Fertility and climate instability in agriculturally-dependent contexts: Parity transitions in Albania, Moldova, and Uzbekistan

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Abstract

Climate change is anticipated to increase rainfall and temperature variability and extremes across the planet. Researchers have begun to focus attention on the behavioral and biological health effects of climate change but research addressing women's reproductive health and fertility outcomes in a context of climate change is extremely limited. Climate instability occurs at very fine-scales and has the potential to impact the fertility behaviors and reproductive health outcomes of individuals and couples. **In this paper we use a combination of survey data and high resolution climate data to focus on pregnancy timing and outcomes in three climate sensitive countries - Albania, Moldova and Uzbekistan**. Contraception and abortion are wide-spread and culturally acceptable in these countries. Observing the link between climate and childbearing in settings of high fertility control allows us to investigate the sensitivity of biological mechanisms to climate instability and also those mechanisms relating to the demand for children.

Contributions of this research

This project uses an innovative combination of climate, livelihood and population data to investigate births in agriculturally-dependent countries with relatively low levels of fertility. Related population-environment research has historically focused only on wealthy countries (with a particular interest in heat stress), or on the primarily high fertility countries in sub-Saharan Africa. We expand on this research focused on reproductive outcomes, climate, and rural livelihoods through an examination of birth spacing and parity progression in communities where both contraception and abortion are widely available, culturally acceptable, and routinely used. The research demonstrates the use of climate variables as proxy-measures for micro-level agricultural production in communities without agricultural data; it also highlights the linkages between climate, livelihoods, and fertility, in middle income, lower fertility countries.

Introduction

Climate change is anticipated to increase rainfall and temperature variability and extremes across the planet. Although researchers have begun to focus attention on the behavioral and biological health effects of climate change - research focused on women's reproductive health and fertility outcomes is extremely limited (Grace 2017). We argue that there are multiple pathways through which climate change can influence childbearing. First, households and communities that are dependent on rainfall for their livelihoods - to produce either agricultural products for consumption or income - are particularly vulnerable to resource instability and the adverse health impacts of climate change (Brown et al. 2014, Brown et al. 2015, McMichael 2013, Watts 2015). Household resources can be constrained if an agricultural season is poor because of insufficient or poorly timed rains. For poor households, adjusting to limited resources may require reducing consumption which may ultimately influence the demand for children as well as threaten the childbearing process through poor nutrition related to food insecurity (Grace 2017, Grace and Nagle 2014). In addition, heat-waves may increase the risk of thermal stress, especially if people are increasing their physical labor to make-up for potential losses as temperatures increase (Call et al. 2017). Because of increased nutritional demands and the physical and energy demands related to childbearing, pregnant and breastfeeding women may be at the greatest risk for adverse health impacts associated with climate change through these direct and indirect pathways (Grace et al. 2015, Davenport et al. 2017).

In this paper we focus on pregnancy timing and outcomes in three climate sensitive countries - Albania, Moldova and Uzbekistan. These countries represent relatively poor countries, among the poorest countries in Europe and Central Asia, where dependence on agriculture for food and economic resources is high for rural households. Unlike in many other poor contexts, contraception and abortion are wide-spread, culturally acceptable and often free of charge in these countries (AIC 2004; Institute of Statistics 2010; NCPM 2006), although induced abortion appears to be under-reported in the Albanian DHS. Observing the link between climate and childbearing in a setting of high fertility control, therefore, allows us to investigate the sensitivity of not just biological mechanisms to climate instability but also of demand for children while considering a range of relevant individual and household characteristics.

Most rural livelihoods in these three countries are based on small-scale farming, however no relevant data that captures spatial and temporal variation in agricultural production exists. Recent advancements in remote sensing and in the harmonization of population-environment data has produced fine-scale rainfall, temperature, and vegetation data that can be used to approximate within-year agricultural production at the community level. This data and framework facilitate an investigation of how spatially and temporally varying resource variability, as driven by agricultural production, and climate conditions influence fertility behavior and outcomes.

Of additional interest is that Albania, Moldova and Uzbekistan were state-socialist countries belonging to the former Eastern Bloc until the 1990s. This shared history includes universal health care and education as well as a command economy that extended to collectivized agricultural production (Lerman et al. 2004). After the fall of communism, the three countries maintained universal basic education and health care, but underwent radical privatization reforms (Lerman et al. 2004, Alcantara et al. 2013, Muller and Munroe 2008). Most relevant to climate issues is the privatization of agricultural production, which essentially ended national level collectivization and central planning of agricultural practices. Given the time periods covered by the data used in this project, we are able to observe the relationship between climate instability and fertility during the period of socialist land management and also during the period of private ownership.

Background

Demographic research assessing the role of contextual factors, whether within a country over time or between countries, commonly relies on aggregate-level fertility indicators such as fertility rates. Using fertility rates to measure the importance of contextual variation sacrifices vital information for understanding fertility behavior or fertility outcomes (Neyer & Andersson 2009). First, context can influence individuals differently depending on sub-group characteristics, and estimating an average of these varying relationships can lead to misleading conclusions. Second, fertility behavior consists of tempo and quantum dynamics that are generally inseparable in fertility rates. In this research, we explicitly assess whether variation in fertility appears to be driven by changes in birth spacing and parity progression. Climate instability may create resource conditions under which individuals decide to wait/hurry to have the next child or have/forego having another child. In our setting, the question related to parity progression and spacing includes the decisions related to both allowing and continuing a pregnancy. We first discuss the motivational aspects of these decision-making processes; we then discuss biological mechanisms through which climate instability may prohibit pregnancy from occurring or resulting in a live birth.

Behavioral mechanisms

Variation in childbearing related to climate instability may result from differences in the demand for children. Theories related to the demand for children suggest opposing effects of climate instability on childbearing. As far back as Malthus, a link between strained natural resources and limiting childbearing has been made. More narrowly defined in relation to household resources, Becker (1981) predicted that strained resources would lower the demand for children because of the inability to meet the costs of further children. Mukhopadhyay (1994) argues that farm households, on own or leased land, are unique because they are likely to use food output (all or partial) for own consumption. They are insulated from food insecurity related to economic crises by being able to meet food needs outside the economic market. This benefit of agricultural production can be seen even where families with access to small plots of lands for growing own food were more likely to continue childbearing than families without during a national economic crisis in Russia (Bühler 2004). On the other hand, they are particularly vulnerable to crop failure or low agricultural output related to climate instability because their livelihood is threatened both in terms of production for own consumption and production for the market. Recent research on wealthy countries has highlighted the role uncertainty related to economic instability plays in delaying childbearing as well (see, e.g., Special Collection by Kreyenfeld et al. 2012), which is another mechanism through which climate instability might be linked to childbearing.

Farm households are also unique because it is common to use family labor (all or partial) (Mukhopadhyay 1994). This means that the indirect costs of childbearing—i.e., opportunity costs of women related to substituting care for productive labor (Becker, 1981)—may also increase if a higher demand for agricultural labor increases the value of women's time spent in productive labor. This pathway suggests that childbearing timing and parity progression would be negatively related to resource strain. But from a perspective considering the value of children, we might expect that the demand for children may also increase when the need for children's labor in agricultural production increases (Caldwell 1976; Schultz 1973). Evidence to support this direction of relationship exists for Nepal (Brauner-Otto and Axinn, 2017; Biddlecom et al. 2005), but research on other settings is scarce. Whether this relationship can be expected in our research setting is unclear, given that it relies on women and children having a low status in society, where their labor is required for household subsistence (O'Neill, MacKellar, & Lutz, 2001; Biddlecom et al. 2005).

Biological mechanisms

In terms of the role of biological factors, fertility outcomes can be impacted by heat, primarily through thermal stress, or by nutritional constraints related to food insecurity. A small literature on pregnancy and heat has revealed some inconclusive results that at times show that extreme temperatures are detrimental to pregnancy outcomes while, at other times, demonstrating no significant linkage (see Deschênes et al. 2009, Basu et al. 2010, Strand et al. 2011). Among the results, researchers theorize that pregnant woman and fetuses are more sensitive to heat stress, which may impact healthy fetal development (Ruff 1994). Heat stress may also increase the risk of pre-eclampsia and resulting pre-term births or negatively impact a woman's sleep patterns resulting in adverse fetal development (Behrman and Butler 2007, Okun et al. 2009, Strand et al. 2011).

With regards to precipitation, rainfall patterns may be associated with seasonal disease transmission or potentially with drinking water quality. In food insecure communities, like many of the communities under investigation in this analysis, where agricultural production and labor demands are heavily tied to rainfall, rainfall variability can serve as a measure of seasonal and annual variations in physical labor demands and food production or food availability (see Grace et al. 2015 and Brown et al. 2014). Individual fertility responses to climate variability and the associated failures in the food system or household food insecurity likely vary according to a variety of individual characteristics. Given that there is a great deal of heterogeneity in climate and the associated agricultural production, individuals and communities are expected to vary in terms of their vulnerabilities and responses. Individual-level analyses of pregnancy outcomes that consider multiple scales of influence are necessary for developing an improved understanding of pregnancy in both high fertility and low fertility countries. In summary, climate (heat and rainfall) can have biological and behavioral effects on birth outcomes and the nature of these effects can vary dramatically within a country and according to general livelihood strategies (this data will be discussed in the data section).

Setting

Substantial variation exists among living conditions in the three countries we study; economically, Albania out-performs the other two and Moldova fares the worst. According to the Human Development Index (United Nations Development Program 2016), Albania ranks highest (75^{th}) of the three, in comparison to 105^{th} in Uzbekistan and 107^{th} in Moldova. These three countries are similar in terms of relatively low fertility levels, parity progression patterns (Billingsley & Duntava 2017), and agricultural dependence. They are all climate-sensitive countries in which the economy relies heavily on its agricultural sector and large shares of the population are engaged in agricultural labor: 41% of labor force in Albania (World Factbook 2014 estimate), 34% in Moldova (World Factbook 2016 estimate) and 26% in Uzbekistan (World Factbook 2012 estimate). Nevertheless, each country has its own unique demographic and cultural profile, as well as geographical, climate and agricultural characteristics. Our study benefits from these between-country differences because it allows us to observe women and children across varied weather and land use patterns to identify whether climate influences fertility consistently across different conditions as well as the ways in which they may be context specific.

Historically, Albania, Moldova and Uzbekistan share notable characteristics related to their formerly state socialist systems, which provides us with within-country change that is similar across our case studies. These include women's early integration into the labor force, universal basic education and health care, and collectivized agricultural production. After the fall of communism, the three countries all underwent radical privatization reforms that essentially put the fate of agricultural production in the hands of individual farmers, laborers and land-owners' hands (UNRISD 2002; Mathijs& Noev 2004; Gorton 2001).

We have two competing expectations based on stylized scenarios for how the fall of communism and the subsequent change in land ownership influenced how fertility is related to climate instability. On the one hand, the introduction of a market economy for agricultural products changed the reward structure for agricultural workers. If a crop failed under state socialism, for example, the loss was distributed relatively equally over the population, whereas the quality of life of individual farm owners and respective agricultural workers was more directly influenced by low output after market reform (Spoor 2007). We may expect weaker relationships between agricultural production and fertility before the 1990s for this reason.

Alternatively, the end of state socialism implied more freedom of movement and occupational choice, which meant that people could diversify their incomes through migration and other strategies (see discussion on non-farm income in Davis, 2006). This would suggest a decrease in the climate/weather-fertility link once the 1990s began. Also worth noting is that the internationalization that occurred after the collapse of communism likely allowed for increased innovation in agricultural practices as well as increased access to fertilizers, for example, that helped agricultural systems survive difficult weather.

A final consideration is related to the decline in the agricultural sector during the 1990s. As the service sector developed and individuals became freer to choose their occupations, urbanization occurred and fewer individuals continued to work in agriculture. This means that there may be substantial compositional differences in the people working and living in rural areas before and after the transition to a market economy.

Data - *Using climate data to understand resource availability and variability*

To conduct this analysis we rely on three different types of data - population/health survey data, climate data based on remote sensing, and livelihood data.

Population Data

The Demographic and Health Surveys (DHS) is the world's primary source of information on fertility, contraceptive use, infant and maternal health. While the DHS are generally considered cross-sectional data, they contain detailed information on the timing of births for each surveyed woman. We will maximize the longitudinal potential of the DHS by using this retrospective birth data to investigate the timing of births relative to different individual, community, and livelihood/climate characteristics. The DHS also collects Global Positioning System (GPS) coordinates for the DHS clusters - villages and towns where they collect data. There are approximately 20 households within a "cluster". Each rural cluster is shifted up to 5 km, with 1% shifted up to 10 km, to maintain confidentiality among respondents. We accommodate this random displacement by assuming that the cluster can be located anywhere within a 10 km radius of the provided latitude/longitude (DHS cites). We use all available DHS data for post-socialist countries that contain GPS information and information on the length of time at the current residence (this condition is required to ensure that environmental exposure is properly linked to each woman) - Moldova 2005; Albania 2008; Uzbekistan 2002.

Climate Data

To estimate agricultural production at the level of the rural DHS cluster, we use two recently developed datasets which provide high quality, fine-temporal scale, remotely sensed based estimates of temperature and precipitation. For **precipitation** we use the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) dataset (Funk et al. 2014a). The CHIRPS data set, developed recently by USGS scientists in collaboration with Climate Hazards Group at University of California at Santa Barbara, combines a high resolution (0.05°) climatology (Funk et al. 2012; Funk et al. 2015) with time-varying station data and observations from geostationary weather satellites. In other words, this data relies on station data as well as high resolution remotely sensed data. CHIRPS is currently in use by USAID supported projects for monitoring and forecasting drought conditions in Africa and Central Asia (Funk et al. 2014).

The **temperature** dataset used in this analysis was developed by Sheffield et al. (2006). This dataset has been widely used in various global studies (Sheffield and Wood, 2008a, 2008b; Shukla et al., 2013) and also supports Princeton University's Africa Food and Drought Monitor. The National Center for Environmental Prediction's reanalysis (Kalnay et al., 1996; Kistler et al., 2001) derives the temperature data through a reanalysis process. This process requires a long record of global analyses of atmospheric and surface data, such as air temperature, radiations, wind speed, sea-level pressure and sea-surface temperature.

To generate temperature data as used in this analysis, Sheffield et al. first interpolated reanalysis air temperature from its native resolution of approximately 1.9° latitude × 1.875° longitude to a 2.0° regular grid while allowing for elevation related changes (Sheffield et al., 2006). These gridded data were then spatially downscaled to an 0.5° regular grid using bilinear interpolation with adjustments for change in the elevation. The monthly averaged temperature data was then corrected to match the monthly temperature values of the Climate Research Unit's 0.5° gridded temperature data (New et al., 1999, 2000). This step was undertaken to remove any bias in the temperature data that is inherent in reanalysis products. Finally, the daily values from the uncorrected temperature dataset were shifted so that the monthly values match the corrected monthly averages. This data has been used in a variety of applied health and demography studies and serves as the primary source of temperature data for poor countries (see also Davenport et al. 2017, Grace et al. 2015).

Livelihood Data

Because climate variables may impact people, communities or households differently depending on how people use the land, we include information on general livelihood strategies of a particular area. Additionally, because we do not have specific information on individual-level food production strategies or outputs, we must consider a slightly coarser spatial community-scale. These areas can be thought of as qualitative differentiations of the landscape into broad areas described by a general category of how most people in an area produce food or earn money (we call this a livelihood). Instead of using political boundaries to help contextualize our DHS clusters and climate variables, we rely on specific livelihood maps. These maps are constructed somewhat differently based on specific country needs but provide the same type of information on general livelihood strategies. Livelihood data and corresponding reports for Albania, Moldova, and Uzbekistan come from the recent World Bank reports on climate change vulnerability and agriculture - Albania (Sutton et al., 2013a), Moldova (Sutton et al., 2013b), and Uzbekistan (Sutton et al. 2013c). These reports provide detailed information on land use within each broad livelihood zone. They also provide information on land use before and after the transition, food insecurity, and climate sensitivities. Table 1 provides a summary of the environmental data that will be used in this study.

Table 1. Environmental datasets

Dataset	**Uses**	**Spatial Resolution**	**Temporal Resolution**
CHIRPS precipitation	Drought, flood, growing season	~5 km	Daily, monthly, 1981-present
Temperature - Sheffield reanalysis	Growing season, heat stress,	~50 km	Daily, 1981-present
World Bank Livelihood zones	Food and income acquisition; climate vulnerability	N/A	N/A

Analysis

To analyze the transition to parenthood and higher parities, we approximate a piecewise constant event history model that is paired with monthly climate data by using discrete-time multilevel hazard analysis (Barber et al. 2000). This modeling approach allows us to include cohorts of women who may not yet have experienced the event of interest by properly censoring these observations. It also allows us to consider the relevance of time-varying factors to the timing of parity transitions. Because women are nested within geographical clusters and livelihood zones, we must also adjust the standard errors for non-independence between these individuals as well as remove the confounding influence of shared unobserved and stable characteristics related to livelihood zones. We use a random effects specification to address this clustering, which allows the intercept to vary across locations (Rabe-Hesketh & Skrondal 2012). Hazard-odds ratios indicate within- and between-zone correlations and are interpreted as the average influence of an independent variable as it changes across individuals and between zones.

The time scale is specified as age in the transition to first birth analysis and we observe women from the month they turn 16 until they enter parenthood or they were interviewed. The time scale for all later parity analyses is specified as time since the previous birth and these women are observed from the month of the previous birth until they have another child or are interviewed. Because of sample size issues, we combine parities of three or more into a 3+ category.

Each observation in our data represents a person/month and the value of many variables changes on a monthly basis. Hazard-odds reflect the combined influence of how quickly the event of interest occurred and whether it ever occurred. To observe birth timing and spacing more closely, we interact our key climate variables with the time scale in each model.

Measures

We include standard individual level controls - age (time varying), educational attainment, month of the year and year. Month is included to capture seasonal factors and year dummies are included to capture period effects associated with both the fertility transitions that have occurred during our observation period, as well as to capture the political transition from socialist to post-socialist economies and periods of economic crisis at the national level. Additionally, we include rainfall total and variability, temperature, number of days above 100F (a measure used to indicate heat stress). We also use a drought index that captures hot and dry days occurring at the same time. A dummy variable for growing season and harvest season will also be included.

Anticipated Results

Behavioral theories of fertility suggest that women or conjugal couples may choose to avoid births at inopportune or stressful and traumatic times – economic downturns, droughts, floods, conflict. These events can be either short term and result in relatively short delays or they can characterize longer periods of time and result in an overall change in completed fertility. And while these events can be experienced as catastrophes at a macro-level, in agriculturally dependent areas, the experiences with drought, sub-par growing conditions and household resource instability are often experienced at a much more local, community or household level. Related research in poor countries with low rates of contraceptive prevalence demonstrates that in communities dependent on agricultural production for the procurement of food and money, climatic variability - which can result in “boom” agricultural years for households, serious food shortages or less extreme food rationing - has both short or long term impacts on the quantum and tempo of fertility. This research has further demonstrated that there are major differences in individual responses according to individual characteristics as well as reflecting the way the individual interacts with the community conditions. In other words, behavioral responses reflect individual characteristics, context and interactions between the individual and the context. In climatically sensitive and agriculturally dependent Albania, Moldova, and Uzbekistan, where contraception is widespread, the ways that women and couples space or delay conceptions or pregnancies is not well understood. Additionally, how these experiences are shaped by context and the variability in fertility behaviors within different context is also rarely examined in these countries.

We anticipate that our results will highlight how environmental context, including climate characteristics, is one factor that shapes individual fertility outcomes. Moreover, we anticipate that these results will demonstrate the importance of considering individual variability within environmental and agricultural contexts – in other words, attending to both within community variability in response to climate change as well as across community variability in response to climate change. The results from this research will expand scientific insight into the linkages between climate change, fertility and reproductive health. This research is particularly unique because it aims to investigate how these linkages play out in countries with established public health and educational systems and where low fertility and contraceptive use are culturally accepted.

References

AIC (Analytical and Information Center), Ministry of Health of the Republic of Uzbekistan [Uzbekistan], State Department of Statistics, Ministry of Macroeconomics and Statistics [Uzbekistan], and ORC Macro. (2004). *Uzbekistan Health Examination Survey 2002.* Calverton, Maryland, USA: Analytical and Information Center, State Department of Statistics, and ORC Macro.

Alcantara, C., Kuemmerle, T., Baumann, M., Bragina, E. V., Griffiths, P., Hostert, P., ... & Sieber, A. (2013). Mapping the extent of abandoned farmland in Central and Eastern Europe using MODIS time series satellite data. *Environmental Research Letters*, *8*(3), 035035.

Barber, J.S., Murphy, S., Axinn, W., & Maples, J. (2000). Discrete-Time Multilevel Hazard Analysis. *Sociological Methodology*, 30: 201-235.

Basu, R., Malig, B., Ostro, B. (2010). High ambient temperature and the risk of preterm delivery. Am J Epidemiol, *172*(10): 1108-17.

Becker, G. (1981). *A treatise on the Family*. Cambridge, MA: Harvard University Press.

Behrman, R.E., & Butler, A.S. (2007). Preterm birth: Causes, consequences and Prevention. The National Academies Press, Washington, DC.

Biddlecom, A., Axinn, W. G., Barber, J. (2005). Environmental effects on family size preferences and subsequent reproductive behavior in Nepal. *Population and Environment*, *26*(3): 183-206.

Billingsley, S., & Duntava, A. (2017). Putting the pieces together: Fertility trends across 40 years of birth cohorts in 19 post-socialist countries. *Post-Soviet Affairs*, *33*(5): 389-410.

Brauner-Otto, S. R., & Axinn, W. G. (2017). Natural resource collection and desired family size: a longitudinal test of environment-population theories. *Population and Environment,* 1-26.

Brown, M. E., Grace, K., Shively, G., Johnson, K. B., & Carroll, M. (2014). Using satellite remote sensing and household survey data to assess human health and nutrition response to environmental change. *Population and environment*, *36*(1), 48-72.

Brown, M. E., Antle, J. M., Backlund, P. W., Carr, E. R., Easterling, W. E., Walsh, M., ... & Dancheck, V. (2015, December). Climate Change and Global Food Security: Food Access, Utilization, and the US Food System. In *AGU Fall Meeting Abstracts*.

Bühler, C. (2004). Additional work, family agriculture, and the birth of a first or a second child in Russia at the beginning of the 1990s. *Population Research and Policy Review*, *23*(3), 259-289.

Call, M., Mayer, T., Sellers, S., Ebanks, D., Bertalan, M., Nebie, E., & Gray, C. (2017). Socio-environmental drivers of forest change in rural Uganda. *Land Use Policy*, *62*, 49-58.

Caldwell, J.C., 1976. Toward a restatement of the demographic transition theory. Population and Development Review 2, 321–366.

Davenport, F., Grace, K., Funk, C., & Shukla, S. (2017). Child health outcomes in sub-Saharan Africa: A comparison of changes in climate and socio-economic factors. *Global Environmental Change*, *46*, 72-87.

Davis, J. (2006). Rural non-farm livelihoods in transition economies: emerging issues and policies, Journal of Agricultural and Development Economics Agricultural and Development Economics Division, 3 (2): 180–224.

Deschênes, O., Greenstone, M., & Guryan, J. (2009). Climate change and birth weight. *The American Economic Review*, *99*(2), 211-217.

Funk, C., Michaelsen, J., Marshall, M., (2012). Mapping recent decadal climate variations in precipitation and temperature across Eastern Africa and the Sahel. In: Wardlow, B., Anderson, M., Verdin, J. (Eds.), Remote Sensing of Drought: Innovative Monitoring Approaches. CRC Press, Boca Raton, FL, USA, p. 25.

Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., (2015). The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. Sci. Data 2.

Funk, C., Hoell, A., Shukla, S., Bladé, I., Liebmann, B., Roberts, J.B., Robertson, F.R., Husak, G., (2014). Predicting East African spring droughts using Pacific and Indian Ocean sea surface temperature indices. Hydrol. Earth Syst. Sci. 18, 4965–4978.

Gorton, M. (2001). Agricultural land reform in Moldova. *Land Use Policy, 18*(3): 269-279.

Grace, K., & Nagle, N. N. (2015). Using high-resolution remotely sensed data to examine the relationship between agriculture and fertility in Mali. *The Professional Geographer*, *67*(4), 641-654.

Grace, K., Davenport, F., Hanson, H., Funk, C., & Shukla, S. (2015). Linking climate change and health outcomes: Examining the relationship between temperature, precipitation and birth weight in Africa. *Global Environmental Change*, *35*, 125-137.

Grace, K. (2017). Considering climate in studies of fertility and reproductive health in poor countries. *Nature Climate Change, 7*, 479-485.

Institute of Statistics, Institute of Public Health [Albania] and ICF Macro. (2010). *Albania Demographic and Health Survey 2008-09.* Tirana, Albania: Institute of Statistics, Institute of Public Health and ICF Macro.

Kalnay, E., Kanamitsu, M., Kistler, R., Collins, W., Deaven, D., Gandin, L., Iredell, M., Saha, S., White, G., Woollen, J., (1996). The NCEP/NCAR 40-year reanalysis project. Bull. Am. Meteorol. Soc. 77, 437–471.

Kistler, R., Collins, W., Saha, S., White, G., Woollen, J., Kalnay, E., Chelliah, M., Ebisuzaki, W., Kanamitsu, M., Kousky, V., (2001). The NCEP-NCAR 50-year reanalysis: monthly means CD-ROM and documentation. Bull. Am. Meteorol. Soc. 82, 247–267.

Kreyenfeld, M., Andersson, G., and Pailhé, A. (2012). Economic uncertaintly and family dynamics in Europe: Introduction. *Demographic Research, Special Collection, 27*: 835-852.

Lerman, Z., Csaki, C., & Feder, G. (2004). Evolving farm structures and land use patterns in former socialist countries. *Quarterly Journal of International Agriculture*, *43*(4), 309-336.

Mathijs, E., & Nivelin N. (2004). Subsistence Farming in Central and Eastern Europe: Empirical Evidence from Albania, Bulgaria, Hungary, and Romania. *Eastern European Economics,42*(6), 72-89.

McMichael, A. J. (2013). Globalization, climate change, and human health. *New England Journal of Medicine*, *368*(14), 1335-1343.

Mukhopadhyay, S.K. (1994). Adapting household behavior to agricultural technology in West Bengal, India: Wage labor, fertility, and child schooling determinants. *Economic Development and Cultural Change, 43*: 91-103

Müller, D., & Munroe, D. K. (2008). Changing rural landscapes in Albania: cropland abandonment and forest clearing in the postsocialist transition. *Annals of the Association of American Geographers*, *98*(4), 855-876.

NCPM (National Scientific and Applied Center for Preventive Medicine) [Moldova] and ORC Macro. (2006). *Moldova Demographic and Health Survey 2005.* Calverton, Maryland: National Scientific and Applied Center for Preventive Medicine of the Ministry of Health and Social Protection and ORC Macro.

New, M., Hulme, M., Jones, P., (1999). Representing twentieth-century space-time climate variability. Part I: Development of a 1961–90 mean monthly terrestrial climatology. J. Clim. 12, 829–856.

New, M., Hulme, M., Jones, P., (2000). Representing twentieth-century space-time climate variability. Part II: Development of 1901–96 monthly grids of terrestrial surface climate. J. Clim. 13, 2217–2238.

Neyer, G., & Andersson, G. (2008). Consequences of family policies on childbearing behavior: Effects or artifacts? *Population and Development Review, 34*(4), 699-724.

Okun, M.L., Roberts, J.M., Marsland, A.L., Hall, M. (2009). How disturbed sleep may be a risk factor for adverse pregnancy outcomes. *Obstetrical & Gynecological Survey, ;64*(4):273–280.

O'Neill, B., MacKellar, F.L., and Lutz, W. (2001), *Population and Climate Change*. Cambridge University Press.

Rabe-Hesketh, S., & Skrondal, A. (2012). *Multilevel and Longitudinal Modeling Using Stata*. Third Edition. College Station, TX: Stata Press.

Schultz, T., (1973. The value of children: An economic perspective. *Journal of Political Economy, 81*, S2–S13.

Sheffield, J., Goteti, G., Wood, E.F., (2006). Development of a 50-year high-resolution global dataset of meteorological forcings for land surface modeling. J. Clim. 19, 3088–3111

Sheffield, J., Wood, E.F., (2008). Global trends and variability in soil moisture and drought characteristics, 1950–2000, from observation-driven simulations of the terrestrial hydrologic cycle. J. Clim. 21, 432–458.

Sheffield, J., Wood, E.F., (2008). Projected changes in drought occurrence under future global warming from multi-model, multi-scenario, IPCC AR4 simulations. Clim. Dyn. 31, 79–105.

Shukla, S., Sheffield, J., Wood, E.F., Lettenmaier, D.P., (2013). On the sources of global land surface hydrologic predictability. Hydrol. Earth Syst. Sci. 17, 2781–2796.

Spoor, M. (Ed.) (2009), *The Political Economy of Rural Livelihoods in Transition Economies; Land, Peasants and Rural Poverty in Transition*. London and New York: Routledge.

Strand, L. B., Barnett, A. G., & Tong, S. (2011). The influence of season and ambient temperature on birth outcomes: a review of the epidemiological literature. *Environmental Research*, *111*(3), 451-462.

Sutton, W.R., Srivastava, J.P., Neumann, J.E., Strzępek, K.M., & Droogers, P. (2013a). Reducing the Vulnerability of Albania's Agricultural Systems to Climate Change, International Bank for Reconstruction and Development / The World Bank.

Sutton, W.R., Srivastava, J.P., Neumann, J.E., Iglesias, A., & Boehlert, B. (2013b). Reducing the Vulnerability of Moldova's Agricultural Systems to Climate Change, International Bank for Reconstruction and Development / The World Bank.

Sutton, W.R., Srivastava, J.P., Neumann, Droogers, P., A., & Boehlert, B. (2013c). Reducing the Vulnerability of Uzbekistan's Agricultural Systems to Climate Change, International Bank for Reconstruction and Development / The World Bank.

UNRISD. 2002. Agrarian Reform, Gender and Land Rights in Uzbekistan (available at http://www.unrisd.org/unrisd/website/document.nsf/(httpPublications)/C2919AC1CD7B5379C1256CCA00369D07?OpenDocument). Geneva, Switzerland.

United Nations Development Program (2016), Human Development Report 2016, Human Development for Everyone. United Nations Development Program.

Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., ... & Cox, P. M. (2015). Health and climate change: policy responses to protect public health. *The Lancet*, *386*(10006), 1861-1914.

World Factbook, (2017). Washington, DC: Central Intelligence Agency.