative effects of climatic fluctuations. The estimated models will also control for other demographic and socioeconomic variables at the individual and contextual levels. Individual covariates refer to age, sex, socioeconomic status, migrant status, family type (e.g., number of members, presence of other relatives), and household characteristics (e.g., availability of a heating system). At the same time, the contextual variables include the economic series of grain prices and socioeconomic characteristics of the parish in question (e.g., annual proportion of workers in the agricultural sectors). By including interactions between meteorological variables and each sociodemographic variable, we will examine the differential impact of climate fluctuations depending on the different sets of individual, household, and contextual characteristics. In these terms, we will depict the sociodemographic features that make a person or population group more vulnerable to climate fluctuations and extreme climate events.

Modelling Count

Data We also adopt regression models for deaths, marriages, and childbirth counts to fully exploit climate information in the second half of the eighteenth century. The meteorological variables will be included as the main independent covariates. In these terms, parishes will be observed each month. They represent the unit of analysis for comparing the impacts of climate fluctuations on demographic events and behaviors in different geographical (rural and urban) parts of the Bologna area (towns and hinterlands). This modeling approach could be framed on the broader family of the generalized linear models assuming a Poisson or negative binomial distribution that better adapts to count data (Sahani et al. 2022). Moreover, to account for the over-dispersion of our dependent variables in the dataset, we can choose negative binomial regression instead of ordinary Poisson regression. As each parish's set of time series is available, a panel regression approach will also be possible.

Project development

Phase 1: Initialization and Harmonization

- In the first year, our unit will focus on collecting documentary sources.

- A primary task will be to integrate and harmonize the datasets that have already been gathered from previous research activities.

- The kickoff meeting will be crucial to discuss data collection strategies, standard practices for data harmonization, and sharing details about the sources and data already available.

Phase 2: Data Collection and Model Development

- In the subsequent months, we will continue data collection and start working on existing datasets to bridge any gaps.

- By the end of this phase, we aim to identify and possibly develop analytical models suitable for our data.

- To facilitate this, we will hire dedicated staff through an annual research grant. Their responsibilities will include collecting relevant literature, processing the existing data, gathering any missing data, and initiating preliminary analyses.

Phase 3: Data Analysis and Model Refinement

- The latter part of the first year will be marked by an intermediate meeting, which is envisioned to take the form of a workshop.

- External experts, both from Italy and abroad, will be invited to provide insights on our preliminary findings.

- Feedback from this workshop will guide the refinement of our data analysis strategy.

Phase 4: Comprehensive Data Analysis and Reporting

- The second year will primarily focus on a deep dive into data analysis, deciphering the links between climatic/meteorological outcomes and demographic behaviors.

- During this phase, while primarily focusing on the Bologna region, we'll also look for insights from comparative data to enhance our findings.

- Another staff member will be recruited via an annual research grant to assist in this crucial phase.

Phase 5: Conclusion and Dissemination

- By the end of the second year, we plan to host a final conference. This event will spotlight the research results obtained by our Bologna team, marking the culmination of our project.

References

Alfani, G. (2010). Climate, population and famine in Northern Italy: General Tendencies and Malthusian Crisis, ca. 1450-1800. Annales de démographie historique, 120(2).

Andalón, M. et al. (2016). Weather Shocks and Health at Birth in Colombia. World Development, 82.

Åström, D. et al. (2016). Evolution of Minimum Mortality Temperature in Stockholm, Sweden, 1901–2009. Environmental Health Perspectives, 124(6).

Beltran, A., et al. (2013). Associations of Meteorology with Adverse Pregnancy Outcomes. International Journal of Environmental Research and Public Health, 11(1).

Bengtsson, T. & Reher, D. (1998). Short and medium term relations between population and economy. In C. Núñes (Ed.), Debates and Controversies in Economic History, Proceedings of the Economic History Congress, Madrid.

Breschi, M. & Gonano, G. (1999). Relazioni di breve periodo tra decesssi, età e clima. Toscana 1818-1939. In Pozzi L. & Tognotti E. (Eds), Salute e malattia fra ’800 e ’900 in Sardegna. EDES.

Breschi, M. & Livi-Bacci, M. (1997). Month of Birth as a Factor in Children’s Survival. In Bideau A., Desjardins B. & Brignoli H.P. (Eds.), Infant and Child Mortality in the Past, Oxford.

Cittadella, A. (2016). Girolamo Venerio. Agronomia e meteorologia in Friuli tra Settecento e Ottocento. EUT.

Collet, D. & Schuh, M. (Eds.) (2018). Famines During the ‘Little Ice Age’ (1300–1800). Springer.

Conti, S. et al. (2005). Epidemiologic study of mortality during the Summer 2003 heat wave in Italy. Environmental Research, 98(3).

Dalla-Zuanna, G. & Rosina, A. (2011). An Analysis of Extremely High Nineteenth-Century Winter Neonatal Mortality in a Local Context of Northeastern Italy. European Journal of Population, 27(1).

Derosas, R. (2009). The joint effect of maternal malnutrition and cold weather on neonatal mortality in nineteenth-century Venice: An assessment of the hypothermia hypothesis. Population Studies, 63(3).

Ekamper, P. et al. (2009). 150 Years of temperature-related excess mortality in the Netherlands. Demographic Research, 21.

Fornasin, A. & Rizzi, L. (under review). Environmental and economic determinants of neonatal mortality in a northern Italian city in the early 19th century.

Galloway, P. (1985). Annual variations in deaths by age, deaths by cause, prices, and weather in London 1670 to 1830. Population Studies, 39(3).

Galloway, P. (1994). Secular changes in the short-term preventive, positive, and temperature checks to population growth in Europe, 1460-1909. Climatic Change, 26.

Karlsson, L. et al. (2021). Socioeconomic disparities in climate vulnerability: neonatal mortality in northern Sweden, 1880–1950. Population and Environment, 43(2).

Lam, D. & Miron, J.A. (1996). The effects of temperature on human fertility. Demography, 33(3).

Lamb, H. (1982). Climate, History and the New World. Methuen.

Lee, R. (1981). Short-term variation: vital rates, prices, and weather. In Wrigley E.A. & Schofield R.S (Eds), The Population History of England. 1541-1871. CUP.

Le Roy Ladurie E. (1967). Histoire de climat depuis l'an mil. Flammarion.

Manfredini, M. (1997). A rural population of Northern Italy: Madregolo during the XIX century. EurAsian Project on Population and Family History, Working Paper Series, 12.

Manfredini, M. (2009). Seasonality of births in present-day Italy, 1993-2005. Human Ecology, 37(2).

Menne, M. et al. (2012). An Overview of the Global Historical Climatology Network-Daily Database. Journal of Atmospheric and Oceanic Technology, 29(7).

Muttarak, R. & Dimitrova, A. (2019). Climate change and seasonal floods: potential long-term nutritional consequences for children in Kerala, India. BMJ Global Health, 4(2).

Muttarak, R. (2021). Demographic perspectives in research on global environmental change. Population Studies, 75.

Post, J. (1977). The last great subsistence crisis in the Western world. Johns Hopkins University Press.

Richards, T. (1983). Weather, nutrition, and the economy: Short-run fluctuations in births, deaths, and marriages, France 1740–1909. Demography, 20(2).

Sahani, J. et al. (2022). Heat risk of mortality in two different regions of the United Kingdom. Sustainable Cities and Society, 80.

Scalone, F. et al. (2017). Exploring unobserved heterogeneity in perinatal and neonatal mortality risks: The case of an Italian sharecropping community, 1900–39. Population Studies, 71(1).

Scalone, F. & Samoggia, A. (2018). Neonatal mortality, cold weather, and socioeconomic status in two northern Italian rural parishes, 1820–1900. Demographic Research, 39.

Schumann, B. et al. (2019). Weather extremes and perinatal mortality – Seasonal and ethnic differences in northern Sweden, 1800-1895. PLOS ONE. Edited by J. Shaman, 14(10).

Stothers, R. (2000). Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258. Climatic Change, 45.

Xoplaki, E. et al. (2001). Variability of climate in meridional Balkans during the periods 1675–1830 and its impact on human life. Climatic Change, 48.