19 Environmental Demography

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Human population dynamics are central to questions of both the causes and consequences of environmental change and these dynamics have had a long history of public and policy attention. Population growth has been of particular concern; likely as far back as civilization itself (Dietz & Rosa, 1994). Much contemporary focus has, however, been shaped by the writings of Thomas Robert Malthus in the late 1700s. Malthus contended that given its exponential growth pattern, population increase would necessarily outpace increases in the means of subsistence, notably food. He further contended that hunger, misery, and war would ultimately result, bringing population back into check but not without grave human cost (Malthus, 1798). Such population-centric perspectives on environmental change can still be found today within "neo-Malthusian" perspectives emphasizing population growth as a primary driver (Hunter & Prakash, 2019).

Environmental demography complicates the simplistic assumption that human population growth represents a singular, dominant force in environmental change. For instance, to better understand society-environment relationships, environmental demographers disaggregate population change into its constituent elements: fertility, mortality, and migration and consider the interplay between these demographic dynamics and aspects of natural environments. While many demographers make use of individual- or household-scale information, the ultimate goal is to better understand the intersections between social, economic, cultural, and political processes as they combine to shape population outcomes. Environmental demographers bring aspects of the natural environment into demographic inquiry as well.

This chapter provides an overview of environmental demography as an interdisciplinary perspective on myriad aspects of the population-environment connection. Throughout, we offer examples of sociological scholarship that illustrate the utility of the sociological perspective on issues of inequality, sociocultural context, and environmental perceptions. This overview begins with a general introduction to population-environment linkages and includes brief discussion of factors that mediate this association. The three core demographic processes, fertility, mortality, and migration provide the remainder of the chapter's topical structure and for each of these demographic processes, we review several contemporary case studies illustrating their environmental dimensions.

Before proceeding, it is important to note that demography, as the statistical study of population, emerged centuries ago; Population estimates were undertaken as far back as the sixteenth

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century (Bonar, 2014). *Environmental* demography, however, is a relatively new subdiscipline that explicitly focuses on the environmental dimensions of population dynamics. The review provided here is necessarily cursory and the literature presented has been chosen to illustrate core themes within environmental demography's evolution and also as it is today practiced.

Demographic Dynamics and Their Mediating Factors

Consider a spatially-bounded population be it a city, region, or nation. The absolute size of this population changes as babies are born and as residents die. Any migration into or out of the population also influences its overall size, which combined with consumption patterns, ultimately shapes its environmental impact. Socioeconomic factors, cultural norms, and available technologies act as critical "mediating factors" that add complexity to the population-environment connection beyond the simplistic neo-Malthusian lens (see Fig. 19.1).

The critical influence of mediating factors is clearly demonstrated by cross-national comparison of "ecological footprints", heuristic tools that measure the ecological assets, such as land, oceans, and forests, necessary for a particular population's average consumption. The footprint is presented as the global hectares required to meet a population's needs based on average global productivity per hectare. Underscoring the importance of mediating factors in a population's environmental impact, France, a nation of approximately 66 million residents has an aggregate ecological footprint (301 million hectares) twice that of Bangladesh (126 million hectares) although Bangladesh has two times the residents (Global Footprint Network, 2018). Cultural factors such as lifestyle shape these distinctions, along with technological needs and environmental policies. Ultimately these intersections determine the ways in which human populations impact the environment.

As reflected in the footprint calculation, environmental demographers often make use of quantitative data reflecting characteristics of aggregates such as counties, states, or nations. Household-or individual-scale data are also useful for closer examination of factors such as age, gender, and education as related to smaller scale decisions of environmental consequence, such as consumption. In both cases, statistical approaches can be used to better understand the associations between social and environmental patterns and processes.

For instance, at the macro-scale, sociologists have long been active in empirical investigation of the population-environment particularly within cross-national comparisons. Such scholarship expanded upon the well-known IPAT identity that specified environmental impact as the multiplicative product of population (P), affluence (A) and technology (T) (Commoner et al., 1971; Ehrlich & Holdren, 1972). The expanded model—STIRPAT—allows for differential influence of P, A, and T through estimation of:

$$I_i = aP_i^b A_i^c T_i^d e_i$$

where a represents the constant which scales the model, e is the error term, i represents units of time and b, c and d are parameters to be estimated (hence STIRPAT represents "Stochastic Impacts by Regression on Population, Affluence, and Technology") (Dietz & Rosa, 1994). Much of this work reveals important variation in population-emissions associations across settings (e.g., Dietz & Rosa, 1994; Liddle, 2014). For instance, Jorgenson and Clark (2010) use panel data from 1960 to 2005 representing a diverse sample of nations to estimate these connections. While they find population to be a primary driver of total national-level anthropogenic carbon dioxide emissions, the associations vary substantially by region and across time. In particular, the positive impact of population size on carbon dioxide emissions declined between 1960 and 2005 for African nations while remaining the same for most high-income countries (Jorgenson & Clark, 2010). This body of literature undergirds the argument that mediating factors, such as sociocultural patterns, influence aggregate "ecological footprints" by shaping processes such as consumption.

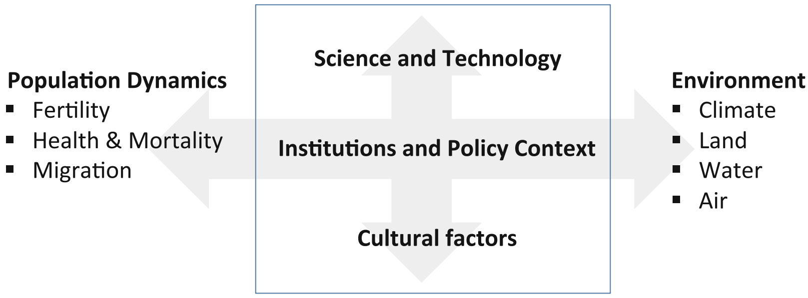


Fig. 19.1 Mediating factors shape population-environment connections

Environmental Dimensions of Human Fertility Patterns

From a demographic perspective, fertility refers to the process through which members of a population produce live births, thus, adding new members (Preston et al., 2001). Demographers have long studied fertility patterns and processes, with the Growth of American Families Survey taking place in 1955 and 1960, followed by the 1965 National Fertility Survey. These data collection efforts were designed to allow for examination of marital fertility and family planning in the United States.

Results from scholarship across the globe suggest myriad factors shape fertility including four "proximate determinants": marriage, contraception, abortion, and post-partum infecundity (Bongaarts, 1978) in addition to women's rights (Dixon, 1975). Over the past several decades, demographers have explored the many ways in which social and economic factors interact to influence these proximate determinants, and in turn, influence fertility. Such factors include access to healthcare (Cain, 1983) as well as education and employment opportunities (Singh et al., 1985). In addition, recently expanded investigations into fertility determinants are integrating environmental factors, especially as climate change threatens livelihoods across the globe (Dunlap, 2010; Molnar, 2010; Sellers & Gray, 2018).

The following section reviews contemporary studies on environmental aspects of fertility rates, preferences, and behaviors such as the timing of childbearing. While not an exhaustive review, the section covers several main themes within the broader literature including the Vicious Circle Model (VCM) and issues related to natural hazards and disasters, environmental quality, and land availability and tenure. Taking a sociological lens to these topics calls attention to the sociocultural aspects of fertility-environment linkages, as well as inequalities in the ways in which these linkages manifest.

The Vicious Circle Model

The Vicious Circle Model (VCM) conceptualizes an inverse relationship between fertility and environmental context, namely that degraded environments yield higher fertility (Dasgupta, 1995). The mechanism underlying this association is household labor demand as children can contribute to household labor supply especially in settings characterized by high levels of agriculture or natural resource-dependence (Caldwell & Caldwell, 1987). Moreover, children provide wealth to parents across their lifetimes as they diversify risk and secure long-term care (Cain, 1983, 2018). The Vicious Circle Model is so-called since high fertility in response to challenging environmental conditions serves to subsequently increase resource pressure (Marcoux, 1999; O'Neill et al., 2001).

A vicious circle has been identified in several locations including Pakistan, South Africa, and Nepal. For instance, in Pakistan, households furthest from critical wood sources have higher fertility (Filmer & Pritchett, 2002) while a similar association has been found in South African settings (Aggarwal et al., 2001). Sociologists Biddlecom et al. (2005) brought issues of gendered labor into this inquiry. They contended that the notion that children can provide labor for natural resource collection may also underlie the connection in Nepal where the time to collect fodder (typically female labor) has been positively correlated with family size—specifically, longer resource collection time has been associated with desires for more children (Biddlecom et al., 2005). This association holds particularly for women (Brauner-Otto, 2014; Brauner-Otto & Axinn, 2017). In West-Central Africa, in communities already characterized by resource shortage such as scarce local vegetation coverage, declines in "natural capital" have also been associated with higher fertility preferences and actual numbers of children (Sasson & Weinreb, 2017).

It is important to note, however, that while the VCM has been identified in particular locales, it does not hold in all settings due to variation in cultural norms, religion, and the perceived value of children which is often related to inheritance customs (de Sherbinin et al., 2008). For instance, another study in Nepal found higher rates of contraceptive use for those that perceived declines in agricultural productivity—the opposite of what would be predicted by the Vicious Circle Model (Ghimire & Mohai, 2005). Similarly, in dry regions of rural Mexico, conditions more favorable to agricultural productivity have been linked to birth timing, perhaps through enhanced livelihood security (Simon, 2017).

Land Availability: Farm Size and Tenure

Another approach to conceptualizing the relationship between fertility and the environment emphasizes land availability such that higher fertility rates have been documented in regions where land inheritance is more secure (Easterlin, 1976). Two competing perspectives have emerged to explain this association: the land-labor-demand and the land security hypotheses (Stokes & Schutjer, 1984).

The land-labor-demand perspective suggests that labor demand drives the desire for more children. Empirical evidence of the association is found in Egypt, Iran, Kenya, Peru, and the Philippines (Clay & Johnson, 1992; Easterlin & Crimmins, 1985; Good et al., 1980; Hiday, 1978; Schutjer et al., 1983). As a specific example, in Kenya, land scarcity and diminished farm size led to lower fertility preferences as parents increasingly chose to substitute investments in education in lieu of land inheritance (Shreffler & Nii-Amoo Dodoo, 2009).

In contrast, the land-security perspective emphasizes the importance of land tenure or the formalization of ownership. Here, scholars contend that such ownership confers better living conditions and standards including access to education and health care, and these opportunities lower demand for child labor and, therefore, fertility rates (Stokes & Schutjer, 1984). Such an association has been identified in the Ecuadorian Amazon, where women in households with insecure land access had a 27% higher birth rate as those in households with legal land titles (Pan & Lopez-Carr, 2016). Findings consistent with the land security hypothesis are also found in settings as varied as Egypt, India, Iran, Mexico, and the Philippines (Carr et al., 2006; Good et al., 1980; Hiday, 1978; Schutjer et al., 1983; Vlassoff & Vlassoff, 1980).

Sociologists have long underscored the ways that gender matters, revealing that women tend to have more influence on reproductive decision-making in settings where they have more control of resources including land. This association manifests in Malawi, for instance, where women's sole ownership of land engenders more reproductive health control, while joint ownership with their husband does not (Behrman, 2017).

Fertility Following Natural Disasters

Natural hazards that generate human disasters also influence fertility. For instance, post-tsunami displacement may lead to reduced demand for children as people settle into new locations (temporarily or permanently) and are forced to find new employment and rebuild assets (Carballo et al., 2005). Such post-disaster displacement can also impact access to contraceptives, a challenge particularly noted for racial minority women after Hurricane Ike (Leyser-Whalen et al., 2011). Natural disasters can also cause changes in fertility desires especially after the loss of a spouse or partner (Evans et al., 2010; Hamoudi et al., 2014) and can lead to fetal distress risk and abnormal labor outcomes for women exposed to especially disruptive hurricane events (Zahran et al., 2010, 2013). Below, we highlight three case studies that illustrate these mechanisms.

The 2004 Indian Ocean earthquake and tsunami killed over 170,000 people in the coastal areas of Aceh and North Sumatra, Indonesia and roughly 500,000 were displaced (Gray et al., 2014). A survey of communities in coastal Indonesia found that fertility increased following the tsunami since mothers who had lost children were more likely to have a child afterward. In addition, women without children prior to the tsunami were quicker to initiate family building, especially when living in communities with high mortality levels (Nobles et al., 2015). A similar increase in fertility occurred in Nicaragua after Hurricane Mitch, which killed 3800 in 1998 (Davis, 2017). The increase was especially notable in areas most heavily impacted by heavy rainfall, although fertility returned to pre-storm levels after about 6 years (Davis, 2017).

In the U.S., Hurricane Katrina made landfall on the Gulf Coast in August 2005, resulting in the evacuation of 1.5 million residents, with hundreds of thousands ultimately being permanently displaced (Weber & Peek, 2012). The displacement resulted in a 30% decline in births in New Orleans, although with important racial variation. Fertility among African American women remained below expected values through 2010, while fertility among white women increased (Seltzer & Nobles, 2017). These differential fertility values—along with differential return rates sharply divided along race and class lines—have played an important role in New Orleans' changing racial composition as a higher proportion of current city residents are white as compared to historical composition (see Fig. 19.2).

The Environmental Dimensions of Human Migration

While fertility entails the addition of new members to a population, migration involves moving from one place to another, altering the population size of both origin and destination. Like fertility, human migration is the observable outcome of complex socioeconomic processes and individual and household decision-making. Again sociological perspectives offer critical insight into the sociocultural patterns and processes that shape migration decision-making as well as the underlying social inequalities that are both a cause and consequence of human movement. Below we offer a brief overview of research on the environmental dimensions of migration including discussion of the wide variety of environmental "push" and "pull" factors as well health aspects of the migration-environment connection.

Research designed to understand the patterns and implications of migration is challenged at a basic level by even defining the outcome—a definition of migration requires establishing spatial boundaries that must be crossed, time periods that must be met, and intentions that must be considered. Combining these, researchers often study long-distance and short-distance migration, temporary and permanent migration, and economic motivations as contrasted with others.

Many patterns exist within human mobility and the examination of migration's potential environmental dimensions requires accounting for other known predictors, many of which shape inequalities in resource access and opportunities. For example, higher education, and socioeconomic status more generally, are associated with greater migration probabilities—bringing inequality to the fore as related the human movement. Age also influences movement in that the likelihood of individual migration peaks in early adulthood and again at retirement and, as a result, populations with higher concentrations of individuals at these ages will likely be more mobile. Gender matters too in that motivations for, and patterns of, migration vary in

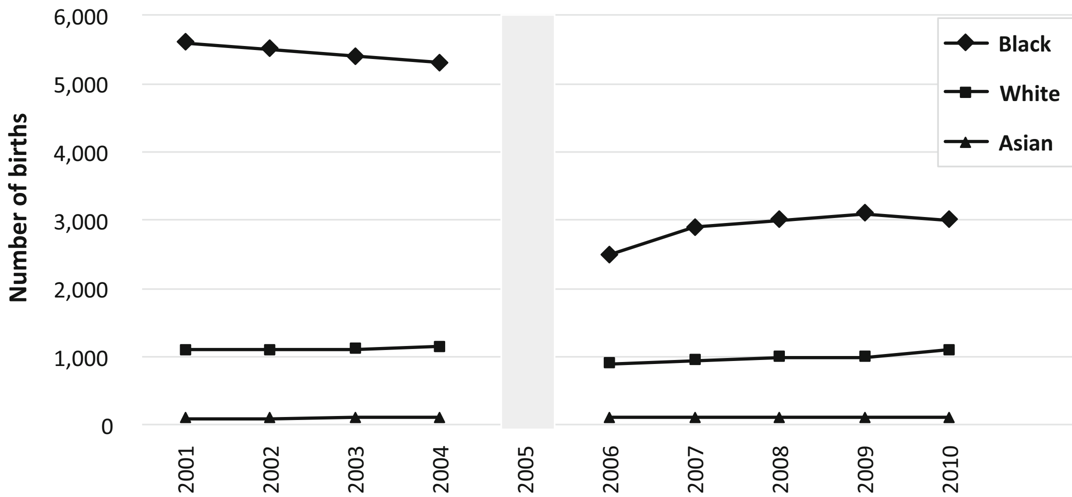


Fig. 19.2 Number of births by race, before and after Hurricane Katrina (2005), Orleans Parish, Louisiana (Orleans Parish (equivalent of a U.S. county) encompasses New Orleans). (Data source: Seltzer & Nobles, 2017)

some settings for men and women. Historically, women have been more likely to migrate for marriage as compared to men, although such disparities are declining and women are increasingly likely to migrate for economic, educational opportunity, or other reasons, as well as increasingly migrate on their own (United Nations, 2017). There are also spatial patterns—rural-to-urban migration tends to be greater than the reverse, in part demonstrating the dominance of economic motivations within migration decision-making.

Migration's Environmental Aspects

In the past two decades, demographers have moved beyond analysis of these well-known socioeconomic and spatial determinants to investigate migration's environmental dimensions. Climate change research, in particular, has raised awareness of the migration-environment connection and the demographic research community has responded with the development of case studies from areas across the globe (Hunter et al., 2015). Much of this research expands on this prior knowledge of migration patterns by exploring the effect on migration of environmental conditions and/or change after controlling for the other known migration correlates. The vast majority of this work has, indeed, found an 'environmental signal' suggesting that the environment plays a role in human movements.

Figure 19.3 presents an oft-used conceptual framework from the UK Foresight Project that integrates migration's environmental dimensions with known micro-, meso-, and macro-scale factors. Age, gender, and education, as noted above, represent micro-scale factors that shape migration decision-making, while social networks and regional policy represent important meso-scale influences. On networks, much sociological research has demonstrated the importance of social connections as migrants follow in the footsteps of acquaintances who can provide assistance in employment and housing searches. As an example, such movement has greatly influenced the Mexico-U.S. migration stream as demonstrated by research documenting this "cumulative causation" ultimately leading to self-sustaining migrant flows (Garip & Asad, 2016). This stream also reveals the critically important influence of the meso-scale influence of policy since the ups and downs in Mexico-US migration have been shaped by a variety of immigration policies including the Bracero Program between 1942 and 1964, which facilitated movement of temporary workers and the 1986 Immigration Reform and Control Act (IRCA), which legalized undocumented immigrants that had arrived before 1982.

Today, the political and cultural climate combined with increased U.S. border enforcement and changes in economic opportunities following the Great Recession have all influenced the decline in Mexico-US migrant flows (Gonzalez-Barrera et al., 2015). The role of economic conditions is represented in the Foresight conceptual framework as a macro-scale influence on migration patterns; indeed, economic conditions in both origin and potential destination areas have a strong impact on migration, with much research suggesting their dominance in decision-making (e.g., Neumann & Hermans, 2017). That said, economic factors are not the only macro force acting upon migration; population composition, socio-cultural prejudice, and expectations regarding family caretaking represent additional influences. Again, considering Mexico-US streams, destination choices are shaped by population composition in that cumulative causation processes may increase the likelihood of migration to destinations with larger immigrant proportions. Also, characteristic of broader socio-cultural forces, Mexican laborers in the U.S. experience individual and institutional forms of prejudice and discrimination with important implications for health (Finch et al., 2001), while also shaping desires to return home (Moran-Taylor & Menjivar, 2005). Such desires are also affected by culturally-derived responsibilities to family, with traditional Mexican culture emphasizing values related to interdependence and family obligation (Markus & Kitayama, 1991).

Beyond these macro-scale sociocultural, demographic, and economic migratory influences, a particularly useful aspect of the Foresight framework is its explicit integration of environmental dimensions. Consider the impact on subsistence agriculture of chronic and more acute extreme events such as drought and flooding which have been linked to migration in a wide variety of settings including rural Bangladesh, Tanzania, and Mexico (Haeffner et al., 2018; Hassani-Mahmooei & Parris, 2012; Kubik & Maurel, 2016). Environmental factors can also yield indirect influence on other macro factors such as employment opportunities. For instance, when Hurricane Katrina devastated the U.S. Gulf Coast in 2005, the dramatic loss of local businesses lessened economic opportunities for residents interested in returning, especially in hard-hit sectors such as state and local government, education and health services, and leisure and hospitality (Groen & Polivka, 2008; Vigdor, 2008). More generally, Hurricane Katrina impacted the historical migration "system", or longstanding spatial patterns on in- and out-migration connecting the region with the nation (Fussell et al., 2014).

Environmental "Push" Factors

Findings from several settings illustrate key themes in the connection of migration and drought, temperature change, and natural disasters. As an example and as noted above, much is known about the correlates of Mexico-U.S. migration streams and this strong foundation has offered an excellent base from which researchers have examined potential environmental aspects. Mexico-U.S. migration streams have important connections with temperature and rainfall patterns, above and beyond sociodemographic and economic correlates. Specifically, net of these sociodemographic and economic correlates, the likelihood of a household sending a migrant to the U.S. is greater from dry regions. Such connection is logical in that rural Mexican livelihoods are heavily agricultural-dependent (Eakin, 2006). Even so, the connection isn't quite so simple since research has demonstrated that periods of rainfall shortage are associated with U.S. migration only from Mexican cities with low levels of marginalization—areas with higher levels of education and income. This association suggests that international migration from rural Mexico is not typically a response to climate pressures for the most impoverished households in the most

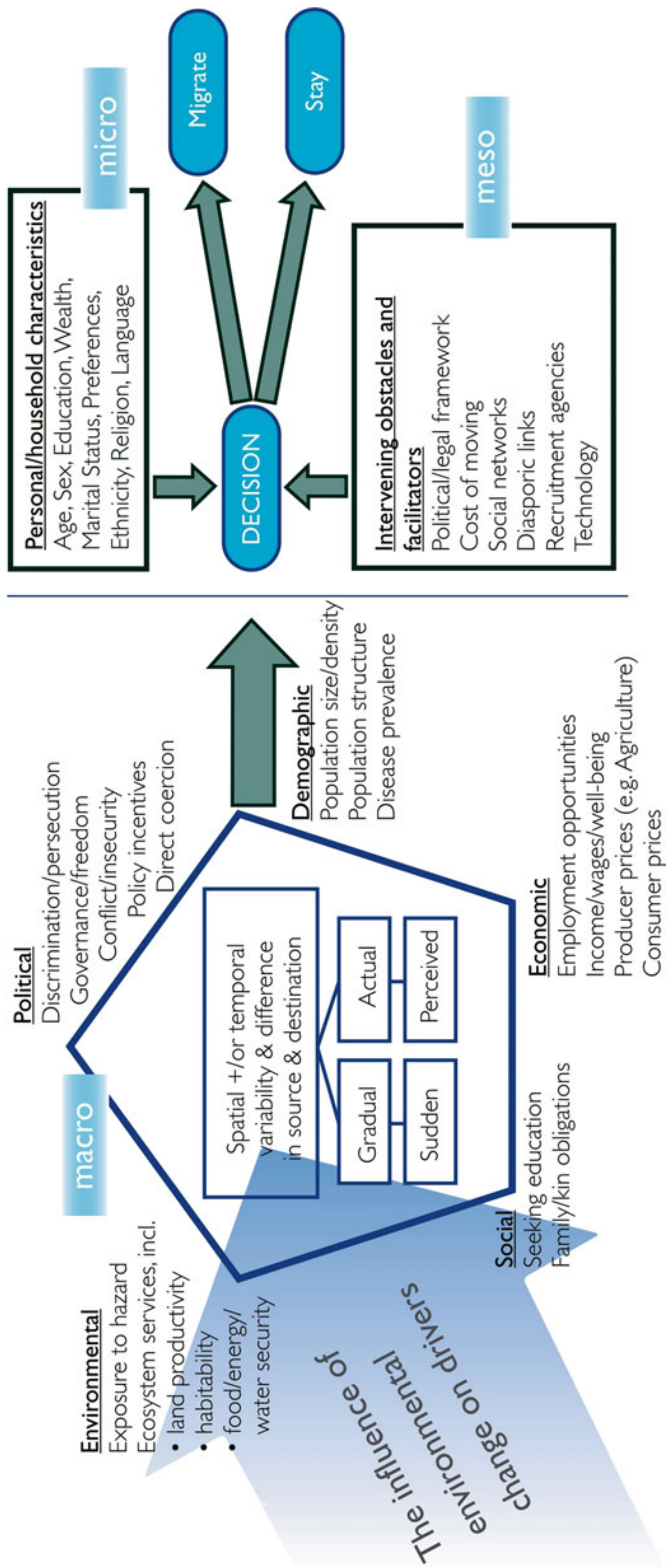


Fig. 19.3 The environmental dimensions of human migration. (Source: Black et al., 2011)

impoverished places. Instead, since migration is often costly, it is more likely to be used by households with some level of available resources (Riosmena et al., 2018).

Such resources are not solely financial; social networks are a resource as well. Networks facilitate movement by offering connections to help reduce some of migration's uncertainty in finding housing or employment and other aspects of settling in. Back to the Mexico example, recent research finds that the association between drought and U.S. migration also predominantly characterizes movement from places with strong transnational migration networks (Hunter et al., 2013; Riosmena et al., 2018). Such networks are often reflected by measures of proportion of households receiving remittances from abroad or recently having sent or received an international migrant.

In addition to shifts in rainfall, temperature changes have also been associated with migration. In Indonesia, for instance, higher temperatures are linked with lower levels of migration, potentially due to the positive benefits of warm spells on agricultural production in this geographic setting (Thiede & Gray, 2017). A related association has been found casting a wider contextual net as well. In a study including over 150 nations, the migration-environment connection was also mediated by agricultural reliance. That said, instead of generally reducing migration, it was periods of extreme heat that demonstrated an effect through yielding higher levels of international migration during these periods of environmental strain (Thiede et al., 2016).

These two studies of migration as linked to temperature changes represent a critically important finding of the broader literature on migration-environment: the specific association is highly context specific. Thinking back to Fig. 19.3 this should be no surprise given the wide variety of additional factors that ultimately shape the environmental dimensions of migration.

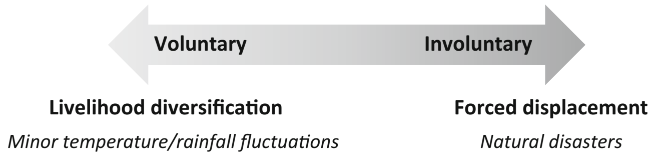
A continuum becomes a useful tool for organizing some of the context-specific nuance inherent in the migration-environment connection (Fig. 19.4). Livelihood-related migration, such as that noted above, can potentially be seen as more voluntary—as a household strategy to diversify income sources and thereby spread risk (Arango, 2017). As a contrast, residents of areas experiencing ongoing dire conditions may have little choice. Pacific Islanders, notably those on Tuvalu and the Marshall Islands, provide powerful examples and were some of the first to receive both scholarly and policy attention with regard to the migratory implications of sea level rise (e.g., Mortreux & Barnett, 2009). Today, relocation options are constrained for residents of small island states due to customary land tenure rights of potential destinations within the region. Restrictive migratory policies in other locations, such as the United States and Australia, also inhibit movement (Crate & Nuttall, 2016). Several "mediating factors" are represented in this example such as culture (i.e., land ownership norms) and policy (i.e., immigration policy). The absence of sustainable technological solutions (i.e., sea walls) also shapes these migration flows.

Migration's Environmental Impact

An intriguing association also exists with regard to the environmental impacts of migration itself. There are at least two pathways through which such impacts manifest. First, migrants may influence population pressures within the places where they move. That said, scholarship in the U.S. has found that immigrants tend to have less environmentally impactful consumption patterns that native-born residents. Using a STIRPAT approach, an urban-focused analysis in the U.S. found that counties with a relatively larger foreign-born populations had lower levels of some harmful emissions than counties with relatively more native-born residents (Squalli, 2009).

A second pathway through which migration brings environmental impacts is through the remittances that return to origin households. As an example, research in Ghana has found that remittances are used to finance infrastructure within the origin households as well as to support consumption needs. As related to the

Fig. 19.4 The continuum of migration-environment connections



environment, remittances were used to buy fishing nets, dig wells, build water harvesting infrastructure, and buy fertilizer—all of which shift population-environment dynamics (Musah-Surugu et al., 2018).

Environmental "Pull" Factors

While climate strain or other environmental challenges may act as "push" factors for would-be migrants, environmental characteristics can "pull" migrants too. Consider the high levels of population growth in amenity regions of the American West which offer access to environments often found appealing such as coastlines and mountain vistas. As contrasted with overall rural population loss, amenity-rich rural areas in the U.S. grew nearly 20% between 1990 and 2015 (Florida, 2018). Such movement is occurring in rural areas across the globe, from Costa Rica to Spain (Elizburu, 2007; Matarrita-Cascante et al., 2015). Environmentally-related amenity migration to rural areas has environmental implications of its own since residential expansion and shifts in the use of private lands impact habitat and reshape local resource demands (Abrams et al., 2012).

Research explicitly examining urban-rural distinctions in the "pull" of natural amenities tends to find stronger associations in rural regions as compared to urban (Chi & Marcouiller, 2013; Rickman & Wang, 2017). Even so, natural amenities can drive economic growth in major urban areas, thereby pulling new residents (Rickman & Wang, 2017). Consider the challenges facing high-amenity metropolitan areas such as Seattle where economic and population growth have intersected to create affordability and ecological challenges (e.g., Robinson et al., 2005; Sirianni, 2007; Voith & Wachter, 2009).

Environmental Dimensions of Population Health

In her 2007 Presidential Address to the annual meeting of the Population Association of America (PAA), Sociologist Barbara Entwisle implored demographers to better consider the ways in which "places—local, social, and spatial contexts" impact populations and their health (Entwisle, 2007: 687). Subsequent research has shown that local contexts—where we live, work, and play—influence our mental health, risk of experiencing violence and injury, and even how long we live (e.g., Arcaya et al., 2016; Ross, 2000; Wray et al., 2011). In fact, there are entire literatures devoted to the ways in which specific characteristics of neighborhoods (e.g., quality of the built environment, order/disorder, access to fresh food and other amenities, proximity to toxins and hazards) improve or deteriorate public health. Below we provide a brief overview of climate-health connections followed by several examples of innovative research on health-environment from an environmental demographic perspective focused on several African settings, as related to mental health, and finally as linked to climate-related migration.

An Overview of Climate-Health

Climate and environmental factors influence health both directly and indirectly (Levy & Patz, 2015). Such connections include morbidity and mortality from heat waves (Basu, 2015), respiratory and allergic disorders (Kinney et al., 2015), water- and food-borne diseases (Rose & Wu, 2015), malnutrition and food security (Dangour et al., 2015), mental health effects of extreme heat and drought (Doherty, 2015) and neighborhood disadvantage (Downey & Van Willigen, 2005;

Ross, 2000), and collective violence (Levy & Sidel, 2015). Moreover, the most recent IPCC 1.5 report warns of the many threats to human health if the planet continues to warm at its current pace (Ebi et al., 2018). Some estimates suggest that climate change will cause 250,000 excess deaths per year between the years 2030 and 2050 (WHO, 2018). While the IPCC 1.5 report describes the future health impacts of continued warming, the consequences of climate change for human health are already being felt. In the U.S., the most recent National Climate Assessment makes clear that climate change affects the health of all Americans through altered exposures to heat waves, floods, droughts, and other extreme events; changes to the quality and safety of the air we breathe; and stresses to mental health and well-being (Ebi et al., 2018).

The health impacts of climate change reviewed above are not, however, equally distributed—offering a critical point of entry for sociologists. Climate scientists predict greater temperature increases over land and at higher latitudes, while precipitation changes will make mid to lower-latitude areas more arid. Coastal populations will be forced to contend with more frequent and severe flooding and rising sea-levels (Field et al., 2014). Prior climate-health research has largely focused on health impacts from heat stress, extreme weather, and infectious disease (McMichael et al., 2006). Such work documents that heat extremes are often deadly (Mora et al., 2017), especially for vulnerable populations like those with mental illness (Curriero et al., 2002), children and youth (O'Neill et al., 2003; Zahran et al., 2008), the elderly (Díaz et al., 2002), and low-income populations (Klinenberg, 2015). Urban environments are particularly sensitive to heat waves, known as the urban heat island effect, whereby the built environment (e.g., concrete) absorbs and retains heat, further amplifying the rise in temperatures (McGeehin & Mirabelli, 2001). Figure 19.5 reveals many such climate-health connections.

Also linked to climate change, sea-level rise can indirectly influence health through impaired crops, livestock, and fisheries, which in turn have negative impacts on agricultural yields and nutrition. The right-hand side of Fig. 19.5 illustrates how environmental degradation to land, coastal ecosystems, and fisheries can displace populations and worsen mental health outcomes as a result of lost livelihoods (Durkalec et al., 2015; Ellis & Albrecht, 2017). In Western Australia, for example, farmers' sense of place is intimately tied to their health, as weather influences their emotional and psychological states (Ellis & Albrecht, 2017). Changes to land and sea ecosystems may also alter vector-pathogen-host relationships and impact infectious disease patterns, spread, and seasonality (Wu et al., 2016). In this way, cholera and salmonella multiply more rapidly in higher temperatures and Dengue fever is sensitive to climatic variation associated with El Nino and La Nina events (Hales et al., 1999; Hopp & Foley, 2003).

Innovative Considerations of Climate-Health in African Settings

To illustrate how environmental conditions interact with social factors to influence health, we highlight three studies from the African context. Taken together, they demonstrate that failing to consider environmental conditions may result in an incomplete understanding of the mechanisms underlying health disparities and outcomes. Further, these environment-health connections will likely become even more significant as climate change progresses, with the impacts disproportionately burdening marginalized groups and poor nations.

HIV and Water Quality in Kenya Local environments shape what populations eat, where they work, and where they play. For communities in Nyanza Province on the shores of Kenya's Lake Victoria, the local environment also shapes one's risk of contracting HIV as changes in the lake's ecology have been connected to early and high HIV prevalence.

Sociologist Mojola (2011) offered a groundbreaking argument that the eco-social context must be considered in any public health

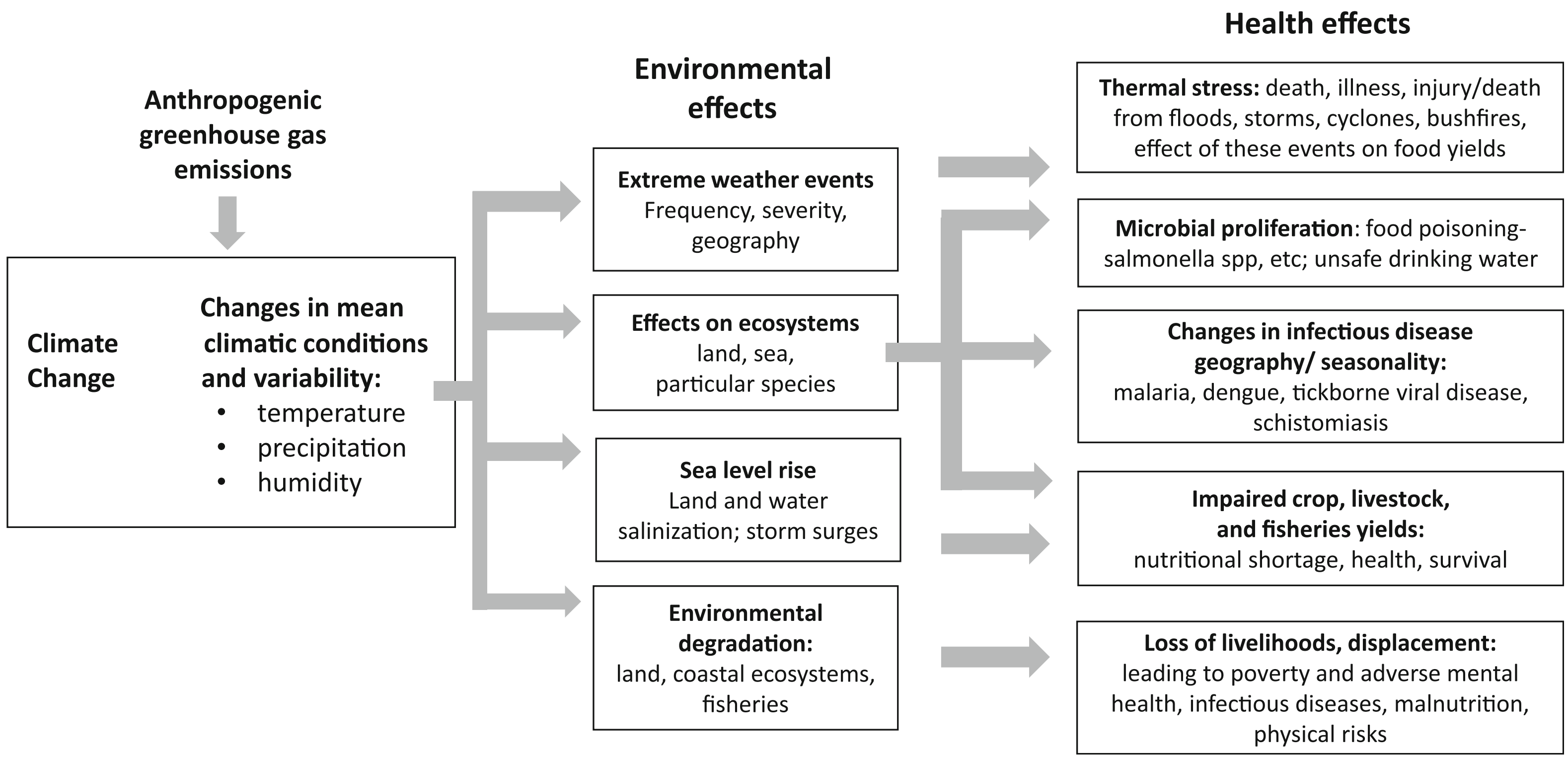


Fig. 19.5 Main pathways by which climate change affects population health. (Adapted from McMichael, Woodruff, and Hales 2006)

intervention designed to lessen HIV prevalence. Her research uncovered important eco-social connections in that, first, nutrient changes in Lake Victoria resulted from a variety of pressures including deforestation, loss of wetlands, and untreated sewage. The nutrient changes fueled growth of water hyacinths which led to fish populations migrating to the lake's relatively less polluted sections. As a result, male fishers migrated too. The Lake Victoria fishing economy is heavily gendered—men catch fish while women sell the fish at market—and as fishers migrated, they developed relationships with new female business partners over which they had leverage given overall decline of fish populations. Male dominance reduced women's control over condom use and, therefore, over protection against sexually transmitted diseases, ultimately increasing HIV prevalence (Mojola, 2011). In all, lake ecology was an important factor in the number of sexual partners and efforts to prevent disease spread.

Natural Resource Buffer for HIV-impacted Households in South Africa Local environments also influence household food security, as natural resources offer important sustenance. A survey in northeastern South Africa found 90% of households make use of wild vegetables, while over two-thirds use wild fruit in their diets (Hunter et al., 2007). These resources are also used for income generation as households sell collected materials and/or resource-derived products such as baskets and mats (Mbiba et al., 2019).

Like Kenya, South Africa has been hard hit by HIV/AIDS. In fact, South Africa has the largest HIV epidemic in the world. The nation is home to 19% of the global number of people living with HIV and 11% of AIDS-related deaths (UNAIDS, 2019). In the nation's rural regions, local natural resources provide a critical safety net when households experience health crises—notably, adult mortality from HIV/AIDS. Natural resources play a critical role in fending off hunger especially in the face of household loss of a male breadwinner. Wild foods act as a substitute for previously purchased goods (Hunter et al., 2007).

Climate Strain and Infant Health Outcomes Across Africa Reproductive and infant health outcomes are also influenced by climate variability and related extremes in temperature and precipitation (e.g., Bakhtsiyarava et al., 2018). For example, environmental stress can adversely affect the dietary intake of pregnant women which can impact fetal growth. The utero period is critical for human development and low birth weight is associated with many negative longer-term outcomes, such as future health challenges and lower educational attainment and income (Walker et al., 2007). This connection between environmental conditions and birth weight outcomes has been documented across 19 African countries (Grace et al., 2015).

Climate and Mental Health

Existing research also documents both direct and indirect climate impacts on human mental health. Direct mechanisms include exposure to trauma as a result of elevated rates of violence and aggression (Berry et al., 2010), while indirect mechanisms include impacts to physical health (e.g., heat exhaustion) and damages to community environments such as schools and churches, with negative consequences for social cohesion (Berry et al., 2010; Klinenberg, 2018).

The mental health outcomes of drought are similar, largely resulting from economic loss and challenges to livelihoods, reductions in social support, and lost sense of place attachment (Vins et al., 2015). To illustrate, the relative risk of suicide is 15% greater for rural males in Australia during drought (Hanigan et al., 2012). As another example, challenges to one's relationship to place have impacted the mental health of indigenous Inuit communities in Canada surrounded by declining sea ice (Durkalec et al., 2015; Ellis & Albrecht, 2017).

Reviewing dozens of studies that analyzed the relationship between climate change and mental health outcomes, Thompson et al. (2018) conclude that the strongest evidence exists for the link between warmer temperatures and suicide. In California, between 2005 and 2013, rising temperatures were linked to more emergency room visits for mental health disorders, suicide, and intentional injury/homicides (Basu et al., 2017). Case studies from around the world, including the United States, Mexico, India, and Australia support these links too. In India, where suicide rates have doubled since 1980, Carleton (2017) suspected that suicides might increase following climate extremes that lower crop yields. Indeed, once above 20 degrees Celsius in the growing season, every one degree increase has been associated with 70 additional suicides, on average (Carleton, 2017). Similarly, across U.S. counties, a one degree Celsius rise in the monthly average temperature has been linked to 0.7% higher suicide rates; In Mexican municipalities, such rates rose by 2.1% (Burke et al., 2018). These relationships cannot be dismissed as entirely spurious, as the same researchers found that the use of depressive language on social media also increased during warmer periods (Burke et al., 2018).

The Complex Relationship Between Migration, Health, and Climate

We conclude this section on climate-health by focusing on migration as a particular demographic outcome and its relationship with climate and health. As reviewed above, considerable research has documented the myriad ways in which climatic changes and environmental factors shape human migration (Hunter et al., 2015). The literature further shows that migration also has important health dynamics. For example, international migration tends to be positively selective on health, meaning that migrants often exhibit better health than their non-migrant counterparts in places of origin. This association makes intuitive sense as migration is inherently a difficult process—involving relocation from one's known cultural, economic, and political context. Additionally, both temporary and permanent forms of voluntary migration strain social relationships and require the establishment of new ones. As such, the "healthy migrant effect" asserts that migration is not a random process, but rather a selective one (Akresh & Frank, 2008; Riosmena et al., 2013).

In addition to health and as reflected in Fig. 19.3, other personal characteristics (e.g., age, sex) and meso-level factors (e.g., economic, political contexts) shape one's ability to relocate following climate stressors such as drought (Schwerdtle et al., 2018). Yet, challenging climates may influence the health profiles of migrants seeking to relocate (McMichael et al., 2012). In this way, Hunter and Simon (2017) investigated whether drought might alter the "healthy migrant" effect for the international migration stream between Mexico and the U.S.

In semi-dry regions of Mexico, healthy selectivity is lower in times of rainfall scarcity. In other words, in periods where climate stress challenges livelihoods, migration is not related to health—both healthy and unhealthy household heads are equally likely to move. On the other hand, in periods of more rainfall, health selectivity is greater. During these times, livelihoods are less challenged, perhaps allowing these health selection processes to take place, as relatively healthy households have a greater likelihood of sending a migrant to the U.S. In this way, periods of reduced climatic strain might allow for greater selection in that there is less migration and those that do move are in better health. Such intersections are important in that they can shape health service needs in both sending and receiving areas. Even so, examination of this triad from a demographic perspective is nascent and more research is needed to fully elucidate the complexities within the migration-health-climate intersection.

Conclusion

The complexity of the society-environment connection requires investigation from multiple perspectives and environmental demography offers one such lens. The demographic perspective, particularly the social demographic perspective, interrogates the intersections between social, economic, cultural, and political processes as they combine to shape population outcomes. Here, we have offered several glimpses into how environmental factors are embedded within social demographic inquiry including climate context and fertility, migration, and population health and mortality. Specifically considering the sociological perspective, the discipline's lens highlights the ways in which structural inequalities shape the population-environment association. Examples include research on gendered perceptions of resource constraints and their relation with desired family size (Biddlecom et al., 2005), the importance influence of social networks in shaping the viability of migration as an adaptation to environmental stress (Riosmena et al., 2018), and differential vulnerability to HIV/AIDS as a consequence of inequalities in access to resources along the shores of Lake Victoria (Mojola, 2011).

A central benefit of taking a broad population perspective is the potential to shed light on how individual- and household-scale processes aggregate to generate population outcomes. There is a wide variety of contemporary topics that require additional research attention as such scholarship should motivate and inform policy. Many such questions arise as populations across the world—indeed, the global population—face climate change. For instance, what is the appropriate response as populations are faced with relocation due to sea-level rise? In what ways might climate change shift migration patterns such that health policy should be adjusted in both sending and receiving regions? What of differential increases in suicide risk in particular? What are the implications for reproductive health policy as women increasingly encounter disasters and other environmental stressors that challenge the sustainability of their livelihoods? Such questions certainly do not fall solely within the purview of environmental demographers, but a population lens can offer important insight—insight that becomes all the more important as the world faces a changing, uncertain climate future.

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