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The Differential Influence of Geographic Isolation on Environmental Migration: A Study of Internal Migration Amidst Degrading Conditions in the Central Pacific

Hugh B Roland[*], **Katherine J Curtis**[**]

[*] Nelson Institute for Environmental Studies, University of Wisconsin-Madison, 122 Science Hall 550 North Park Street, Madison, WI 53706

[**] Community and Environmental Sociology, University of Wisconsin-Madison, 316B Agricultural Hall 1450 Linden Drive, Madison, WI 53706

Abstract

This study investigates how geographic isolation interacts with declining environmental and economic conditions in Kiribati, an island nation wherein which limited access to financial resources amidst degrading environmental conditions potentially constrain capital-intensive, long distance migration. We examine whether geographic isolation modifies the tenets of two dominant environmental migration theses. The environmental scarcity thesis suggests that environmental degradation prompts migration by urging households to reallocate labor to new environments. In contrast, the environmental capital thesis asserts that declining natural resource availability restricts capital necessary for migration. Results show that the commonly applied environmental scarcity thesis is less valid and the environmental capital thesis is more relevant in geographically isolated places. Findings indicate that geographic isolation is an important dimension along which migration differences emerge. As overall environmental and economic conditions worsen, likelihoods of out-migration from less remote islands increase whereas likelihoods of out-migration from more isolated islands decrease.

Keywords

environmental migration; geographic isolation; climate change; Kiribati

INTRODUCTION

Scholars generally agree that environmental migration is driven by economic, political, demographic, social, and environmental forces, with environmental changes interacting with and shaping each of these forces (Black, Adger, Arnell, Geddes, & Thomas, 2011). However, research also demonstrates that precisely how environmental and economic influences affect migration varies spatially and by migration distance and cost (Findley, 1994; Gray, 2010; Henry, Schoumaker, & Beauchemin, 2003; Massey, Axinn, & Ghimire, 2010; Riosmena, Nawrotzki, & Hunter, 2013). According to the traditional, dominant

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framework known as the *environmental scarcity thesis*, poor environmental conditions may prompt out-migration in search of more hospitable natural environments and better livelihoods. In contrast, the *environmental capital thesis* asserts that resource scarcity and limited financial means associated with poor environmental conditions may actually restrict out-migration (Geest, 2011, pp. 128–129; Hunter, Luna, & Norton, 2015; see also Gray, 2009 for similar logic though different terminology). We investigate whether geographic isolation is a significant force underlying variation in the likelihood of migration.

Research investigating environment-related migration and factors that might complicate or restrict migration is increasingly relevant given the mounting human risks associated with climate change. In the context of climate change, migration is often described as an adaptation strategy, the other options being protection (e.g., building sea walls) and accommodation (e.g., planting salt-tolerant crops) (Dronkers et al., 1990; L. Perch-Nielsen, Bättig, & Imboden, 2008; McLeman & Smit, 2006). However, in some geographically isolated places, out-migration may not be a realistic option because of unavailable financial means necessary for the high cost of long distance migration (Warner, Ehrhart, Sherbinin, Adamo, & Chai-Onn, 2009).

Social vulnerability also influences environment-related migration. Social vulnerability is defined as community and individual capacities to withstand and respond to threatening conditions (Levine, Esnard, & Sapat, 2007; Zahran, Brody, Peacock, Vedlitz, & Grover, 2008). Threatening conditions include social and environmental changes, and community and individual capacities refer to livelihood impacts and resource access and use (Neil Adger, 1999). Social vulnerability, a traditional migration push factor, may become a barrier in places where migration requires long distances and high costs. The most socially vulnerable populations, and those with the greatest relative deprivation, thus may remain in place to confront worsening environmental (and associated economic and social) conditions. Adaptation through out-migration may not be a viable option for all populations located in environmentally degrading places. This study addresses the need to understand whether the likelihood of migration differs systematically between more and less isolated contexts.

Given the potential for varying migration responses to similar environmentally degrading conditions, we address a central question to environmental migration research: How do worsening environmental and economic conditions affect out-migration in geographically isolated places versus less geographically isolated places? We address this question by drawing on the environmental scarcity and environmental capital theses, and by comparing internal out-migration flows between more and less geographically isolated islands in the central Pacific islands of Kiribati. Our analysis compares changes in the probability of out-migration between 2000–05 and 2010–15, and between more and less geographically isolated island groups.

Kiribati is made up of 32 atolls and one island. Most internal migration is from outlying islands to the main island of Tarawa, home to roughly half of the country's population. The islands span an ocean area the size of the continental United States, and internal migration involves distances large enough to capture potential impacts of geographic isolation on out-migration. As a result, the Kiribati spatial context enables a comparison of migration between islands that are more and less geographically isolated from the main destination, Tarawa. Within Kiribati, poverty is high, livelihoods on outlying islands are largely subsistence, and costs of living and cash requirements are increasing (Kiribati Census, 2005; Kiribati Census, 2015; Tokamauea et al., 2014). Economic stresses are thus already high and risks are growing as environmental conditions degrade through rising temperatures and sea-levels, increasing erosion and seasonal weather irregularities, and more frequent and severe storms.

Previous calls for research have urged analyses of longitudinal data to test migration responses to relative deprivation (Stark & Bloom, 1985). Our study responds to this call and demonstrates the utility of taking a longer-run view of environmental migration by comparing internal out-migration flows in Kiribati over a ten-year period. In doing so, our study makes several unique contributions. First, while research has compared short and long distance migration scenarios related to changing environmental conditions and poorer access to natural resources (Findley, 1994; Gray, 2010; Henry et al., 2003; Massey et al., 2010), ours is the first to examine these migration scenarios in a context of geographic isolation. Second, most research investigating heterogeneity in environment-related migration has considered cases such as temperature, droughts, rainfall, and storms, which more directly disrupt economic activity and affect livelihoods, for example via lower agricultural yields, and, thus, are more directly linked to economic drivers (Fussell et al., 2017; Henry et al., 2003; Hunter, Murray, & Riosmena, 2013; Nawrotzki & DeWaard, 2018). Rather than focus on a single environmental factor, our study acknowledges the overall environmental context.

THEORIZING DISTANCE AS A CONDITIONING INFLUENCE ON MIGRATION

Distance is chief among the central tenets of migration theory. Beginning with Ravenstein's Laws of Migration (1885), refined by Lee (1966), and updated for the environmental context by Findlay (2011), scholars generally accept that long distance migration is less common than short distance migration due to the higher costs of relocating to farther destinations. When considering the role of distance in migration, two theses within the environmental migration literature, the *environmental scarcity thesis* and the *environmental capital thesis*, are at odds with one another.

Scholars have empirically demonstrated that the greater deprivation a household faces, the larger incentive they have to out-migrate in search of improved economic opportunities (Stark & Bloom, 1985). The environmental scarcity hypothesis describes such deprivation-driven migration in the context of environmental changes (Hunter et al., 2015). Within this context, families diversify their economic risk to offset unpredictable climate conditions by having family members seek employment elsewhere (Massey, 1990). Accordingly, out-migration only slows once economic circumstances have improved in the place of origin (Massey et al., 1998; Villarreal & Blanchard, 2013).

Conversely, the environmental capital thesis argues that migration capabilities are directly linked to local poverty and inequality and, key to this thesis, natural resources that provide financial capital necessary for migration (Hunter et al., 2015; Massey et al., 1998). It follows that in places with worsening environmental conditions, the likelihood of out-migration declines in tandem with the natural resources necessary to support such mobility. Consequently, migration, particularly across long distances, might not be a universally accessible option.

Natural resources and isolation are at play in both the environmental scarcity and the environmental capital theses, yet the way in which these two factors presumably shape migration sharply contrasts. Isolation dampens the migration-promoting effect of declining natural resources asserted in the environmental scarcity thesis. However, isolation exacerbates the migration-prohibiting effect of declining natural resources outlined in the environmental capital thesis. With this theoretical distinction in mind, we anticipate that the migration-incentivizing role that environmental and economic challenges play in the environmental scarcity hypothesis only pertains to contexts in which migration costs are reasonable and, associated, distances to potential destinations are short. In remote settings, the environmental capital thesis is likely the more applicable framework.

Cases of geographic isolation have not been a central focus in previous studies, but researchers have compared the effects of poor environmental conditions on long and short distance migration (Findley, 1994; Gray, 2010; Henry et al., 2003; Massey et al., 2010). Short-term and short distance environmental migrants tend to be less financially endowed than long distance and international migrants, since long distance and permanent migration is more costly (Findlay, 2011; Findley, 1994). Inhospitable environmental conditions and periods in which households have lower access to natural capital increase internal migration, but these same conditions also decrease or postpone more costly international migration (Gray, 2010; Riosmena et al., 2013). Similarly, during harsh environmental periods, communities with higher prior migration rates and, consequently, stronger migration networks experience greater international migration (Hunter et al., 2013; Lindstrom & Lauster, 2001; see also Nawrotzki & DeWaard, 2018). Meanwhile, residents of isolated places and others who lack moving capacity, such as older and low income populations, are more likely to stay (Koko Warner & Laczko, 2008).

Climate alone seldom prompts permanent migration decisions (Abu, Codjoe, & Sward, 2014; Black et al., 2011; Hunter, 2005; Martin et al., 2014) despite rhetoric around sea level rise and “sinking islands” (Kelman et al., 2015; Kempf, 2009; Mortreux & Barnett, 2009; Rudiak-Gould, 2013). Low-lying atoll residents are more likely to migrate in search of economic opportunities, better living conditions, and greater access to services, although the environment still influences these drivers (Kelman et al., 2019). Our study does not assume that climate is a major, direct driver of migration. Rather, we assert that climate influences economic and social factors which, especially for some people and places, increases resource paucity and poverty and potentially promotes or constrains migration options (Kelman et al., 2015).

THE MIGRATION AND ENVIRONMENTAL CONTEXT OF KIRIBATI

Internal Migration in Kiribati

In this study, we position migration distance as a proxy for migration cost and difficulty. Migration cost and difficulty are a product of both absolute and relative distance, including the ease of movement between places. For instance, the burden of migration might be reduced by regular and affordable ferry service or air links between two physically distant islands. In the Kiribati context, relative distance largely corresponds with absolute, spatial distance between the outer islands and Tarawa. Islands more geographically proximate to Tarawa have more frequent and affordable travel services compared to more geographically distant islands. Consequently, absolute distance is a reasonable approximation of relative distance in Kiribati.

Comparing internal migration scenarios has several important advantages over analyzing international migration. These advantages include the need to consider fewer operating forces, environmental and nonenvironmental (Findlay, 2011; Lindstrom & Lauster, 2001), easier measurement since all movement is captured in one nation's census data (Rowland, 2003), and the absence of reporting problems associated with immigration (Passel, Van Hook, & Bean, 2004). A benefit of studying Kiribati is that challenges common for immigration are not at issue in our analysis of internal migration while, at the same time, internal migration distances vary dramatically between islands, and approximate distances are on par with traditionally conceived long distance migration. Migration decisions involve numerous factors, but in atoll nations and the Pacific region, economic factors, influenced by the environment, are primary migration drivers (Butcher-Gollach, 2012; Kelman et al., 2019; Locke, 2009; McCubbin, Smit, & Pearce, 2015; Mortreux & Barnett, 2009; The World Bank, 2020a). Indeed, migration dynamics in Kiribati are typical of environmental migration (and migration more generally): migration is overwhelmingly toward a proximate urban center and strongly influenced by economic drivers (Findlay, 2011; Findley, 1994; Lindstrom & Lauster, 2001). The main island of Tarawa, shown in Figure 1, offers the most opportunities for formal employment and access to resources, including education and healthcare, and life there is considered easier since it does not involve the same degree of physical work as outer island subsistence living (Tokamauea et al., 2014).

Outlying island residents also have compelling reasons to stay in place. Migration in the Pacific often involves leaving an area that has been home for generations and abandoning a celebrated way of life (Mortreux & Barnett, 2009; Rudiak-Gould, 2013). Moreover, travel costs are high in proportion to low cash incomes (Office of Te Beretitenti, 2012), and migration involves major logistical obstacles, including transportation access. Islands further from Tarawa (the South Gilbert Islands and the Line Islands) tend to have higher Tarawa-bound migration costs and difficulty. Flights to Tarawa from islands in the South Gilberts (as of April 2019, ranging from $97 to $183) may be twice as expensive as flights from an island in the more proximate North and Central Gilberts (ranging from $41 to $86 USD). Tarawa-bound flights are generally scheduled once a week ("Air Kiribati Domestic and Regional Schedule," 2019), but service is unreliable (The World Bank, 2020a). Flights to Tarawa are unavailable from the Line Islands. Boat travel is more affordable than flying, but islands further from Tarawa have less frequent service (Office of Te Beretitenti, 2012). For the two islands closest to Tarawa, several boats ferry passengers on the 3 to 5 hour trip (Gay, 2012, p. 108). For islands in the South Gilberts, service is unscheduled and unreliable, and travel takes at least two days (Office of Te Beretitenti, 2012). The boat that provides most of the domestic shipping among the Gilbert Islands visits islands roughly once every two months (Gay, 2012, p. 99). Tarawa-bound service from the Line

Islands is still more infrequent, and high shipping costs may even prevent the collection of government-subsidized copra (Gay, 2012, p. 100; Office of Te Beretitenti, 2012; The World Bank, 2015). Additionally, boat travel is dangerous and weather dependent, and boats often lack safety equipment and are overloaded (Office of Te Beretitenti, 2012). In 2018, 95 people died when an inter-island ferry sank (Abete, 2018), and a similar accident resulted in 35 deaths in 2009 (Office of Te Beretitenti, 2012).

Declining Environmental and Economic Conditions in Kiribati

Although migration within Kiribati is challenging, declining environmental and economic conditions provide a context in which migration might be increasingly attractive if not necessary. While environmental conditions have not changed uniformly across Kiribati (Cazenave & Cozannet, 2014; Locke, 2009), environmental circumstances have increased risks across the island nation (Bach, 2017; Tokamauea et al., 2014). From 1993 to 2012, rates of sea level rise in the central Pacific were three times larger than the global rate (Cazenave & Cozannet, 2014). Sea level rise may increase erosion, flooding, land loss, inundation, and salt water intrusion (L. Perch-Nielsen et al., 2008; Woodroffe, 2008). The Pacific has also experienced an increase in the number and intensity of El Niño events and exceedingly high sea levels during La Niña events. High tides and storm surges accompanying these events in Kiribati commonly lead to erosion and flooding, and erosion sites on several Kiribati atolls already have had several generations of seawalls (Connell, 2015).

Droughts differentially affect islands in Kiribati (Locke, 2009). A drought occurs when rainfall is at or below the lowest 10% of the historical record and breaks once rainfall returns above the lowest 40% of the historical record (Kiribati Meteorological Service Division Office of Te Beretitenti, 2017). The mean annual precipitation across Kiribati is 2,100 mm (Kiribati Meteorology Service, Australian Bureau of Meteorology, & CSIRO, 2015), lowest in the South Gilbert Islands (1,892 mm) and the Line Islands (811 mm) (Abete-Reema, Tonganibeia, Teariki-Ruatu, Redfern, & Willie, 2004).

Droughts can result in salt water contamination of fresh water sources, reduced crop yields, and increased vulnerability for subsistence livestock producers (Animal Genetic Resources Report for the Republic of Kiribati, 2003; Locke, 2009). From early 2007 to early 2009, drought conditions severely affected water supplies in the South Gilbert Islands (Australian Bureau of Meteorology and CSIRO, 2014; Kiribati Meteorology Service et al., 2015). Government reports for each of the South Gilberts describe droughts hindering agricultural production, including less abundant coconuts and subsistence crops like breadfruit, pawpaw, and banana trees. Consequently, families store coconuts in anticipation of drought and grow crops near to homes so that they may be more easily tended (Office of Te Beretitenti, 2012). Droughts also force residents to severely limit water usage and make long trips to collect fresh water (Office of Te Beretitenti, 2012).

Environmental conditions are degrading across Kiribati, despite sub-national differences in type and intensity. Reports from the Kiribati government stress declining conditions in each island (Office of Te Beretitenti, 2012). These reports identify concerns related to coastal erosion and sea water intrusion, marine resource depletion and inaccessibility, droughts, and declines in agricultural activity on almost every island (Office of Te Beretitenti, 2012). Country-wide poverty assessments and household income and expenditure survey data confirm worsening economic, health, and social conditions (Tokamauea et al., 2014; Tiroa, 2006). Australian government and United Nations reports on conditions between the study periods describe “a sense that life is becoming more difficult” (Tokamauea et al., 2014) and a country that “appears to be slipping backwards” in meeting Millennium Development Goals (Eastman & Katz, 2014). Recent data show declining per capita income, due to formal sector employment growth not keeping up with population growth, alongside increases in costs of living and cash expenses (Tokamauea et al., 2014). Population growth has also increased demands on scarce resources (Bach, 2017; Connell, 2015), and a high dependency ratio threatens to exacerbate already high levels of poverty (Kiribati Census, 2005; Tokamauea et al., 2014). Health concerns and crises, such as high levels of childhood nutrition deficiency and diarrheal diseases, the highest child mortality rate in the Pacific, increasing child mortality due to malnutrition, rising incidence and prevalence of tuberculosis, high prevalence of HIV/AIDS, and high levels of gender-based violence and gender inequality, are all indicators of worsening or low population well-being (Crook, Farran, & Roëll, 2016; Eastman & Katz, 2014; Hoy et al., 2015; Kodish et al., 2019; Tokamauea et al., 2014).

The subsistence nature of outer islands makes livelihoods particularly susceptible to environmental changes and environment-related economic migration (Bach, 2017; Tokamauea et al., 2014). Outside of public service employment (i.e., teaching), one of the few ways outer island residents earn cash livelihoods is through government subsidized copra production, and copra production is highly dependent on enviornmental conditions (Kiribati Census, 2005; Kiribati Census, 2010). Subsistence livelihoods on outlying islands are already considered difficult and have become even more challenging as pests are increasingly prevalent, crops are more difficult to grow, freshwater is increasingly contaminated and scarce, and coastal fishing stocks, which are the most accessible, are declining (Bell, Taylor, Amos, & Andrew, 2016; Post, Bosserelle, Galvis, Sinclair, & Werner, 2018; Tokamauea et al., 2014). Reports of not only fewer fish but also smaller and fewer varieties are increasingly common, and declining fishing stocks have led to lower fishing incomes (Bach, 2017; Eastman & Katz, 2014).

Faced with increased environmental hazards, high population densities also threaten subsistence livelihoods. Research has demonstrated that on small subsistence islands, population densities over 100 people per square kilometer increase livelihood and food and water insecurity risks related to environmental shocks (Curtain & Dornan, 2019). Population density might thus be a proxy for vulnerability to environmental shocks and shifts.[1] In both 2000 and 2010, population densities for 14 out of the 19 outer islands in this study were larger than 100 people per square kilometer threshold, with an average population density of 138 and 145 people per square kilometer for outer islands in 2000 and 2010 respectively (Kiribati Census, 2000; Kiribati Census, 2010).

[1]An alternative perspective is Boserup’s highly influential counter-Malthusian theory that increased population density is accompanied by adaptation in the form of agricultural intensification, which is necessary to support the growing population (Boserup, 1965).

Despite its geographic isolation, Kiribati is not insulated from global systems or crises. The 2007–08 Global Financial Crisis, which occurred between the two study periods, led to inflation, lower remittances, and large government deficits. With inflation, cash earners may find that the real value of their pay falls (McCann, 2014, p. 20). Inflation ranged from 0.5% to 6.7% in 2000–05 and from −0.4% to 4.7% in 2010–15 yet rose to 8.3% in 2008, a high not seen since 1996 (The World Bank, 2020b). Accompanying declines in government spending on social services and economic development during this period, along with high global fuel and rice prices, exacerbated vulnerability (Eastman & Katz, 2014). Generally worsening conditions for the environment, ecosystem service availability, and economic situations are apparent across Kiribati, which, combined with varying distances between islands, make Kiribati an appropriate study site for our investigation of the potential impact of geographic isolation on migration.

DATA AND ANALYTICAL STRATEGY

Data

We rely on origin-destination migration flow data from the 2005 and 2015 Kiribati censuses (Kiribati Census, 2005; Kiribati Census, 2015). Raw data consist of matrices that compare population by island of enumeration in the census year with island of residence in the census five years prior. Age and sex are not included, which prevents more nuanced examination of migration decision-making and trends. Nevertheless, these matrices allow for comparisons of the numbers and rates of individuals moving to and from each island between two five-year periods, 2000–05 and 2010–15. We compare 2000–05 and 2010–15 out-migration rates between islands that are more and less geographically isolated from the primary migration destination, Tarawa. On average, 58% of out-migration in 2000–05 and 61% of out-migration in 2010–15 was to Tarawa. We compare rates of migration to Tarawa to test our theses on geographic isolation's modifying impact on migration.

Analytical Approach

We take two approaches to arbitrate between the environmental scarcity and the environmental capital theses, one comparing migration between islands within the same period and the other comparing change in migration between periods. In the first approach, we compare out-migration within period between more and less isolated islands. Given the context of poor environmental and economic conditions and limited access to resources, higher out-migration among more isolated islands would support the environmental scarcity thesis. In contrast, lower out-migration among more isolated islands within the same context would support the environmental capital thesis. In the second approach, we leverage time series data to assess change in migration among the islands. Increasing out-migration among the more isolated islands would support the environmental scarcity thesis, whereas declining out-migration among the more isolated islands would support the environmental capital thesis.

Island Groupings—Addressing the potential effect of geographic isolation on migration likelihood as environmental and economic conditions decline requires comparisons between islands more and less geographically isolated from the primary migration destination. To make these comparisons, we compare migration rates between three island groups (Figure 1). The North Gilbert and Central Gilbert districts (together made up of eight islands, excluding Tarawa) are the least geographically isolated islands, or the most proximate to Tarawa. We group the two districts together because Tarawa is located in the center of the combined grouping. Islands in the North Gilbert and Central Gilbert districts are between 59 km and 227 km from Tarawa. The South Gilbert district (also eight islands) are farther from Tarawa with distances ranging between 269 km and 614 km. The Line Islands district (three islands) are the farthest from Tarawa and, thus, the most isolated islands. Islands within this group are between 2,976 km and 3,288 km from Tarawa. We exclude Tarawa, Banaba, and Kanton from our analysis. Tarawa is the nation's primary internal migration destination. Banaba and Kanton are distinct from other islands in Kiribati in terms of environmental degradation (i.e., mining-related, see Edwards, 2013), environmental risks (i.e., higher elevation reduces perceived risks for residents considering migration, see Hermann & Kempf, 2017), and migration patterns (i.e., consistent with very low populations and settlement abandonment).

The island groupings are frequently used to describe migration flows in Kiribati census reports, and they reflect both geographic distance from Tarawa and commonly used administrative divisions. Political and cultural differences between these divisions are weak (Mcintyre, 2012) and, thus, the cultural theory of risk – where populations are culturally primed to have particular perceptions of and responses to environmental or social changes (Douglas, 1992) – is unlikely to influence migration behaviors between islands.

Migration Probabilities—We calculate migration probabilities from flow data since probabilities account for the population size of the sending island. We begin with matrices of island-to-island migration flows for the two comparison periods, 2000–05 and 2010–15. Following Fussell et al.'s (2014; see also Curtis et al., 2015) approach we calculate matrices of island-to-island migration probabilities by dividing the number of people migrating from each island by the number of people at-risk of migrating, in this case the mid-period population (i.e., the mid-period population for 2000–05 is the average of the island population in 2000 and 2005).

It is useful to describe the data as probability matrices since we use the matrices to calculate aggregated migration probabilities for subsequent analysis. Using the 2000–05 probability matrix as an example, each cell represents the probability that those living on a certain island in 2000 migrated to a different island or stayed at origin in the 2005 census. Each column represents a probability vector of those likely to leave a specific island, although columns do not sum to exactly one because we use mid-period population as the denominator to calculate probabilities. Each row is a distribution of the probability of migrating to a specific island from each of the other islands. Using these probabilities of migrating to each of the different islands from another island, probabilities of leaving for Tarawa are calculated by summing the appropriate origin-destination migration probabilities. We examine probabilities of migrating to Tarawa from other island groups between periods and by island group. We do not report statistical significance in our analyses because the data include the full count of migration flows.

Conceptual Difference-in-Difference—We adopt a difference-in-difference style approach to make comparisons across both geographic isolation and time. Previous research has used difference-in-difference approaches to compare control and treatment groups that were differently exposed to environmental factors or events (e.g. Curtis et al., 2015). However, we are interested in the difference between geographically isolated places and less geographically isolated places and assume similar exposure to environmental conditions. Thus, in our analysis, distance is the treatment effect. The first difference, for each island, is in the probability of out-migration to Tarawa between more geographically isolated and less geographically isolated island groups. The second difference is in the probability of out-migration to Tarawa between the two census periods.

Considerations—Limited data, and particularly limited environmental data, pose a challenge to our research. Certain environmental data, like rainfall, is relatively accessible, and many studies have investigated drought (Obokata, Veronis, & McLeman, 2014). However, island-level environmental data related to broadly declining conditions (i.e., coastal erosion and sea water intrusion, marine resource depletion and accessibility, and droughts and declines in agricultural productivity) is less clear-cut and available, particularly in the Pacific region.

Our study relies on several assumptions related to limited data availability. First, drawing on published reports, we assume that economic and environmental changes are generally declining across island groups during the ten-year study period. However, conditions vary across Kiribati, and islands are differently impacted by environmental events such as drought (Locke, 2009). Integrating data on island-to-island environmental and economic variation would enable scholars to assess whether lower and declining out-migration rates among particular islands coincide with more dramatic environmental degradation.

Second, development projects on specific islands and other local influences like remittances might also generate different changes in environmental, economic, health, and other important conditions between islands that would influence the push toward out-migration. Other studies have accounted for different levels of marginalization, social networks, and technological buffers (Riosmena et al., 2013), but limited data prevents such considerations in our study.

Third, limited data also prevent more comprehensive time-series comparisons. The two observation periods in this study were the only ones for which migration matrices were included in the census. More expansive time-series data would facilitate study of historical migration trends and whether any observed changes are long or short term patterns, and would inform the assumption regarding worsening environmental and economic conditions.

RESULTS

Results show that migration in Kiribati varies according to distance in a manner most consistent with the environmental capital thesis. Presumed worsening conditions appear to encourage migration in search of new opportunities when migration involves shorter distances but constrain longer distance migration. The difference in migration patterns between more and less geographically isolated islands is apparent in changes in island-level out-migration probabilities. We report in Table 1 the probability of out-migration to Tarawa for each island and the island group average for the 2000–05 and 2010–15 periods, as well as changes in out-migration probabilities between the two periods. For comparison, we report the probability of island group out-migration for each island and island group in Appendix A. These migration probabilities include moves to Tarawa as well as moves to outer islands in different island groups. Migration to outer islands in different island groups is less common than migration to Tarawa but is not exceptional. In 2000–05, for example, an average of 115 people for each island (ranging between 45 and 260) moved to an outer island in a different island group. We include this appendix to consider how migration to other outer islands informs our interpretation of Tarawa-only bound migration. Differences in migration probabilities and changes in migration probabilities are similar in both cases.

Island Differences in Migration Probabilities

Analysis of migration probabilities shows that out-migration to Tarawa is higher among the least geographically isolated islands as compared to the more isolated islands. As a group, the North and Central Gilbert Islands reported a probability of 173 people per 1,000 (0.173) out-migrating to Tarawa in 2000–05 and approximately 219 people per 1,000 (0.219) out-migrating in 2010–15. Consistent with the environmental capital thesis, probabilities of Tarawa-bound migration from the more spatially proximate North and Central Gilbert Islands in 2000–05 are generally larger than probabilities for the more distant South Gilbert Islands. For instance, in 2000–05, 164 people per 1,000 (0.164) left the South Gilberts for Tarawa, although this marks only a 9-person difference with the least isolated North and Central Gilbert Islands. In 2010–15, the margin increased to 66 fewer people migrating to Tarawa from the South Gilberts compared to the North and Central Gilberts (153 versus 219 people per 1,000, respectively). While small numbers, the direction of the differences in out-migration is consistent with the environmental capital thesis and contrasts with the environmental scarcity thesis.

The pattern is more striking among the most isolated Line Islands. Only 106 and 81 people per 1,000 left the Line Islands for Tarawa in the two respective periods, generating corresponding differences of 67 and 138 people per 1,000 compared to the least isolated North and Central Gilbert Islands. On average, out-migration to Tarawa among the least isolated islands was 1.6 and 2.7 times higher than out-migration among the most isolated islands in 2000–05 and 2010–15, respectively. The trend generally illustrates that the environmental capital thesis is more applicable than the environmental scarcity thesis in geographically isolated contexts. Where environmental and economic conditions are broadly declining and resources necessary to support difficult moves are increasingly limited, out-migration is lowest among the most geographically isolated islands and highest among the least geographically isolated islands. Adding further support to the environmental capital thesis, analysis of each island separately shows the lowest migration probabilities consistently distribute among the most isolated islands. For 2000–05, the three Line Islands – Kiritimati, Tabuaeran, and Teeraina – are among the eight lowest reported migration probabilities.

Temporal Changes in Migration Probabilities

For the least geographically isolated North and Central Gilbert Islands, changes in migration probabilities from 2000–05 to 2010–15 are positive for all eight islands in the group. As conditions presumably worsened over time, the likelihood that a resident would leave the island group for Tarawa increased for each of the least isolated islands. The average probability of leaving the Tarawa-proximate North and Central Gilbert Islands was 0.173 in 2000–05 and 0.219 in 2010–15, which amounts to 46 more people out of every 1,000 leaving the North and Central Gilbert Islands for Tarawa in 2010–15 compared to 2000–05. In absolute terms, 105 more people left each island in the North and Central Gilbert Islands for Tarawa in 2010–15 compared to 2000–05 (derived by multiplying the average 2010–15 mid-period population (2,272) by the average change in migration probability (0.046)). On average, the probability of out-migration increased by 26.6% for these islands between the two periods, with values among the eight islands ranging from increases of 7.2% (Abaiang) to 87.6% (Makin).

At first glance, the increase in out-migration among the North and Central Gilbert Islands appears consistent with the environmental scarcity thesis: as environmental, related economic, and other conditions decline, residents migrate to new places in search of better opportunities and livelihoods. For more geographically isolated islands, however, we generally find negative changes in migration probabilities. Such declines are consistent with the environmental capital thesis: isolation exacerbates the migration-prohibiting influence of environmental degradation. The positive change in out-migration probabilities for the North and Central Gilbert Islands contrasts with the negative changes in out-migration probabilities found for most of the more isolated islands. Among the South Gilbert Islands, likelihoods of migrating from the island group to Tarawa decrease in four of the eight islands for an average of −6.7% lower Tarawa-bound migration in 2010–15 than in 2000–05. Declines in out-migration to Tarawa ranged from −2.1% (Nikunau) to −48.1% (Tamana) and increases from 7.6% (Nonouti) to 32.5% (Arorae).

Most dramatic are the decreases in out-migration among the most geographically isolated Line Islands. On average, the three islands reported 23.6% less Tarawa-bound migration in 2010–15 than in 2000–05. Declines in out-migration to Tarawa ranged from −4.0% (Tabuaeran) to −38.7% (Kiritimati). The differences in the changes in out-migration probabilities between island groups are 5.7 percentage-points for the North and Central Gilbert Islands and South Gilbert Islands (calculated by summing differences in migration probabilities 0.046 and −0.011) and 7.1 percentage-points for the North and Central Gilbert Islands and Line Islands (calculated by summing differences in migration probabilities 0.046 and −0.025). The differences in the changes in out-migration probabilities between more and less geographically isolated islands support the environmental capital thesis. Migration is markedly lower from more isolated islands than from less isolated islands and generally decreases during a period in which environmental and economic conditions worsened.

Numerically, the probabilities indicate that 11 fewer people out of every 1,000 left the South Gilbert Islands for Tarawa in 2010–15 compared to 2000–05, and 25 fewer people out of every 1,000 left the Line Islands. Expressed in absolute terms (again, derived by multiplying the average 2010–15 mid-period population, 1,700 for the South Gilberts and 2,950 for the

Line Islands, by the average change in migration probability), on average, 19 fewer people left each island in the South Gilberts for Tarawa in 2010–15 compared to 2000–05, and 74 fewer people left each island in the Line Islands group. Such decreases in the number of people leaving can have substantial effects in small island communities like these.

Access to Migration and Age Structure

Considering that we use migration distance as a proxy for migration cost and difficulty, it is important to consider factors that may affect migration access. Cash incomes is one such factor, shown in Table 2. Low cash incomes make inter-island travel difficult for the majority of I-Kiribati. To put migration costs in context, the Kiribati poverty line is $16 per week, and 66% of the population lives below twice the poverty line ($32 per week). Poverty is highest in the South Gilberts (29% of households compared to 22% nationally and 17% in South Tarawa) (Tokamauea et al., 2014).[2] Remittances increase cash available to support migration on outer islands with limited income-generating activities (Office of Te Beretitenti, 2012; Tokamauea et al., 2014). However, remittances received on outer islands are less than in South Tarawa, and declining remittances (Tokamauea et al., 2014) correspond with generally declining environmental and economic conditions during the study period.[3]

One of few income-related measures available for populations at risk of migrating for this study (populations in 2000 and 2010) is cash workers since they reflect the share of the population with liquid assets that might finance migration. Cash work in the 2000 and 2010 censuses is also referred to as "formal work" and includes government or private employees, employers, and the self-employed. Cash workers do not include individuals producing goods such as copra for sale or individuals engaged in unpaid work, such as family work or producing goods for one's own consumption (i.e., subsistence work) (Kiribati Census, 2000; Kiribati Census, 2010). Census data show that proportions of cash workers are low across islands, and lower in outer islands compared to Tarawa. This pattern is consistent with the subsistence focus of outer island economies. In 2000, for example, 25% of persons age 15 years and older were involved in cash work in Tarawa compared to 10% in the North and Central Gilberts, 11% in the South Gilberts, and 18% in the Line Islands (Kiribati Census, 2000; Kiribati Census, 2010). Most changes in the percent of cash workers between 2000 and 2010 are small (between −2% and +7%). The few larger changes in the share of cash workers, South Tabiteuea in the South Gilberts (+16%) and Tabuaeran in the Line Islands (+13%), are matched by greater increases in the likelihood of migrating to Tarawa relative to respective island group averages (Kiribati Census, 2000; Kiribati Census, 2010). In line with results from our analysis of migration probabilities, these data lend support to the environmental capital thesis: greater resource access supports migration in cases of longer distance moves.

Since older populations are less likely to migrate, it is also necessary to examine possible differences between islands in age structure, shown in Table 3. In 2000 and 2010, the

[2]Income data is only available in 2006. Household income averages $8,745 across island groups, ranging from $4,930 to $12,345 (Tiroa, 2006).

[3]Remittance data is only available in 2006. Remittances averaged $1,157 per household in South Tarawa and ranged from $840 to $559 per household across outer island groups (Tiroa, 2006).

proportion of residents 50 and older ranged from 10.2 to 14.1 in the North and Central Gilberts, 11.9 to 19.3 in the South Gilberts, and 7.6 to 10.7 in the Line Islands (Kiribati Census, 2000; Kiribati Census, 2010). Compared to the North and Central Gilbert Islands, the greater proportion of older residents in the South Gilberts suggests a less migration-prone population. The lower proportion of older residents in the Line Islands suggests a more migration-prone population. However, the Line Islands had the lowest probabilities of migrating to Tarawa in both 2000–05 and 2010–15 as well as the greatest declines in migration probabilities between the periods. While likely influential, age structure does not appear to account for the differences in migration that we see.

CONCLUSIONS AND DISCUSSION

We set out to examine whether geographic isolation affects migration behaviors and found that, as environmental and economic conditions broadly declined, out-migration likelihoods increased for all of the less isolated islands and decreased for most of the more isolated islands. Our study advances environmental migration theory by empirically assessing the conditions under which two central and contrasting frameworks pertain. The differences in migration probabilities and the change over time suggest limited contexts in which the commonly assumed environmental scarcity hypothesis applies. Environmental degradation and variability might prompt out-migration as households seek to diversify economic risk in better-connected, less isolated contexts when lower cost and short distance migration is an option. However, our results make clear that the scarcity thesis does not apply to more geographically isolated contexts. Rather than promoting migration, declining environmental conditions and natural resource availability appear to make longer distance moves less likely. This finding supports the contrasting environmental capital thesis, which contends that significant resources are required to migrate and, consequently, migration is less likely in contexts of environmental degradation and associated economic hardship. Long distance migration is costlier in general, and natural resource scarcity that reduces access to resources might further dampen migration.

Comparing our results with those reported in related research further highlights the significance of the differentiating influence of geographic isolation on environmental migration. Research on the effects of declining environmental conditions related to climate change and long-term rainfall shifts on international migration in rural Mexico found that the percentage of households with at least one family member moving overseas declined by 2.4 percentage-points over a ten-year period (Riosmena et al., 2013, p. 12). In Kiribati, we find that the probability of migration increased by 4.6 percentage-points for the least isolated North and Central Gilbert Islands and decreased by 1.1 and 2.5 percentage-points for the South Gilbert Islands and Line Islands, respectively. The effect size differences of 5.7 percentage-points between the North and Central Gilbert Islands and South Gilbert Islands, and 7.1 percentage-points between the North and Central Gilbert Islands and Line Islands are even starker and, we argue, indicate non-trivial differences.

Our findings have implications for populations facing long-term environmental change. Migration can be an effective adaptation strategy (L. Perch-Nielsen et al., 2008; McLeman & Smit, 2006). However, with scarcer resources, people have fewer response options, including migration (Kelman et al., 2015). A trap might develop in which decreasing access to natural and financial resources makes adaption through migration increasingly inaccessible to an increasing share of the world's populations and places. Such traps might occur under drought conditions (Barrett & Santos, 2014; Nawrotzki & DeWaard, 2018), in the context of natural disasters (Carter, Little, Mogues, & Negatu, 2007), and, as shown here, in geographically isolated contexts. Poverty-reduction policies are likely critical for so-called "trapped populations" (Black & Collyer, 2014; Nawrotzki & DeWaard, 2018; Koko Warner & Afifi, 2014). To this end, national priorities in Kiribati and other Pacific countries have already increased their focus on economic development.

There are many migration drivers at play in the Pacific and other places facing dramatic environmental changes (Kelman et al., 2015). Our analysis considers how geographic isolation potentially moderates economic and environmental drivers to affect migration. Data limitations prevent more detailed comparisons between migration differences and specific environmental and economic conditions at the island level. Ideally, we would have data that captures the range of environmental and economic conditions. Future research might examine cases with such data coverage to further investigate the relationship between environmental and economic changes, geographic isolation, and migration. Understanding how geographic isolation and migration distance affect migration behaviors as environmental and related conditions decline may inform related research on vulnerability and risk, enhance preparation for future environmental migrations, and highlight potential limitations of agency-centered migration frameworks and policies that overlook how external factors constrain household migration decision-making.

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Appendix

Appendix A.

Island Group Out-migration Probabilities by Island in 2000–05 and 2010–15, Kiribati Census

	Probability of island group out-migration		**Change in island group out-migration between periods**	
	2000–05	**2010–15**	**Difference**	**Percentage Change**
North and Central Gilbert Islands	0.217	0.254	0.037	17.1
Abaiang	0.237	0.250	0.013	5.5
Abemama	0.227	0.279	0.052	22.9
Aranuka	0.221	0.249	0.028	12.7
Butaritari	0.229	0.250	0.021	9.2
Kuria	0.248	0.288	0.040	16.1

	Probability of island group out-migration		Change in island group out-migration between periods	
	2000–05	2010–15	Difference	Percentage Change
Maiana	0.251	0.273	0.022	8.8
Makin	0.138	0.218	0.080	58.0
Marakei	0.181	0.228	0.047	26.0
South Gilbert Islands	0.237	0.200	−0.037	−15.6
Arorae	0.193	0.213	0.020	10.4
Beru	0.300	0.179	−0.121	−40.3
Nikunau	0.205	0.183	−0.022	−10.7
Nonouti	0.237	0.235	−0.002	−0.8
North Tabiteuea	0.222	0.189	−0.033	−14.9
Onotoa	0.214	0.255	0.041	19.2
South Tabiteuea	0.263	0.195	−0.068	−25.9
Tamana	0.259	0.150	−0.109	−42.1
Line Islands	0.155	0.106	−0.049	−31.6
Kiritimati	0.188	0.111	−0.077	−41.0
Tabuaeran	0.168	0.132	−0.036	−21.4
Teeraina	0.110	0.076	−0.034	−30.9

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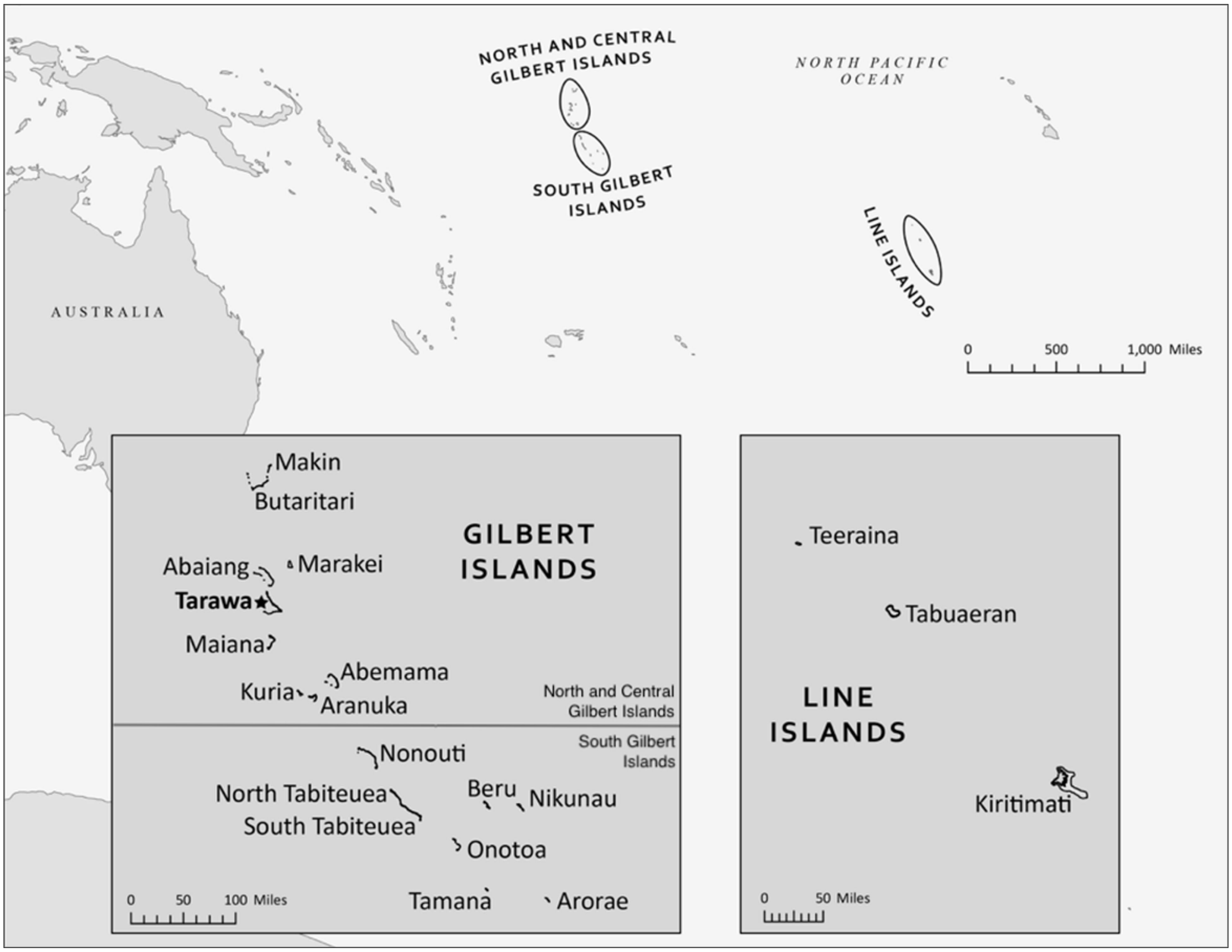

Figure 1.
Islands and Island Groupings, Kiribati

Table 1.

Tarawa-Bound Migration Probabilities by Island in 2000–05 and 2010–15, Kiribati Census

	Probability of Tarawa-bound migration		Change in Tarawa-bound migration between periods	
	2000–05	2010–15	Difference	Percentage Change
North and Central Gilbert Islands	0.173	0.219	0.046	26.6
Abaiang	0.209	0.224	0.015	7.2
Abemama	0.177	0.241	0.064	36.2
Aranuka	0.162	0.187	0.025	15.4
Butaritari	0.193	0.228	0.035	18.1
Kuria	0.198	0.247	0.049	24.7
Maiana	0.199	0.236	0.037	18.6
Makin	0.097	0.182	0.085	87.6
Marakei	0.151	0.207	0.056	37.1
South Gilbert Islands	0.164	0.153	−0.011	−6.7
Arorae	0.123	0.163	0.040	32.5
Beru	0.226	0.137	−0.089	−39.4
Nikunau	0.146	0.143	−0.003	−2.1
Nonouti	0.171	0.184	0.013	7.6
North Tabiteuea	0.146	0.136	−0.010	−6.8
Onotoa	0.166	0.208	0.042	25.3
South Tabiteuea	0.132	0.144	0.012	9.1
Tamana	0.206	0.107	−0.099	−48.1
Line Islands	0.106	0.081	−0.025	−23.6
Kiritimati	0.150	0.092	−0.058	−38.7
Tabuaeran	0.101	0.097	−0.004	−4.0
Teeraina	0.066	0.054	−0.012	−18.2

Table 2.

Percentage of Persons Age 15 Years and Older Who Are Cash Workers in 2000 and 2010, Kiribati Census

	Percentage of persons 15+ years who are cash workers (2000)	Percentage of persons 15+ years who are cash workers (2010)	Change in percentage of persons 15+ years who are cash workers between 2000 and 2010
Tarawa	25.4	24.9	−0.5
North and Central Gilbert Islands	10.3	12.1	1.8
Abaiang	9.7	10.0	0.3
Abemama	10.5	12.7	2.2
Aranuka	13.7	16.4	2.7
Butaritari	11.2	12.5	1.3
Kuria	15.8	14.1	−1.7
Maiana	7.8	9.0	1.2
Makin	10.8	11.1	0.3
Marakei	8.8	15.7	6.9
South Gilbert Islands	10.6	14.4	3.8
Arorae	8.5	8.3	−0.2
Beru	10.6	14.7	4.1
Nikunau	11.0	12.7	1.7
Nonouti	11.0	13.1	2.1
North Tabiteuea	9.6	12.7	3.1
Onotoa	9.3	13.9	4.6
South Tabiteuea	17.2	32.9	15.7
Tamana	9.6	12.4	2.8
Line Islands	18.1	20.5	2.4
Kiritimati	24.7	21.5	−3.2
Tabuaeran	7.7	20.6	12.9
Teeraina	13.7	16.8	3.1

Table 3.

Percentage of the Population 50 Years and Older in 2000 and 2010, Kiribati Census

	Percentage of population 50+ years (2000)	Percentage of population 50+ years (2010)	Change in percentage of population 50+ years between 2000 and 2010
Tarawa	10.0	11.6	1.6
North and Central Gilbert Islands	11.9	12.5	0.6
Abaiang	10.6	12.0	1.4
Abemama	10.2	12.9	2.7
Aranuka	13.3	11.7	−1.6
Butaritari	11.3	12.8	1.5
Kuria	13.0	14.1	1.1
Maiana	13.4	12.4	−1.0
Makin	11.9	12.0	0.1
Marakei	11.5	12.1	0.6
South Gilbert Islands	15.1	15.2	0.1
Arorae	19.3	18.9	−0.4
Beru	13.9	15.4	1.5
Nikunau	15.2	13.8	−1.4
Nonouti	12.0	14.0	2.0
North Tabiteuea	11.9	12.7	0.8
Onotoa	15.0	15.3	0.3
South Tabiteuea	16.0	13.2	−2.8
Tamana	17.9	18.6	0.7
Line Islands	8.0	9.8	1.8
Kiritimati	8.5	10.2	1.7
Tabuaeran	8.0	10.7	2.7
Teeraina	7.6	8.5	0.9