

A Regional Model of Climate Change and Human Migration

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ABSTRACT

As climate change and human migration accelerate globally, decision-makers are seeking tools that can deepen their understanding of the complex nexus between climate change and human migration. These tools can help to identify populations under pressure to migrate, and to explore proactive policy options and adaptive measures. Given the complexity of factors influencing migration, this article presents a system dynamics-based model that couples migration decision making and behavior with the interacting dynamics of economy, labor, population, violence, governance, water, food, and disease. The regional model is applied here to the test case of migration within and beyond Mali. The study explores potential systems impacts of a range of proactive policy solutions and shows that improving the effectiveness of governance and increasing foreign aid to urban areas have the highest potential of those investigated to reduce the necessity to migrate in the face of climate change.

KEYWORDS

Climate Change, Decision Making, Human Migration, Mali, Policy Analysis, System Dynamics Modeling

INTRODUCTION

The nexus between climate change, human migration, and conflict has captured recent headlines as policy makers, researchers, and the public seek to better understand, anticipate, mitigate, and prepare for future circumstances (Rigaud et al., 2018; Wrathall et al., 2018; Null & Hurzer Risi, 2016; Defense Science Board, 2011).

Human migration has long been an important adaptation and risk management strategy for improving quality of life (McLeman & Smit, 2006; Black et al., 2011; Hunter et al., 2015). The United Nations estimates that 258 million people, or 3.4 percent of the world's population, currently live outside their countries of birth (United Nations, 2017a). Significant populations are also displaced internally. The Internal Displacement Monitoring Centre reports that there were 31.1 million new internal migrants displaced by conflict, violence, and disasters in 2016 (IDMC, 2017). The World Bank Group estimates that by 2050 climate change will push tens of millions to migrate within their countries (Rigaud et al., 2018).

Research shows that the decision to migrate is complex and shaped by various and often interacting factors, including macroeconomic conditions (Lilleor & Van den Broeck, 2011; Cummings et al., 2015), household resources and savings (De Arcangelis & Joxhe, 2015), conflict and violence (Reuveny

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& Moore, 2009; Salehyan, 2014; UNHCR, 2016), social networks (Davis et al., 2013; Hunter et al., 2013), environmental degradation (Madgwick et al., 2017), changing climatic conditions (Cattaneo & Peri, 2015), and natural disasters (Mbaye & Zimmerman, 2015; IDMC, 2017).

While it is difficult to separate from other critical factors influencing migration decisions, climate change has emerged as a threat multiplier interacting with a multitude of other socioeconomic, environmental, and geopolitical dynamics to propel increasing numbers of people to move from vulnerable to more viable areas (Rigaud et al., 2018; DSB, 2011). Changing climatic conditions have the potential to place increased stress on vulnerable populations through intensifying damage to homes and critical infrastructure, reducing food production, compromising health and hygiene, and degrading ecosystems (WHO 2017; Gamble et al., 2016).

As policy makers, researchers, and the public seek to better understand the climate-migration connection and anticipate, mitigate and prepare for the dynamics and impact of migration, analytic tools are needed that reflect the complexity of migration decisions and explore proactive policy options and alternative adaptive measures (Wrathall et al., 2018; Rigaud et al., 2018; UN, 2013).

Many different approaches have been taken toward modeling human migration. The conceptual basis for much of today's migration modeling can be traced back to Ravenstein's seven laws of migration (Ravenstein, 1889). Lee (1966) further shaped the conceptual model of migration by recognizing that certain forces will tend to push a potential migrant from their place of origin while other forces tend to pull the migrant to their point of destination. Additional research has contributed to the modeling of human migration, elucidating the drivers of migration (i.e., social, political, demographic, economic and environmental) and incorporating ideas of adaptive capacity and competing adaptive strategies (Black et al., 2011; Gilbert & McLeman, 2010). Where large and diverse populations are at play, it is difficult to ascribe the myriad of drivers to each community of migrants based solely on first principles or through survey data; rather, empirical methods have found particular value in this space of analysis (Afifi & Warner, 2008; Tikhomirova & Lebedeva, 2015). Agent-based modeling has also found wide application in simulating behaviors and interactions among individuals, families, and communities in response to their changing environment (Kniveton et al., 2011; Barbosa et al., 2011; Walsh et al., 2013, Hassani-Mahmooei & Parris, 2012).

The model presented here builds on of this growing body of human migration modeling research and fills an important gap by developing and tightly coupling a model of migration choice with a multi-sectoral model of the environment in which the potential migrant functions, including feedback of migration decisions on both the sending and receiving communities. Specifically, we developed a system dynamics model (Azar, 2012; Sterman, 2000) that simulates migration behavior within the complex dynamics of the regional economy, labor, population, violence, governance, water, food, and disease. System dynamics modeling has a history of useful application to economics (Ansah, 2017; Omamo et al., 2018, Radzicki & Sterman, 1994), climate change (Langsdale et al., 2017; Sterman et al., 2012), human behavior (Bernard et al., 2016; Naugle et al., 2018), and other factors of interest to the topic of climate-induced migration (Bhushan, 2017; Guma et al., 2018). The model discussed here provides a quantitative means of examining the effects of climate change on social, economic, and political structures and their interdependent influence on human migration. The model also enables exploration of the efficacy and robustness of proactive policy options and alternative adaptive measures.

Although the model is extensible to other regions, a prototype is presented here that explores internal and international migration dynamics between Mali, western Africa, and the rest of the world. Mali was selected as a test case due to its long history of internal and international migration driven by a multitude of economic, social, and geopolitical factors (Hummel, 2015; DiBartolomeo et al., 2010).

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