Washington Journal of Environmental Law & Policy

Volume 4 | Issue 1

7-1-2014

Climate Variability, Land Ownership and Migration: Evidence from Thailand about Gender Impacts

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CLIMATE VARIABILITY, LAND OWNERSHIP AND MIGRATION: EVIDENCE FROM THAILAND ABOUT GENDER IMPACTS

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"*A further demographic response may come about through extreme event impacts on human settlement. [. . .] [F]uture increases in the frequency and intensity of severe weather systems as a consequence of climate change may trigger mass migration.*"

-IPCC 4TH Assessment, Chapter 11 (IPCC 2007)

ABSTRACT: Scholars point to climate change, often in the form of more frequent and severe drought, as a potential driver of migration in the developing world, particularly for places where populations rely on agriculture for their livelihoods. To date, however, there have been few large-scale, longitudinal studies that explore the relationship between climate change and migration. This study significantly extends current scholarship by evaluating distinctive effects of climatic variation and models these effects on men's and women's responsiveness to drought and rainfall. Our study also investigates how land ownership moderates these effects. We find small, but significant, increases in migration above existing migratory levels during periods of prolonged climatic stress, and that these patterns differ both by gender and land tenure.

I. INTRODUCTION

Climate scientists predict that climate change will influence migration patterns of rural residents who rely on agriculture for their livelihoods. While there was some initial concern that climate change would lead to mass out-migration from rural areas into urban areas and across borders, attention has turned instead to the role of selective migration from rural to urban areas as an adaptive strategy for communities affected by climate change. In many cases, these moves are predicted to be internal, and may take the form of either temporary, circular moves or permanent ones.[1]

Migration might serve as a means of alleviating predicted challenges to traditional agricultural livelihoods such as declines in harvest yields brought on by increased and prolonged periods of drought.[2] However, even before climate impacts began to manifest themselves in localities, migration out of rural areas was already deployed as an adaptive strategy for increasingly tenuous livelihoods.[3] Temporary and permanent migration is often used as a way to buffer household exposure to risk, sending members of households to earn additional income that is later remitted back to the family of origin.[4] Thus, it is difficult to highlight climatic change or environmental degradation as the proximate or primary factor explaining migration flows, particularly when considering overlapping causes of migration that include economic, social,

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1. GRAEME HUGO, INTL. ORG. FOR MIGRATION, MIGRATION, DEV. AND ENV'T 1–5 (2008).

2. JON R. BARNETT & MICHAEL WEBBER, THE WORLD BANK, ACCOMMODATING MIGRATION TO PROMOTE ADAPTATION TO CLIMATE CHANGE; BACKGROUND PAPER TO THE 2010 WORLD DEV. REPORT 5-6 (APR. 2010) (BARNETT & WEBBER); Cecilia Tacoli, *Crisis or Adaptation? Migration and Climate Change in a Context of High Mobility*, 21 ENV'T & URBANIZATION 514 (2009); W. Adger et al., *Are There Social Limits to Adaptation to Climate Change?*, 93 CLIMATIC CHANGE 349 (2009), http://eau.sagepub.com/content/21/2/513; LENNY BERSTEIN ET AL., IPCC, CLIMATE CHANGE 2007: SYNTHESIS REPORT 18 (2007).

3. Arjan de Haan, *Livelihoods and Poverty: The Role of Migration — A Critical Review of the Migration Literature*, 36 J. OF DEV. STUDIES 1-2 (1999); Hein De Haas, *Migration and Development: A Theoretical Perspective*, 44 INT'L MIGRATION REV. 227–28 (2010).

4. de Haan, *supra* note 3, at 13; Dominic Kniveton et al., Intl. Org. for Migration, Climate Change and Migration: Improving Methodologies to Estimate Flows 40 (2008); Oded Stark & J. Edward Taylor, *Relative Deprivation and International Migration*, 26 DEMOGRAPHY No. 1, 4 (1989); Tacoli, *supra* note 2, at 520.

and political factors.[5]

Migration and environmental degradation are both complex processes that require multi-level analyses in order to understand how the two interact.[6] Recent conceptual and empirical work provides new explanations for the role of the environment in migration flows and informs the debate about climate change and migration.[7] The overwhelming conclusion from this research is that climate impacts will impose themselves in the context of existing migration systems. One recommendation from these works is that climate impact models must control for existing underlying migration systems. Furthermore, these studies point to the need for greater temporal depth in analyses of human settlement responses to climate variability and for greater attention to the selectivity of migration, especially as it identifies those communities and residents who are more vulnerable to climate impacts.

Our study responds directly to these suggested next steps for research with a longitudinal analysis of climate variability as well as its impact on out-migration from rural, northeastern Thailand over a sixteen-year period. In particular, we examine the net, or additive, effect of climate impacts on existing patterns of migration within a well-developed migration system. We focus on how climate-related variability in the El Niño Southern Oscillation (ENSO) triggers migration as an adaptive response, over and above existing migration inducing factors. And we focus on whether these additive effects are differentially significant for men or women and for residents of households with variable land tenure statuses.

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5. Stephen Castles, *Environmental Change and Forced Migration: Making Sense of the Debate* (UNHCR, Working Paper No. 70, 7 2002); Hugo, *supra* note 1, at 10.

6. Sara Curran, *Migration, Social Capital, and the Environment: Considering Migrant Selectivity and Networks in Relation to Coastal Ecosystems*, POPULATION & ENV'T: METHODS OF ANALYSIS 4 (2002).

7. Sally E. Findley, *Does Drought Increase Migration? A Study of Migration from Rural Mali During the 1983-1985 Drought*, 28 INT'L MIGRATION REVIEW 544 (1994); Sabine Henry et al., *The Impact of Rainfall on the First Out-Migration: A Multi-level Event-History Analysis in Burkina Faso*, 25 POPULATION & ENV'T 430 (2004); Clark L. Gray, *Environment, Land, and Rural Out-migration in the Southern Ecuadorian Andes*, 37 WORLD DEV. 457, 460–63 (2009); Clark Gray & Valerie Mueller, *Drought and Population Mobility in Rural Ethiopia*, 40 WORLD DEV. 40, 137–140 (2012); Douglas S. Massey et al., *Environmental Change and Out-Migration: Evidence from Nepal*, 32 POPULATION & ENV'T 116–120 (2010); R. McLeman & B. Smit, *Migration as an Adaptation to Climate Change*, 76 CLIMATIC CHANGE 34 (2006).

Land tenure is often identified as a critical factor in explaining sustainable land use practices.[8] Secure land rights usually ensure investments in farming practices that maintain soil, water, and nutrients and multi-storied cropping. Concerns about land rights have only recently emerged within climate policy circles with the recognition that land rights are likely to guarantee compliance with the imposition of climate-related land policies or the promotion of climate-suitable development programs.[9] Our study contributes empirical evidence towards the importance of this factor in relation to how land ownership influences migration in the context of significant climate-related variability, namely, more or less exposure to extremes in the ENSO system.

To the extent that men and women are differentially impacted by climate-related events—such as those linked to weather disasters like hurricanes, flooding, droughts, or forest and range fires—the degree to which the structural inequalities between genders determine differential access to power, resources, and opportunities[10] is a critical determinant of the organization of livelihoods.[11] Only a few studies have

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8. Wei Hu, *Household Land Tenure Reform in China: Its Impact on Farming Land Use and Agro-Environment*, 14 LAND USE POL. (1997); Anna Knox et al., *Land Tenure and Payment for Environmental Services. Challenges and Opportunities for REDD+*, LAND TENURE J. (2011); Martha Bonilla-Mohena et al., *Vegetation Change and Land Tenure in Mexico: A Country-Wide Analysis*, 30 LAND USE POL 355 (2013).

9. Arun Agrawal, *The Role of Local Institutions in Adaptation to Climate Change*, SOCIAL DIMENSIONS OF CLIMATE CHANGE: EQUITY AND VULNERABILITY IN A WARMING WORLD 178 (Robin Mearns & Andrew Norton eds., 2010); Anne M. Larson, *Forest tenure reform in the age of climate change: Lessons for REDD+*, 21 GLOBAL ENVTL. CHANGE 541 (2011); Lisa Naughton-Treves & Kelly Wendland, *Land Tenure and Tropical Forest Carbon Management*, 55 WORLD DEV. 1–3 (2014); Emma L Tompkins et al., *An Investigation of the Evidence of Benefits from Climate Compatible Development* 7 (Centre for Climate Change Economics and Policy, Working Paper No. 124, 2013).

10. INT'L FUND FOR AGRIC. DEV., AN IFAD APPROACH TO GENDER MAINSTREAMING: THE EXPERIENCE OF THE LATIN AMERICA AND THE CARIBBEAN DIVISION 7 (2000).

11. Seema Arora-Jonsson, *Virtue and Vulnerability: Discourses on Women, Gender and Climate Change*, 21 GLOBAL ENVTL. CHANGE 745 (2011); S. Bradshaw, *Women, Poverty, and Disasters: Exploring the Links through Hurricane Mitch in Nicaragua*, *in* THE INTERNATIONAL HANDBOOK OF GENDER AND POVERTY: CONCEPTS, RESEARCH, POLICY 48 (Sylvia Chant ed., 2010); SVEN-OVE HANSSON, GENDER ISSUES IN CLIMATE ADAPTATION 9 (Totalförsvarets Forskningsinstitut, (FOI). 2007); Valerie Nelson et al., *Uncertain Predictions, Invisible Impacts, and the Need to Mainstream Gender in Climate Change Adaptations*, 10 GENDER & DEV. 53 (2002); Eric Neumayer & Thomas Plümper, *The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002*, 97 ANNALS OF THE ASS'N OF

focused specifically on the relationship between migration, gender, and climate change,[12] and these have emphasized how poverty is increasingly feminized and that climate change, therefore, will significantly impact women more than men.[13] Our study builds on these calls for attention to differential gender impacts by examining how climate conditions interact with land ownership to distinctively differentiate men's and women's migration responses.

II. OBSERVING CLIMATE IMPACTS ON LIVELIHOODS, MIGRATION, AND GENDER

Previous work involving migration and the environment points towards much greater complexity in human responses to variability in climate and local environmental conditions. Rather than scholars observing the emergence of large numbers of environmental refugees, it appears that climate variability – as opposed to climate change – and a wider array of migration responses, including variations in timing and distance, are key factors that must be taken into account to better assess the relationship.[14] First, migration outcomes are not uniform. Several studies point to the importance of measuring and accounting for the temporal and spatial distinctions of migration, as well as the composition of the migrant streams.[15] Second, the explanations for the variable migration patterns tend to hinge on interactions between the social and economic contexts and the environmental conditions that prompt migration. Furthermore, most empirical examinations have been of one-time, climate-related events and their impacts on humans, tending to rely on post-hoc reconstruction.[16] Alternatively, empirical examinations of

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AM. GEOGRAPHERS 4 (2007).

12. Lori M. Hunter & Emmanuel David, *Climate Change and Migration: Considering the Gender Dimensions*, CLIMATE CHANGE & MIGRATION 4 (2009).

13. Geraldine Terry, *No Climate Justice Without Gender Justice: An Overview of the Issues*, 17 GENDER & DEV. 7 (2009).

14. Findley, *supra* note 7, at 541–42; Gray, *supra* note 7, at 463; Henry, *supra* note 7, at 439.

15. Stefan Leyk et al., *Spatially and Temporally Varying Associations Between Temporary Outmigration and Natural Resource Availability in Resource-Dependent Rural Communities in South Africa: A Modeling Framework*, 34 APPLIED GEOGRAPHY 3 (2012); Massey et al., *supra* note 7, POPULATION & ENV'T 116 (2010).

16. Susana B. Adamo, *Addressing Environmentally Induced Population*

impacts include some comparative assessments of pre- and post-event behaviors,[17] but these rarely examine longer temporal scales that account for either variation in exposure to environmental conditions or adaptive responses to environmental conditions.[18]

Some of the most recent evidence about climate impacts or environment stress upon migration is that they only exacerbate pre-existing conditions that are already propelling people to leave or that they have a relatively small or marginal additional impact in pushing people out of the origin communities. Reuveny[19] finds that environmental stress exacerbates the effect of the political conflict that is pushing people out of their home communities. Others find that climate change intensifies existing migration patterns.[20] Still others argue that the most proximate determinants of migration are the structural conditions that already propel people away from their communities, including wage differentials or poverty.[21]

Displacements: A Delicate Task 15 (2008); Barnett & Webber, *supra* note 2, at 14; Lori M. Hunter, *Migration and Environmental Hazards*, 26 POPULATION & ENV'T 273 (2005); Nils Petter Gleditsch et. al., *Climate Change and Conflict: The Migration Link* 5 (Intl. Peace Academy, Coping with Crisis Working Paper Series 2007); Justin T Locke, *Climate Change-Induced Migration in the Pacific Region: Sudden Crisis and Long-Term Developments*, 175 GEOGRAPHICAL J. 171 (2009); Robert McLeman, *Impacts of population change on vulnerability and the capacity to adapt to climate change and variability: a typology based on lessons from "a hard country,"* 31 POPULATION & ENV'T 291 (2010); Norman Myers, *Environmental refugees: a growing phenomenon of the 21st century*, 357 PHIL. TRANSACTIONS OF THE ROYAL SOC'Y OF LONDON. SERIES B: BIOLOGICAL SCI. 609 (2002); Nicholas Stern, *The economics of climate change*, THE AMERICAN ECONOMIC REVIEW 59 (2008).

17. W. Neil Adger, et al., *Adaptation to Climate Change in the Developing World*, 3 PROGRESS IN DEV. STUD. 187 (2003) Hugo, *supra* note 1, at 21, 462; Lori M Hunter, *The Spatial Association Between US Immigrant Residential Concentration and Environmental Hazards*, INT'L MIGRATION REV. 432 (2000).

18. Alisson F Barbieri & David L Carr, *Gender-Specific Out-Migration, Deforestation and Urbanization in the Ecuadorian Amazon*, 47 GLOBAL & PLANETARY CHANGE 99, 102-03 (2005); Gray & Mueller, *supra* note 7, at 136; Scott T. Yabiku et al., *Migration, Health, and Environment in the Desert Southwest*, 30 POPULATION & ENV'T 134 (2009).

19. Rafael Reuveny, *Ecomigration and Violent Conflict: Case Studies and Public Policy Implications*, 36 HUMAN ECOLOGY 2 (2008).

20. Markos Ezra & Gebre-Egziabher Kiros, *Rural Out-migration in the Drought Prone Areas of Ethiopia: A Multilevel Analysis1*, 35 INT'L MIGRATION REV. 750 (2001); Hansson, *supra* note 11, at 16; W.D SOLECKI, ENVIRONMENTAL HAZARDS AND INTEREST GROUP COALITIONS: METROPOLITAN MIAMI AFTER HURRICANE ANDREW, Ch. 12 (J.K. Mitchell ed., United Nations University Press 1999).

21. RICHARD BLACK, REFUGEES, ENVIRONMENT AND DEVELOPMENT 20 (Longman Development Studies, 1998); Lesley Head, *Cultural Ecology: Adaptation-Retrofitting a Concept?*, 34 PROGRESS IN HUMAN GEOGRAPHY 236 (2010); KEES VAN DER GEEST,

Following the third perspective, social scientists examining climate impacts increasingly point to the importance of conceptualizing livelihood strategies in explaining humans' adaptive responses. A livelihoods framework observes the relative availability of various assets that might shape a household's livelihood strategies. This includes human, financial, physical, social, and natural capital.[22] In these models, climate impacts are observed to influence the availability of natural capital assets, which in turn reshape livelihoods as humans redeploy other capital assets to meet their needs.[23] One strategic option is to deploy human capital assets away from the origin household and community to destinations in order to earn a living and to send remittances back to the origin community.[24]

Depending on the gendered constraints and opportunities in both origin and destination, men and women will be differently propelled out of origin areas or will have to spend their time and investments differently within origin areas. Often livelihood strategies are pursued through a gendered division of labor. Buechler[25] found that climate impacts, via declines in water availability, compromised a recent development project for women's earnings in northwest Mexico. Because these women's families were unable to earn as much of a living from the fruit industries, the men in the families were sent to the U.S. where male migrant labor offered alternative sources of income.[26] In Nepal, tasks that men and women engage in within the household are differentially impacted by climate change, which in turn pushes young men out of the household towards migrant destinations.

WE'RE MANAGING! CLIMATE CHANGE AND LIVELIHOOD VULNERABILITY IN NORTHWEST GHANA 8 (African Studies Centre 2004).

22. L. Bank, *On Family Farms and Commodity Groups: Rural Livelihoods, Households and Development Policy in the Eastern Cape*, 31 SOCIAL DYNAMICS 160 (2005); Joseph Awetori Yaro, *Is deagrarianisation real? A Study of Livelihood Activities in Rural Northern Ghana*, 44 J. OF MOD. AFR. STUD. 127 (2006).

23. Molly E. Brown et al., *The Effect of Vegetation Productivity on Millet Prices in the Informal Markets of Mali, Burkina Faso and Niger*, 78 CLIMATIC CHANGE 182 (2006); Hunter & David, *supra* note 12, at 3.

24. Hunter & David, *supra* note 12, at 7.

25. Stephanie Buechler, *Gender, Water, and Climate Change in Sonora, Mexico: Implications for Policies and Programmes on Agricultural Income-Generation*, 17 GENDER & DEV. 58 (2009).

26. Massey et al., *supra* note 7, at 127.

Climate-related disaster events can also lead to population mobility, although the outcomes vary from temporary to permanent. Some argue that when these disasters disrupt social structures that undergird support or welfare systems, groups at the margins defined by race/class/gender and age can be the most vulnerable to a disaster's impacts.[27] Many assume that since women are more likely to be in poverty and since the poor are the most vulnerable to disaster impacts; it logically follows that women will also be more vulnerable than men.[28] The empirical evidence supporting this prediction is mixed, in part because men and women perceive risk differently and respond to risk differently.[29] For the purposes of our study, the climate-related disaster research is not directly relevant, since in our study the context of climate change in Thailand is one related to its slow onset. However, differential perceptions of risk do matter as men and women's relationship to land and livelihoods colors their views of a growing risk. In a study of small farmers in South Africa, Terry[30] finds that women recognized heavy rainfalls as a distinct risk, whereas more men than women perceived drought as a distinct climate risk. Consequently, men and women pursue different livelihood strategies in response to their perceptions of risk.

One vital aspect of livelihoods and risk is land ownership. Land ownership as an asset serves as both a natural capital asset and a financial capital asset. The conflation of these two forms of capital, as it is captured by land ownership, explains how, on the one hand, land might be a natural capital asset that keeps people from migrating, while on the other hand, land ownership as a form of financial capital (mortgaged or rented) might underwrite expensive migration trips.[31] Land

27. A. Oliver-Smith, *Disasters and Forced Migration in the 21st Century*. *Understanding Katrina: Perspectives from the Social Sciences* (2006), *available at* http://understandingkatrina.ssrc.org/Oliver-Smith; Reuveny, *supra* note 19, at 3; KATRINA AND THE WOMEN OF NEW ORLEANS, NEWCOMB COLLEGE CENTER FOR RESEARCH ON WOMEN 5 (2008).

28. Elaine Enarson, *What Women Do: Gendered Labor in the Red River Valley Flood*, 3 GLOBAL ENVTL. CHANGE PART B: ENVTL. HAZARDS 1–2 (2001); Alice Fothergill & Lori A. Peek, *Poverty and Disasters in the United States: A Review of Recent Sociological Findings*, 32 NAT. HAZARDS 92 (2004); Nelson, *supra* 11, at 51.

29. ALICE FOTHERGILL, HEADS ABOVE WATER: GENDER, CLASS, AND FAMILY IN THE GRAND FORKS FLOOD, 37–38 (SUNY Press. 2004).

30. Terry, *supra* note 13, at 8.

31. Gray, *supra* note 7, at 466.

owned can also serve as an investment opportunity for migrant remittances.[32] Most research finds a negative effect of land ownership on migration, but most often these effects are non-linear.[33] Gray finds that land area farmed is negatively related to local migration but positively related to international migration.[34] In a study of settlement patterns in the Ecuadorian Amazon, Laurian and Bilsborrow[35] find that land area farmed decreased for men's rural-urban migration but had no effect on women's migration. The quality of environmental amenities and land is also a factor in explaining migration outcomes. Findings from such disparate places as the United States, Nepal, and Burkina Faso, show that with environmental degradation of land-based resources—both objective and perceived—outmigration increases.[36]

In sum, while the evidence is still somewhat unclear with regards to the precise impact of climate on migration, most research about rural regions of the world suggest that scientists and policy makers should focus on understanding livelihood impacts as the most proximate mechanism. Doing so will also reveal the differential impacts of climate on different segments of the population in a region. Our study extends previous research by examining variable climate conditions and their influence on individual migration out of a rural district in northeastern Thailand over a sixteen-year period. These lengthy observations of individual behavior—with additional, significant detail about villages, households, and individuals—allows us to control for the ongoing processes that have been driving rural-urban migration in the region for a

32. Leah K. VanWey, *Land Ownership as a Determinant of International and Internal Migration in Mexico and Internal Migration in Thailand*, 39 INT'L MIGRATION REV. 147 (2005).

33. Benjamin Davis et al., *Domestic and International Migration From Rural Mexico: Disaggregating the Effects of Network Structure and Composition*, 56 POPULATION STUD. 295 (2002); Gray, *supra* note 7, at 458–459; L. Laurian & Richard E. Bilsborrow, *Why do People Migrate? A Contextual Model of Migration in Ecuador* (as cited in Gray, *supra* note 7, at 463) (2000); Mariapia Mendola, *Migration and Technological Change in Rural Households: Complements or Substitutes?*, 85 J. OF DEV. ECON. 161 (2008); VanWey, *supra* note 32, at 147.

34. Gray, *supra* note 7, at 457.

35. Laurian & Bilsborrow, *supra* note 33, at 463 (as cited in Gray, *supra* note 7).

36. Myron Gutman et al., *Two Population-Environment Regimes in the Great Plains of the United States, 1930-1990*, 27 POPULATION & ENV'T 197 (2005); Henry, *supra* note 7, at 446; Massey et al., *supra* note 7, at 112.

number of decades and more precisely observe responses to climate impacts. Furthermore, we account for variable exposure to climate condition, relate these conditions with land ownership, and estimate our predictive models of migration on segregated samples of men and women. Doing so addresses a persistent observation in the scholarly literature: men and women differently perceive climate risks and differently respond to those risk perceptions.

III. THAILAND: SOCIAL AND ENVIRONMENTAL INSIGHTS

Thailand and the lower Mekong Region of Southeast Asia are a particular focus of climate research in recent years because of several regional climatic and geographic conditions. In 2010 Thailand faced its worst drought in 20 years resulting in the water level of the Mekong River falling to its lowest level in 50 years.[37] Then, in late 2011, the lower Mekong River and Chao Phraya River regions experienced some of their worst flooding. Increasingly intense and severe weather events are forecasted for much of the region, raising uncertainties about how best to adapt.[38] The region is already a significant source of the world's rice exports, primarily from Thailand and Vietnam, with significant potential for increased yields from Cambodia, Laos, and Myanmar.[39] The region is also subject to impact from global climate systems, namely ENSO, which has been responsible for a variable, but regular, seasonal monsoon pattern that produces the precipitation that yields dependable riverine and rain-fed irrigation for rice-growing agricultural systems.[40] While there has been some debate about how much of the variability in the monsoonal patterns during recent decades is due to global climate change versus due to naturally occurring patterns,[41] recent results indicate a long-term trend

37. Danny Marks, *Climate Change and Thailand: Impact and Response*, 33 CONTEMP. SE. ASIA: A J. OF INT'L & STRATEGIC AFF. 231-232 (2011).

38. *Id.* at 233.

39. Alice G. Laborte et al., *Rice Yields and Yield Gaps in Southeast Asia: Past Trends and Future Outlook*, 36 EUR. J. OF AGRONOMY 9–10 (2012).

40. *Id.* at 11.

41. Arief Anshory Yusuf & Herminia Francisco, *Climate Change Vulnerability Mapping for Southeast Asia*, ECON. & ENV'T PROGRAM FOR SE. ASIA 5 (EEPSEA), SINGAPORE (2009); Judy Eastham, et al., *Mekong River Basin Water Resources Assessment: Impacts of Climate Change*, WATER FOR A HEALTHY COUNTRY NATIONAL

in rising temperatures in the region and this trend is projected to coincide with rising precipitation on land areas.[42] However, while projections suggest the possibility of rising precipitation, patterns of precipitation between 1950 and 2005 indicate falling average rainfalls, more frequent droughts, alternating with episodic, intense and heavy rainfalls that result in flooding. Between 1950 and 1975 there were only four droughty years of low intensity. However, between 1975 and 2000 there have been fourteen droughty years and five of those were between 1989 and 1994.[43] In addition, recent research indicates that changes in temperature and CO_2 will adversely affect rice yields in Thailand and Laos.[44] Thailand is still heavily reliant on agricultural productivity, with many rural communities significantly involved in producing agricultural products for local consumption and export. Thailand's export economy draws heavily upon post-harvest processing of grains, animal feed, and oils; manufacturing of fruit, vegetables, and spice products for export; preservation of processed fish, fowl and meat products for export; and production of other plant-based products (e.g., rubber and Styrofoam from manioc).[45] This agricultural dependence means that rural communities are particularly vulnerable to climate uncertainties. Nevertheless, rural communities are already fairly diversified in their income streams, and ever since Thailand's boom in export manufacturing, which began in the late 1970s, rural communities are a primary source of low-wage labor migrants to export manufacturing zones in urban or semi-urban areas.[46]

RESEARCH FLAGSHIP REPORT CSIRO 11 (2008); THE ECON. OF CLIMATE CHANGE IN SE. ASIA: A REGIONAL REV. 22 (Asian Development Bank, 2009).

42. Guillaume Lacombe et al., *Multi-Year Variability or Unidirectional Trends? Mapping Long-Term Precipitation and Temperature Changes in Continental Southeast Asia Using PRECIS Regional Climate Model*, 113 CLIMATIC CHANGE 13 (2012).

43. Marks, *supra* note 37.

44. Mukand S. Babel et al., *Evaluation of Climate Change Impacts and Adaptation Measures for Rice Cultivation in Northeast Thailand*, 46 CLIMATE RESEARCH 232 (2011); Chitnucha Buddhaboon et al., *Climate Scenario Verification and Impact on Rain-fed Rice Production*, REPORT OF APN CAPABLE PROJECT, SOUTHEAST ASIA START REGIONAL CENTER, CHULALONGKORN UNIVERSITY, THAILAND 14 (2004); W. Chaowiwat & K. Likitdecharote, *Effect of Climate Change on Potential Evapotranspiration Case Study: Lower Chaopraya Basin*, THE 1ST NPRU ACADEMEIC CONFERENCE 80 (2009).

45. Marks, *supra* note 37, at 240.

46. Aphichat Chamratrithirong et al., *National Migration Survey of Thailand* 7 (1995).

Migrant remittances back to rural, origin communities has grown from five percent of rural farm incomes in the 1970s to more than fifty percent of household incomes by the 1990s.[47] Thailand is no different from many parts of the world where climate impacts are expected to influence livelihoods. Just as in these other parts of the world, migration in Thailand is an already well-developed livelihood strategy for the diversification incomes, raising living standards and generation of financial capital for investments in other rural opportunities.[48]

Our study draws upon the existing research infrastructure in Thailand to analyze secondary data from Nang Rong, Buriram, Thailand that matches individuals, households and communities to their landscape between 1984 and 2000. This 16-year period captures the beginning of the shift in predictable climate patterns to the more unpredictable patterns and it captures the emergence, growth, and establishment of rural-urban migrant streams connecting. Nang Rong, in the northeast region of Thailand, is a good choice for a study site because of the history of internal migration in the area. Nang Rong is a former frontier region that has undergone considerable land use and population changes during the latter half of the twentieth century.[49] Nang Rong has also been the focus of extensive study and much is known about the motivations and consequences of circular labor migration from the area. Considerable quantitative and qualitative data have also been collected on the environment and migration there.[50] Seasonal migration is common in Nang Rong, where the rainy, monsoon season is often followed by drought-like conditions that require people to migrate in

47. Sara R. Curran & Abigail M. Cooke, *Unexpected Outcomes of Thai Cassava Trade: A Case of Global Complexity and Local Unsustainability*, 5 GLOBALIZATIONS 120 (2008).

48. Stark & Taylor, *supra* note 4, at 12; VanWey, *supra* note 32, at 169.

49. Barbara Entwisle et al., *An Agent-Based Model of Household Dynamics and Land Use Change*, 3 J. OF LAND USE SCI. 82 (2008).

50. Sara R. Curran et al., *Gendered Migrant Social Capital: Evidence from Thailand*, 84 SOCIAL FORCES 229-230 (2005); Filiz Garip, *Social Capital and Migration: How Do Similar Resources Lead to Divergent Outcomes?* , 45 DEMOGRAPHY 596-97 (2008); Leah K. Vanwey, *Land Ownership as a Determinant of Temporary Migration in Nang Rong, Thailand*, 19 EUR. J. OF POPULATION / REVUE EUROPÉENNE DE DÉMOGRAPHIE 124 (2003); Ronald R. Rindfuss et al., *Panel Studies and Migration*, 36 SOCIAL SCIENCE RESEARCH 377 (2007).

search of non-agricultural labor opportunities to supplement their incomes and families' livelihoods.[51]

Nang Rong, Buriram is located in the southern portion of the northeastern region of Thailand. The middle of the district is transected by a national highway running west to east and connecting Bangkok to the Laotian border on the eastern side of the nation. The Nang Rong district is primarily agricultural, relying on a variety of crops for subsistence, consumption, and sale to markets both within the district, the capital, and beyond. It is located on the Korat Plateau, which is characterized by relatively infertile soils, poor drainage, and inconsistent precipitation.[52] Rain-fed rice cultivation is typical in the lower elevations with corn, cassava, sugar cane, and forest products in the upper elevations.[53] In general, the land is highly vulnerable to drought and prone to unsustainable agro-ecological conditions.[54] The predominance of environmental stress in the ecological system figures prominently in the narratives of villagers.[55] These narratives are also prominent throughout the northeast region of Thailand and explain historic and contemporary migration flows out of the region to metropolitan or ecologically richer regions of the country.[56] It is the preponderance of local explanations combined with the contemporary global discussions about climate variability and migration that motivates our inquiry.

Drought is a frequent explanation for migration amongst villagers. In 2007, this research team collected migration histories from each of the communities where the panel survey had been conducted in 1984, 1994 and 2000. Some examples of villager accounts follow:

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51. Curran, *supra* note 50, at 235.

52. Stephen J Walsh, et al., *A multiscale analysis of LULC and NDVI Variation in Nang Rong district, Northeast Thailand*, 85 AGRIC., ECOSYSTEMS & ENV. 49 (2001).

53. Curran & Cooke, *supra* note 47, at 118; Walsh, *supra* note 52, at 49.

54. William F Welsh, *Characterizing Patterns of Land Degradation Potential and Agro-Ecological Sustainability in Nang Rong, Thailand*, 74 PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING 772 (2008).

55. SARA R CURRAN & YOTHIN SAWANGDEE, DEMOGRAPHIC FACTORS AFFECTING AGRICULTURAL DECISION-MAKING (Institute for Population and Social Research Mahidol University 1998); Curran, *supra* note 50, at 231.

56. Chamratrithirong, *supra* note 46, at 11.

Sample Village 1
Researcher: *Can the village elders please tell us when the locals started to leave the village to work elsewhere both near and far? Can you recall?*
Villager 1: *Do you recall? (Asking someone near them.)*
Villager 2: *Yes, in 1979. I remember that I just got married. It was very dry. Drought was in 1979 and 1980.*
Villager 3: *Yes, very dry.*
Villager 4: *We could not harvest rice due to water shortage.*
Villager 2: *In any year with good rain, we do not go anywhere. (laughter). We grow rice here!*

Sample Village 2
Villager 1: *In 1999-2000. The drought hit us again. People went to do construction work in Muang Thong Thani.*
Villager 2: *They had a foreigner as a contractor at Muang Thong. Several people got rich working there. Several of them did very well for themselves.*
Researcher: *Who came to tell you about going to Soi Kreb Mom in Muang Thong?*
Villager 3: *I went with my neighbors and some time we went to see what jobs are available and do it there and then. Mostly people in this district will know each other.*
Researcher: *Did almost everyone in the district go to work?*
Villager 4: *Yes, we all went out to work.*
Villager 2: *People from Amphoe Chamni, Nauad and Nong Pluang all go to work outside.*
Villager 4: *Yes, all of us.*

Thailand has undergone several land reform efforts since the mid-1950s when the first Land Code was established.[57] However, the registration of land and land claims as well as the recognition of land titles have proceeded slowly with over twenty-one agencies involved in the identification and administration of land procedures. De facto land use and usufruct rights have also complicated what is understood to be public or private land. Several major legal changes in land law have also been implemented since the 1954 Land Code,

57. Orapan Nabangchang Srisawalak, *Land Tenure Data in Thailand* (2006), *available at* www.fao.org/docrep/009/a0306t/A0306T09.

including ones in 1975, 1994, and 2000.[58] Consequently, farmers and farm households are well aware of the status of their land rights and land holdings and invest in their property and livelihood strategies accordingly.[59] The most secure type of land title is a 'Chanote,' also known as 'Nor Sor 4,' and is the only title that can be mortgaged or sold. Three other types are not transferable: 'Nor Sor 3 Gor,' 'Nor Sor 3,' and Possessory Right (usufruct rights). Most paddy fields and the household's primary homestead in Thailand have been brought into confirmed, Chanote land title.[60] Most forested land or upland areas are less likely to have free and clear titles, and many farm households hold claim to additional lands in these areas with a lesser title status with the understanding that those lands are not owned, per se, but that these titles will transfer as long as the households maintain those properties.[61] Research about land ownership and land tenure security indicates that farming households view land with any form of title as owned land. In addition, variation in amounts of land in various titling forms explains less in farming investments than do the quality of the land and the availability of agricultural labor.[62]

Gender relations in Thailand and the northeastern region add some additional complexity to considerations about who might be more or less vulnerable to climate impacts. Thai rural women have long played an important role in household economies.[63] They work next to their husbands and brothers in the rice fields and are often described as "holding the purse strings" with regard to financial planning.[64] Also, many historic and ethnographic studies describe women's relations with their husbands as egalitarian. Women's participation in

58. *Id*.

59. Nareeluck Wannasai & Rajendra P Shrestha, *Role of Land Tenure Security and Farm Household Characteristics on Land Use Change in the Prasae Watershed, Thailand*, 25 LAND USE POL. 215-217 (2008).

60. Srisawalak, *supra* note 57.

61. Wannasai & Shrestha, *supra* note 59, at 223..

62. *Id*. at 227.

63. Anchalee Singhanetra-Renaud & Nitaya Prabhudhanitisarn, *Changing Socio-Economic Roles of Thai Women and Their Migration*, *in* GENDER AND MIGRATION IN DEVELOPING COUNTRIES 160 (Sylvia Chant ed., 1992).

64. Bencha Yoddumnern-Attig, *Thai Family Structure and Organization: Changing Roles and Duties in Historical Perspective* 12 (1992).

rural-urban migrant streams is considerable, reaching as high as sixty percent of all migrants.[65] These rates are only surpassed in Asia by the migration rates of women from the Philippines and Japan.[66] It is important to note that these moves are rarely associational (family moves), but are instead primarily for jobs for the women themselves.[67]

These positive characterizations of women's status are increasingly questioned by recent scholarship. Researchers note that women predominate in the low wage, low skill sectors of the economy, including low wage service jobs, prostitution, agricultural wage labor, and low skill manufacturing, such as in textiles, parts assembly for electronics, and food processing plants.[68] Importantly, women consistently earn one-third to one-half as much as men in similar occupations.[69] Outside of seasonal construction labor, much of the destination labor market is sex-segregated. Men tend to work in heavier industries, such as taxi driving, motorcycle services, automobile servicing, and construction.[70]

Further, patterns of marriage and settlement adjudicate against strong household ties with sons and tend towards strong ties with daughters, especially in northeastern Thailand.[71, 72, 73] Thai households are matrilocal; that is, a husband moves to the wife's family's house for two days to five years—usually until the first child is a year old. In the ideal situation, the husband provides an important source of farm labor. The inheritance norm is bilateral, but sons usually abdicate their land inheritance to their sisters or brothers-in-law because they will be moving to their wife's household and

65. Chamratrithirong, *supra* note 46, at 30; Darunee Tantiwiramanond, Gender and Development in Thailand 12 (1995).

66. Tantiwiramanond, *supra* note 65, at 12.

67. Chamratrithirong, *supra* note 46, at 31.

68. CHALONGPHOB SUSSANGKARN, LABOUR MARKETS 362 (Peter G. Warr ed., Cambridge University Press. 1993); Tantiwiramanond, *supra* note 65, at 15.

69. Tantiwiramanod, *supra* note 65, at 17.

70. Sussangkarn, *supra* note 68, at 365.

71. Blanc-Szanton M.C., *Gender and Inter-Generational Resource Allocation Among Thai an Sino-Thai Households*, *in* STRUCTURES AND STRATEGIES: WOMEN, WORK AND FAMIY 96-97 (Leela Dube & Raini Palriwala eds., 1990).

72. F. De Jong Gordon et al., *Gender, Values, and Intentions to Move in Rural Thailand*, 30 INTER'L MIGRATION REV. 751 (1996).

73. Yoddumnern-Attig, *supra* note 127, at 11.

will receive, instead, some other form of inheritance such as money, cattle, or more recently education.[74] Youngest daughters are particularly advantaged with regards to household resources because they often inherit the homestead and a larger portion of the land. Access to these resources comes at a price. These daughters and their husbands are expected to care for the daughter's parents in their old age.[75] These gender patterns of migration, family responsibilities, and marital ties suggest that the relationships men and women have with the land and their natal households are likely to be quite different. Furthermore, the pull of the destination labor markets might also be different, especially if male opportunities are greater. Even if male migration opportunities are greater, some of the male migrants end up in agricultural labor markets, which may be just as vulnerable to climate impacts.

Based on our review of previous research we expect that for communities in rural areas that are agriculture- and resource-dependent for livelihoods, migration is a variable but growing adaptation to local ecological uncertainties, net of other factors that might push or pull rural residents out of rural communities to migrant destinations. Our expectations about human responses to climate conditions revolve around four factors: land ownership; climate conditions that are either significantly wetter or drier than those of an average year; gender; and duration of exposure to wetter or drier conditions, namely twelve-month exposure or twenty-four-month exposure to fifty percent or more of months being wetter or drier than average.

Specifically, we expect that the amount of land owned will require more labor, limiting out-migration. Wetter climate years will also keep labor local and farming-based, while drier climate years will push household members out of the region to migrant destination labor markets. Given the varied relationships of women and men to farm, family, and labor markets, we expect there to be gender differences in response

74. Charles F Keyes, *Mother or mistress but never a monk: Buddhist Notions of Female Gender in Rural Thailand*, 11 AMERICAN ETHNOLOGIST 231 (1984); VIRIYA LIMPINUNTANA et al., AN AGROECOSYSTEM ANALYSIS OF NORTHEASTERN THAILAND 17-20 (Khon Kaen University 1982).

75. Keyes, *supra* note 74, at 233; Yoddumnern-Attig, *supra* note 64, at 13.

to non-average climate conditions, particularly when households own land. For women in larger landowning households, we expect wetter climate years to prevent them from migrating. Given women's commitments to land and family, we also expect that shorter duration exposure to drier climate conditions will influence women less than men, while longer duration exposure to droughty conditions will propel women out of the region for non-farm labor migration.

IV. DESCRIPTION OF DATA AND METHOD OF ANALYSIS

A. Nang Rong Migration Data and Baseline Information

Our migration data come from the Nang Rong Surveys, a longitudinal panel data collection effort conducted by the Carolina Population Center at the University of North Carolina and the Institute for Population and Social Research at Mahidol University in Thailand.[76] We employ all three waves of data (collected in 1984, 1994, and 2000) for our analyses. The 1984 data collection was a census of all households and individuals residing in fifty-one villages within Nang Rong. It included information on individual demographic characteristics, household assets, and village institutions as well as agricultural, natural, economic, social, and health resources. The 1994 survey followed all 1984 respondents still living in the original villages, as well as respondents from twenty-two of the original fifty-one villages who had moved to one of the four primary destinations outside of the district, plus any new village residents since 1984. The 1994 surveys included all questions from the 1984 survey, as well as a ten-year retrospective life history about education, work, and migration, a survey about the age and location of siblings, and a special survey of migrants' migration experiences and histories. The 2000 round of surveys built on the previous data collection efforts by following all of the 1994 respondents and adding to the database any new residents and households in the original villages since 2000.

The 1994 and 2000 surveys included a migrant follow-up

76. *Nang Rong Projects*, UNC Carolina Population Center, http://www.cpc.unc.edu/projects/nangrong/ (last updated Sept. 25, 2013).

component. This was conducted among persons who had resided in twenty-two of the original 1984 villages, and defined a migrant as someone who was a member of a 1984 household and had since left a village for more than two months to one of four destinations: the provincial capital, Buriram; the regional capital, Korat or Nakhon Ratchasima; Bangkok and the Bangkok Metropolitan Area; or the Eastern Seaboard provinces. The migrant follow-up in 2000 included migrants identified and interviewed in 1994 and individuals who had lived in the village in either 1984 or 1994 but subsequently migrated to one of the four primary destinations. The retrospective recall items in the survey allow us to measure timing and sequencing of moves (outgoing and returning), migrant destination, occupation in destination, and duration of stay. The data for these analyses focus only upon villagers from the twenty-two villages with a migrant follow-up component. In these villages, the follow-up rate is fairly high, approximately seventy-five percent, because the survey team relied on multiple search methods.[77] This means that migrant selectivity bias is minimized among this group of villagers and villages.

Our analysis file relies primarily on the data found in the life history modules implemented in both 1994 and 2000. With these data we construct an analysis file that is comprised of person-year-move records. For each individual, we have information about sequence of residences and moves within a year for the preceding ten years in the case of the 1994 survey and for the preceding six years for the 2000 survey. Retrospective life histories were collected for most individuals who had ever resided in Nang Rong in any 1984, 1994, or 2000 household and who were thirteen to forty-four years old at some point during this time period. Our analyses examine individual behavior prospectively from 1984 and 1994 to 2000, and we do not include individuals who newly appear in households in 2000. We measure migration as any move outside of the Nang Rong district for two months or more. Other studies have shown that the cumulative patterns of migration are quite different across villages, with some villages exhibiting quite steep trajectories of accumulated migration experience and others exhibiting much lower rates

77. Rindfuss, *supra* note 50, at 383.

of increase.[78] Overall, migration out of the region during this period of time is growing. In 1984, among thirteen to forty-four year olds, only 7.7 percent had ever migrated. By 2000, among seventeen to fifty-one year olds, seventy-two percent had migrated out of the district. For the most part, these are short-term moves, with most moves lasting less than one year.

In previous studies using these data, we developed a fairly robust model of migration that takes into account the influence of social networks and individual and household factors on migration.[79] For all of the baseline variables that are time-varying, we measure up through t-1 years. Because prior migration experience by the individual, other members of the family, or their neighbors is so influential for predicting migration, we separately estimate the number of migrant trips and number of migrant months spent away from Nang Rong up through year t-1. We do so for the individual, every member of the individual's household, and every member of the individual's village. The village or household migrant trips and the months of migrant experience do not include the experience of the observed individual. [80]

Table 1: Characteristics of Nang Rong Villagers in 1984 and 2000, means (s.d.)

	1984	2000
Male (Female)	0.51 (0.50)	0.47 (0.50)
Age	19.06 (4.52)	28.87 (7.08)
Married (or not)	0.26 (0.44)	0.65 (0.48)
No Schooling	0.02 (0.14)	0.01 (0.09)
Primary Schooling or Less	0.74 (0.44)	0.66 (0.47)
Some Secondary School	0.22 (0.42)	0.21 (0.41)
Secondary Schooling or more	0.04 (0.19)	0.13 (0.34)
Landless	0.08 (0.26)	0.09 (0.43)
1-10 Rai Owned	0.18 (0.39)	0.24 (0.43)
11-25 Rai Owned	0.28 (0.45)	0.32 (0.47)
More than 25 Rai Owned	0.46 (0.50)	0.35 (0.48)

78. Curran, *supra* note 51, at 239; Filiz Garip & Sara Curran, *Increasing Migration, Diverging Communities: Changing Character of Migrant Streams in Rural Thailand*, 29 POPULATION RES. AND POL'Y REV. 659, 661 (2009); Garip, *supra* note 50, at 594.

79. Curran, *supra* note 51, at 247.; Garip & Curran, *supra* note 78, at 250; Garip, *supra* note 50, at 600.

80. *See* Curran, *supra* note 50, at 239 (for more details).

Ever a Temporary Migrant in 1984	0.11 (0.31)	0.05 (0.23)
HH Member Ever Temp. Migrant '84	0.23 (0.42)	0.17 (0.38)
Cum. # of Migrant Trips (t-1)	0.08 (0.28)	2.18 (3.07)
Cum. # of Months as Migrant (t-1)	0.81 (2.96)	52.77 (56.75)
HH Cum. # of Migrant Trips (t-1)	0.03 (0.10)	1.07 (1.29)
HH Cum. # of Migrant Months (t-1)	0.67 (2.02)	48.93 (40.04)
Vil. Cum. # of Migrant Trips (t-1)	0.06 (0.03)	1.96 (0.36)
Vil. Cum. # of Migrant Months (t-1)	0.67 (0.41)	48.87 (10.03)
Ever Migrated	0.08 (0.27)	0.72 (0.44)
Total Number of Persons	3464	5618

In addition, we account for the individual's sex, age (including an age-squared term to account for the non-linear relationship between age and migration, particularly the diminishing likelihood of migration as people age), marital status (married or not), educational attainment (less than primary and completion of primary school, some secondary schooling, secondary schooling or more), and land ownership. The land ownership status is based on a Thai land measurement unit, 'rai.' One rai is equivalent to 0.395 acres (one acre = 2.53 rai). Based on our fieldwork, the following land ownership categories that are the most meaningful to rural villagers are the following: landless, near landless or 1-10 rai, 11-25 rai, and 25 rai or more. Land ownership is defined by villagers' understanding of their control over the investments and yields of their land, and it includes their homestead properties. Table 1 displays the descriptive statistics for our sample of Nang Rong residents in 1984 and 2000. As the sample matures, it grows in size as younger village members "age into" the sample (they enter the data when they are thirteen years old) and it shrinks slightly as older members age out of the sample (when they are older than fifty-one years). Reflecting the aging of the bulk of the sample, the mean age grows from nineteen years old in 1984 to twenty-eight years old in 2000. The percentage married grows from twenty-six percent to sixty-five percent between 1984 and 2000. The sample became more educated over the time period, with a tripling of those with secondary schooling or higher. Land ownership changed somewhat, with fewer individuals coming from landed households (more than 25 rai owned) and more individuals with smaller landholdings (1-10 rai owned).

This change in ownership may reflect the growing population as well as the division of family land among children as they marry and set up independent households. As mentioned earlier, the accumulated experiences of migrants, both in terms of number of trips and number of months as a migrant, grow substantially across individuals, households, and villages between 1984 and 2000.

B. ENSO: An Annual, Global Environmental Measure

To the baseline data files we add El Niño Southern Oscillation (ENSO) data as our global environmental measure and to proxy year effects in our regression analysis. ENSO is a key source of inter-annual variation in weather and climate in the world, and the subject of much study.[81] ENSO occurs roughly every two to seven years and its impacts differ depending on the region of the world. In Thailand, El Niño events result in warmer, drier conditions, while La Niña events lead to cooler, wetter conditions. Prior to 1980, there was little correlation between monsoonal rainfall totals in Thailand and ENSO events. However, Singhrattna et al. find that post-1980, due to a shift in circulation patterns; there is now a strong link between rainfall variability during summer monsoons and ENSO in Thailand.[82] As a result, Thailand is now particularly susceptible to fluctuations in the sea surface temperature in the Pacific Ocean, resulting in a decline in summer monsoon rainfall. Farmers rely on the summer monsoons to irrigate their fields, so we anticipate that in years where the preceding summer monsoon rainfall totals were lower, we will see an increase in the odds of out-migration. On the other hand, during La Niña periods when conditions are cooler and wetter than normal, we anticipate a decrease in the odds of out-migration. To our knowledge, few studies have examined the impacts of ENSO events on migration patterns in agricultural areas that rely on reined agriculture. A case

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81. Kevin E. Trenberth & Julie M. Caron, *The Southern Oscillation Revisited: Sea Level Pressures, Surface Temperatures, and Precipitation*, 13 J. CLIMATE 4358, 4361 (2000); Klaus Wolter & Michael S. Timlin, *El Niño/Southern Oscillation Behaviour Since 1871 as Diagnosed in an Extended Multivariate ENSO Index* 31 INT'L J. CLIMATOLOGY 1074, 1081 (2011).

82. Nkrintra Singhrattna et al., *Seasonal forecasting of Thailand summer monsoon rainfall*, 25 INT'L J. CLIMATOLOGY 649, 657 (2005).

study of Ecuador that is part of a larger European Union study on Environmental Change and Forced Migration (EACH-For) includes results of qualitative fieldwork that suggests people may have migrated due to the 1997 El Niño event, but no quantitative study has been conducted to verify these claims.[83]

We use the Oceanic Niño Index from the National Weather Service's Climate Prediction Center. The data is reported as three month running averages of sea surface temperatures in the Niño 3.4 region (5oN-5oS, 120o-170oW). Warm (El Niño) and cold (La Niña) episodes are noted when temperatures remain 0.5 degrees Celsius above or below normal temperatures for five overlapping three month periods. Specifically, we derive a measure of accumulated El Niño or La Niña by counting the number of preceding months (counting back twelve months and twenty-four months) from the start of the typical land preparation and beginning of rice cultivation, usually in May for most farmers in the region. We then calculate the portion of the preceding twelve or twenty-four months that is characterized by one or the other event or the absence of either event, which we categorize as a neutral event month. We chose a threshold of fifty percent of the months, to capture the predominant modal ENSO event, and coded for each of these preceding time periods for each type of event. For example, if the preceding six months, twelve months, or more had El Niño events, then we coded those year observations as El Niño. We coded all years either as predominantly El Niño, La Niña, or average (neither event). We followed the same procedure for the preceding twenty-four months. Distinguishing between the preceding twelve months and twenty-four months of accumulated events provides an opportunity to evaluate how the effect of exposure may differently influence behavior. We suspect that farmers and farm families might be particularly influenced to make a migratory move if there are two years of predominantly droughty climate experiences, as opposed to only one.

83. OSCAR ALVAREZ GILA ET AL., ECUADOR: CASE STUDY REPORT FOR THE EACH-FOR PROJECT 19 (2009).

C. Estimating the Effect of Climate Conditions, Land Ownership, and Gender Upon Migration

Empirical estimations to date, modeling migration and environmental dynamics, have employed various statistical methods to evaluate the impact of drought or environmental change on migration behavior. Findley's study of the impact of drought on migration in rural Mali uses bivariate regression analysis to compare migration types, migrant destinations, and the age-sex composition of migrants.[84] Others rely on post-event case studies to ask how people responded to drought.[85] A number of papers use event history analysis models to measure the odds of a migration event.[86]

Our model is different from these in its longitudinal structure and because it adds a set of baseline attributes of individuals that might account for possible unobserved heterogeneity related to our explanatory factors and the dependent variable. We are interested in predicting whether a person in $time_t$ is living outside of Nang Rong district or not. Our model prospectively measures migration and takes the following form, accounting for the correlated error structure of multiple observations from individuals, we estimate a random effects logistic equation:

(1) $Prob(Mig_{it}) = f(Climate_{it-1}, Land\ Ownership_{it-1}, Individual\ Characteristics_{it-1,}\ Accumulated\ Migration_{it-1},)$

where $Prob(Mig_{it})$ is a $person_i$'s probability of living outside of Nang Rong in $year_t$, Mig_{it} is 1 if $person_i$ moved out of Nang Rong at some point during $year_{t,}$ and 0 otherwise.

All of the independent variables are lagged one year to their values at $_{t-1}$. Our models are estimated separately for a sample

84. Findley, *supra* note 7, at 548.

85. Genevieve Gilbert & Robert McLeman, *Household Access to Capital and Its Effects on Drought Adaptation and Migration: A Case Study of Rural Alberta in the 1930s*, 32 POPULATION & ENV'T 3, 5 (2010); K. Van der Geest et al., *Migration and Environment in Ghana: A Cross-District Analysis of Human Mobility and Vegetation Dynamics*, 22 ENV'T AND URBANIZATION 107, 110 (2010).

86. Gray, *supra* note 7, at 460; Gray & Mueller, *supra* note 7, at 135. Henry et al., *supra* note 7, at 403; Massey et al., *supra* note 7, at 111; Clark Gray & Richard Bilsborrow, *Environmental Influences on Human Migration in Rural Ecuador*, 50 DEMOGRAPHY 1217, 1219 (2013); Valerie Mueller et al., *Heat Stress Increases Long-term Human Migration in Rural Pakistan*, 4 NATURE CLIMATE CHANGE 182 (2014).

of men and women. We estimate four models, including a base model explaining out-migration. For the base model of controls we include measures of sex, age (measured with two terms, age and age-squared), educational attainment, marital status, migration experience (including measures of accumulated migration experience among the individuals themselves, household members, and other community members), and household land ownership.

We then test four models to evaluate the impact of climate variability. The first model estimates the impact of accumulated impact of months of ENSO events for the preceding twelve months. The second estimates the impact of accumulated impact of months of ENSO events over the preceding twenty-four months to capture longer and more stressful or healthier climatic events. The third and fourth models replicate the first two but also estimate an interaction effect between land ownership status and climate conditions for both the twelve-month and twenty-four-month exposure. Since we have strong evidence to suspect that men and women behave differently in response to prior migration—land ownership and climate conditions—we separately assess these models on a male-only sample and a female-only sample.

Table 2: Log-odds Coefficients Predicting Migration in Year T (Explanatory Variables Observed in T-1), 1984-2000

	ENSO 12 Month Exposure		ENSO 24 Month Exposure	
	Male	Female	Male	Female
Age	1.157*	1.082*	1.161*	1.087*
Age*Age	0.996*	0.997*	0.996*	0.997*
Married (or not)	0.808*	0.396*	0.806*	0.394*
Primary Schooling or Less (Omitted)				
Some Secondary School	0.826*	0.676*	0.816*	0.664*
Secondary Schooling or more	1.708*	2.073*	1.708*	2.075*
Landless (omitted)				
1-10 Rai Owned	0.976	0.986	0.978	0.983
11-25 Rai Owned	0.907	0.783*	0.908	0.784*
More than 25 Rai Owned	0.764*	0.655*	0.764*	0.656*
Ever a Temporary Migrant in 1984	0.642*	1.166	0.649*	1.161

HH Member Ever Temp. Migrant '84	1.347*	1.310*	1.349*	1.315*
Cum. # of Migrant Trips	1.175*	1.160*	1.174*	1.158*
Cum. # of Months as Migrant	1.008*	1.007*	1.008*	1.007*
HH Cum. # of Migrant Trips per Capita	1.126*	1.072*	1.130*	1.072*
HH Cum. # of Migrant Months per Capita	0.992*	0.997	0.992*	0.997
Vil. Cum. # of Migrant Trips per Capita	1.114	1.471*	1.051	1.378*
Vil. Cum. # of Migrant Months per Capita	0.994	0.995	0.995	0.996
Average Climate Year (Omitted)				
El Niño	0.831*	0.822	1.182*	1.099*
La Niña	0.568*	0.561*	0.633*	0.638*
Constant	0.064	0.108	0.055	0.093
rho	0.130*	0.177*	0.132*	0.178*
Total Number of Person-Years	25563	29943	25563	29943

* $p \leq .1$

V. RESULTS

The results of our longitudinal analyses of migration responses to climate conditions, controlling for underlying proximate determinants of migration, are found in Table 2, and summarized in Figure 1. Before summarizing the findings for the responses to climate conditions, we first discuss our model results for the control variables. Our model replicates our prior findings in our previous research[87] and confirms findings from similar models applied in other contexts.[88]

Specifically, as individuals age they are more likely to migrate, but that likelihood diminishes at older ages. These patterns are statistically significant for both men and women, but more pronounced for men. Marriage reduces the likelihood of migration, for both men and women, but especially for women.

Education, as with age, has a nonlinear relationship with migration. Those with primary schooling or less *and* those who have completed secondary schooling or more are more likely to migrate than those with some secondary schooling to migrate. These patterns are statistically significant and are the same for men and women. These migrants at different spectrums of schooling are moving for different reasons. Those with only primary schooling are moving to low wage labor sector jobs and those with more than secondary schooling are moving to higher wage jobs or continuing their schooling.[89]

Individuals from landless households are more likely to migrate than those from other households. However, for men, landless status is statistically insignificant from near landless (1-10 rai) or somewhat landed (11-25 rai), but it is statistically significantly different from landed household (more than 25 rai). Men from landed households are significantly less likely to migrate than other household land statuses. The pattern is

87. Curran et al., *supra* note 50, at 245; Garip & Curran, *supra* note 78, at 676.

88. Elizabeth Fussell & Douglas S. Massey, *The Limits to Cumulative Causation: International Migration from Mexican Urban Areas*, 41 DEMOGRAPHY 151, 168 (2004); Douglas S. Massey & Kristin E. Espinosa, *What's driving Mexico-US migration? A theoretical, empirical, and policy analysis*, 102 AM. J. SOCIOLOGY 939, 997 (1997); Douglas S. Massey & Rene M. Zenteno, *The Dynamics of Mass Migration*, 96 PROC. NAT'L ACAD. SCI. 5328, 5333 (1999); Massey et al., *supra* note 7, at 115.

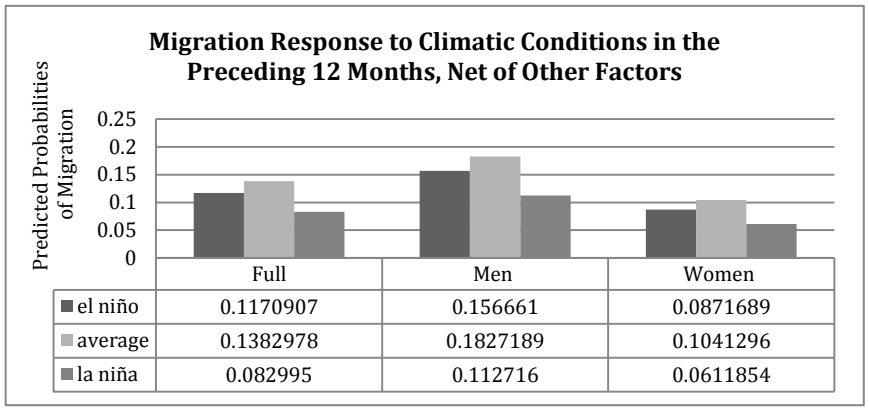
89. Sara R. Curran et al., *Educational Opportunities for Boys & Girls in Thailand*, *in* INEQUALITY ACROSS SOCIETIES: FAMILIES, SCHOOLS AND PERSISTING STRATIFICATION 59, 87 (David Baker et al. eds., 2004).

similar for women, except that coming from either a somewhat landed household (11-25 rai) or a landed household (more than 25 rai) serves to reduce the likelihood of migration.

Finally, prior migration (as measured by whether or not a person or another member of the household was a temporary migrant in 1984 and by accumulated number of migrant trips observed separately at the individual, household, and village level) increases the likelihood of migration. (Again, these results are similar and statistically significant for both men and women). However, as the migrant months increase, accumulated time away reduces the odds of migration among those who remain behind.

A. Migration Responses Depend on Gender and Exposure to Climate Conditions

Figure 1 displays the models' predicted probabilities for migration, varying the values of gender and climate conditions, controlling for all other factors in the models, putting all other variables at their means. These estimates show the net effect of climate conditions on migration. The top graph displays results for a model that estimates impacts of exposure to climate conditions over the preceding twelve months. The bottom graph shows results for a model that estimates impacts of exposure to climate conditions for the preceding twenty-four months. What we observe is that for shorter periods of exposure (twelve months), people are less likely to migrate when it is either a predominately hotter and drier climate or a cooler and wetter climate.



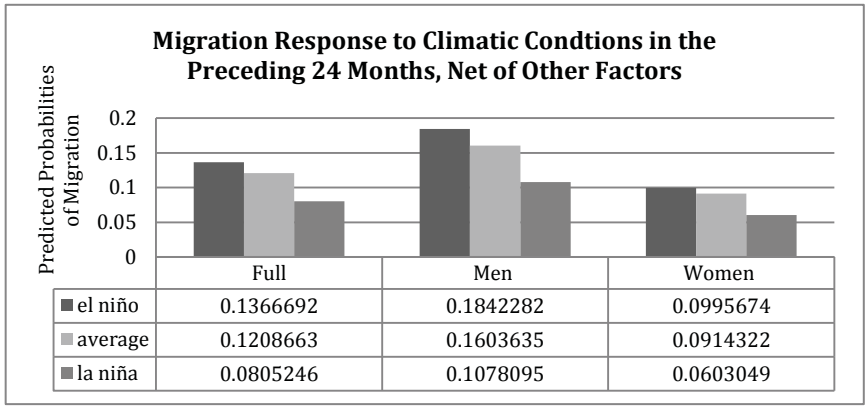


Figure 1: Comparison of Results for Regressions Estimating Probability of Migration Due to Exposure to Climate Conditions, Net of Other Factors[90]

These patterns are similar for men and women. For men, when the preceding twelve months of climate conditions are average (neither hotter nor drier—El Niño—nor wetter and cooler—La Niña), the predicted probability of migration is 0.18. This probability drops to 0.16 for El Niño conditions and to 0.11 for La Niña. It is somewhat surprising to find that exposure to El Niño conditions lowers the probability of migration relative to average conditions. However, it could be that El Niño conditions are being experienced throughout the country, and it may not be worth the effort to leave to find work if that work is also in the agricultural sector. It is not surprising to find that La Niña conditions lower the probability of migration even more. Cooler and wetter conditions hold labor on the land because rice planting occurs earlier, and a longer, wetter rainy season means that it may be possible to grow two crops of rice over the growing season.

For women, the probabilities of migration are lower than for men, but the patterns are similar. Exposure to average climate

90. The estimation technique is a random-effects logit model. The model estimates the likelihood of migrating out of Nang Rong District for 2 months or longer between 1984 and 2000. The other measures included in these models are: sex, age, marital status, education, prior migration experience (measured at the individual, household and village levels), and land ownership status. Each model is estimated on a sample of individuals living in Nang Rong District at the end of the preceding year (in every year between 1984 and 2000) and there are three sets of samples: all individuals, a sample of only women, and a sample of only men. The unit of analysis is a person-year. The climate conditions measure observes whether in the preceding 12 months or the preceding 24 months 50% of the 3-month running average of sea level temperatures were El Niño temperatures (hotter), La Niña temperatures (cooler) or neither (the Average category). Model results are found in Table 2.

conditions results in the highest probability of migration at 0.0998 El Niño conditions lower the probabilities to 0.086, and La Niña conditions lower those probabilities even further to 0.061. Women's ties to their natal households and to the land limit their migration overall, especially when the climate conditions are cooler and wetter.

When we estimate models that lengthen the exposure to climate conditions, we begin to observe the effects that villagers told us they experienced, especially for men. These results are apparent in the bottom half of Figure 1. Exposure to twenty-four months of El Niño conditions increases the probability of migrating to 0.182 for men, and this is a statistically significant increase. For women, there is slight increase in the probability of migrating under similar conditions, but it is not statistically significant. For both men and women, exposure to cooler and wetter conditions lowers the probability of migration significantly.

The somewhat small, net responses to hotter and drier conditions in these models, and the quite vocal evidence in our data about the importance of drought, suggests that there may be conditional factors that either propel individuals out of a place when climate conditions worsen or keep them from migrating, when climate conditions worsen. In particular, we suspect that the role of land ownership and household investments in land mitigates against rapid responses to worsening climate conditions. We explore this possibility next.

B. Land Ownership and Responses to Climate Conditions

Figure 2 displays the results of models that tested for an interaction between land ownership status and climate conditions, net of other conditions or characteristics of individuals, households, or villages. The left side panel shows model results for exposure to climate conditions over the preceding twelve months, and the right side panels show model results for exposure to climate conditions over the preceding twenty-four months. The top two graphs display results for men, and the bottom two graphs display results for women.

Table 3: Log-odds Coefficients Predicting Migration in Year T, Accounting for Climate & Land Tenure Interaction (Explanatory Variables Observed in T-1), 1984-2000		
	ENSO 12 Month Exposure	ENSO 24 Month Exposure

	Male	Female	Male	Female
Age	1.157*	1.082*	1.161*	1.087*
Age*Age	0.996*	0.997*	0.996*	0.997*
Married (or not)	0.807*	0.396*	0.804*	0.394*
Primary Schooling or Less (Omitted)				
Some Secondary School	0.825*	0.676*	0.815*	0.664*
Secondary Schooling or more	1.705*	2.070*	1.712*	2.073*
Landless (omitted)				
1-10 Rai Owned	0.953	0.966	0.895	0.961
11-25 Rai Owned	0.927	0.890	0.968	0.805*
More than 25 Rai Owned	0.713*	0.716*	0.720*	0.658*
Ever a Temporary Migrant in 1984	0.644*	1.166	0.651*	1.162
HH Member Ever Temp. Migrant '84	1.344*	1.311*	1.345*	1.315*
Cum. # of Migrant Trips	1.175*	1.161*	1.174*	1.158*
Cum. # of Months as Migrant	1.008*	1.007*	1.008*	1.007*
HH Cum. # of Migrant Trips per Capita	1.123*	1.071*	1.130*	1.072*
HH Cum. # of Migrant Months per Capita	0.993*	0.997	0.992*	0.997
Vil. Cum. # of Migrant Trips per Capita	1.107	1.473*	1.046	1.383*
Vil. Cum. # of Migrant Months per Capita	0.994	0.995	0.995	0.996
Average Climate Year (Omitted)				
El Niño	0.661*	1.039	0.970	1.218
La Niña	0.666*	0.537*	0.766	0.533*
El Niño * 1-10 Rai	1.398*	0.918	1.418*	0.944
El Niño * 11-25 Rai	1.184	0.725*	1.063	0.866
El Niño * More than 25 Rai	1.306	0.734*	1.313	0.885
La Niña * 1-10 Rai	0.725*	1.236	0.923	1.290
Table 3 (cont'd)				
	ENSO 12 Month Exposure		ENSO 24 Month Exposure	
	Male	Female	Male	Female

La Niña * 11-25 Rai	0.758	0.908	0.644*	1.130
La Niña * More than 25 Rai	0.994	1.064	0.918	1.239
Constant	0.066*	0.101*	0.056*	0.093*
rho	0.131*	0.178*	0.132*	0.178*
Total Number of Person-Years	25563	29943	25563	29943

The patterns of migration, given land ownership status and exposure to climate conditions, are somewhat similar to those discussed in the preceding section, as seen Table 3 and Figure 2. However, land ownership status interacts significantly with climate conditions, although less consistently and significantly for the twelve months of exposure than for the twenty-four months of exposure. For men, when exposed to twelve months of El Niño conditions, it is the near landless men who respond by migrating away. However, this same type of man is significantly less likely to migrate under La Niña conditions. It appears that men in the near-landless category are the most responsive to poor or better climate conditions, in so far as that response is a migratory one. But women from landed (more than 25 rai) and somewhat landed households (11-25 rai) are significantly more likely to stay and not move, compared to their near-landless and landless counterparts, despite El Niño conditions. Women in landholding households are less responsive to worsening climate conditions, at least when observing their exposure over twelve months.

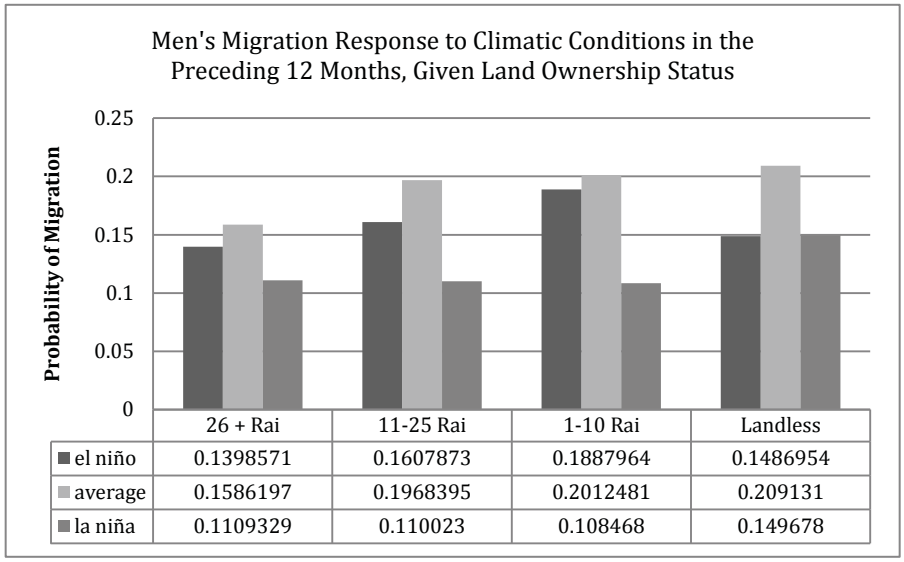
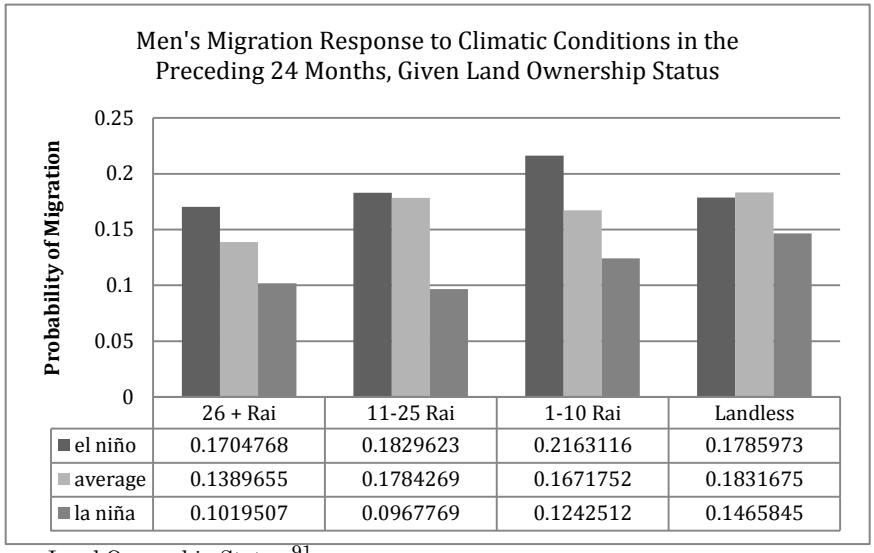
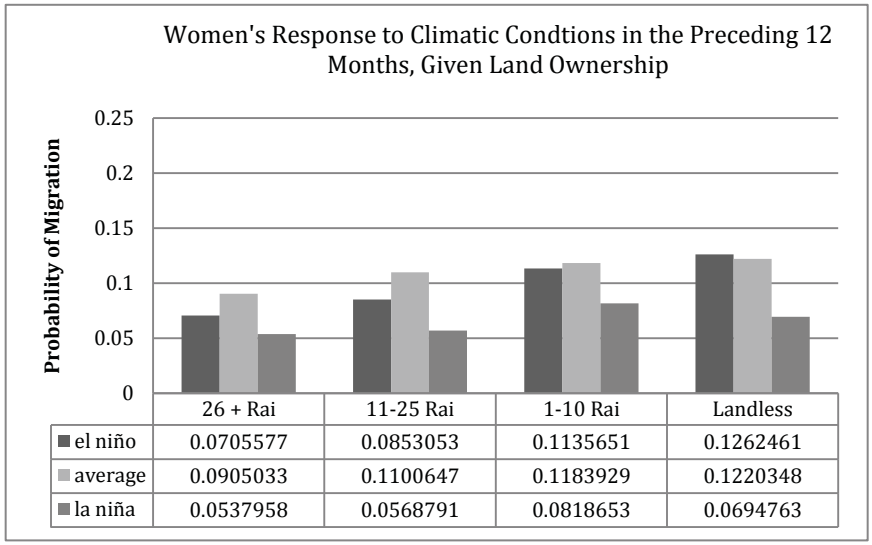


Figure 2: Migration Probabilities Due to Climate Conditions, Conditional on

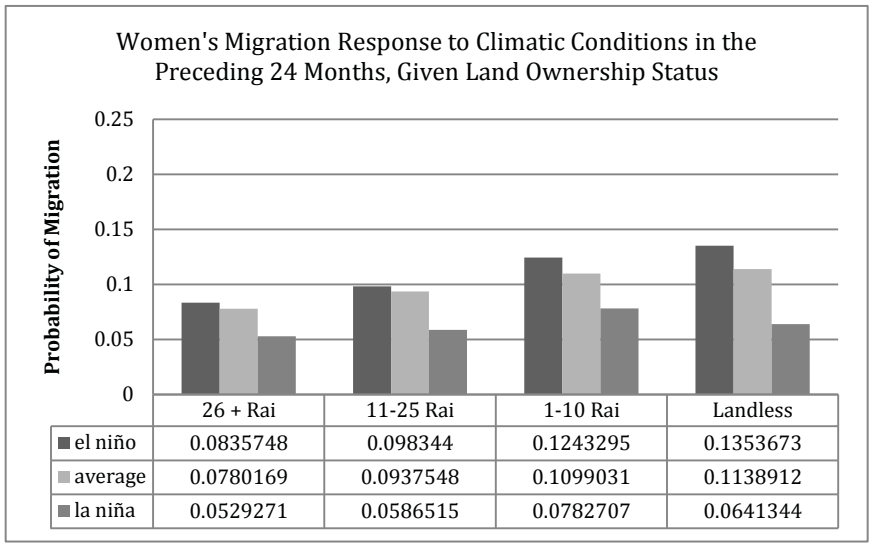


Land Ownership Status.[91]

91. The estimation technique is the same as that used to generate the results for Fig. 1. However, additional variables included in the models were a set of interactions for: land ownership X climate conditions. Model results are found in Table 3.



	26 + Rai	11-25 Rai	1-10 Rai	Landless
el niño	0.0705577	0.0853053	0.1135651	0.1262461
average	0.0905033	0.1100647	0.1183929	0.1220348
la niña	0.0537958	0.0568791	0.0818653	0.0694763



	26 + Rai	11-25 Rai	1-10 Rai	Landless
el niño	0.0835748	0.098344	0.1243295	0.1353673
average	0.0780169	0.0937548	0.1099031	0.1138912
la niña	0.0529271	0.0586515	0.0782707	0.0641344

Fig. 2 cont.

The models estimating exposure to climate conditions over twenty-four months show more consistent patterns across land ownership and gender than do the twelve-month exposure models. In general, larger landowning households are less likely to send migrants than smaller landowning households or landless households, and for each land owning category El Niño conditions lead to higher probabilities, or equal to the average climate condition probabilities, of migration. Only for

men are there significant interaction effects between land ownership and climate conditions. Again, men from near landless households have the highest probability of migrating away, 0.216, under El Niño conditions. And, men from somewhat landed households are the least likely to migrate under La Niña conditions. There are no significant interaction effects for women, although the patterns are similar to the men's patterns: women from near-landless and landless households are the most likely to migrate under long-term and poor climate conditions. And women from landed households and somewhat landed households are the least likely to migrate under La Niña conditions.

VI. DISCUSSION AND CONCLUSION

Our study sought to evaluate the possibility that climate change and worsening climate conditions might lead to significant out-migration from agricultural and natural resource dependent regions. Because previous research has been limited both in controlling for baseline patterns of migration and in measuring prospective responses to variable climate conditions, we chose to evaluate evidence from a sixteen-year panel study of migration patterns in rural, northeastern Thailand, where we could link migration to climate conditions over the same time period. This region is particularly susceptible to fluctuations in the ENSO system, and villagers are very cognizant of how climate conditions affect their livelihood decisions. Importantly, the time period observed in this study coincides with an earlier period of predictable climate conditions shifting to an increasingly variable and less predictable set of climate conditions in Thailand,[92] as expected by climate forecasts.[93] In our models, we estimated exposure to hotter and drier than normal climate conditions, to average climate conditions, and to cooler and wetter than normal climate conditions. And we considered

92. Marks, *supra* note 37, at 250–51.

93. IPCC, *supra* note 5 // Working Group I: The Physical Science Basis, IPCC Fourth Assessment Report: Climate Change 2007 §§ 3.8, 9.5, 10.3 (S. Solomon et al. eds., 2007) *available at* http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-projections-of.html; Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, 2013: Climate Change 2013: The Physical Science Basis 1219-1214 (T.F. Stocker et al. eds., 2013).

whether different lengths of exposure to climate conditions might differentially propel people to migrate. We also considered the possibility that, besides underlying or baseline patterns of migration, climate conditions differentially affect those with variable ties to the land or investments in land. Finally, we considered how men and women will have different responses to the risks of climate conditions and will have differing ties and commitments to place and land owned.

We find that women have lower probabilities of migration overall. Land ownership for women significantly reduces their probability of migration, and it also serves to reduce an adaptive migration response under worsening climate conditions over a twelve-month period, as evidenced by results in Table 3 and Figure 2. Better climate conditions considerably reduce their probability of migration. Men with somewhat more tenuous ties to land (near-landless or landless) appear to be significantly more responsive to climate conditions, either migrating when climate conditions worsen or not migrating when climate conditions are improved, vis-à-vis farming and agriculture. Longer exposure to poor climate conditions pushes people to migrate at higher rates and adaptive migration responses are mixed over a shorter exposure period.

Our results offer a cautionary or conditional response to the IPCC's 2007 dire predictions about mass migration. Our study, along with others now reported in the IPCC 2014 report, suggest far more measured predictions about the variability of human responses and the intermediary factors that serve to buffer or influence adaptive responses, including out-migration. Two quotations from the recent IPCC report highlight these points:

> A further strand of evidence shows social differentiation in access to the resources necessary to mitigate influences migration outcomes (Renaud et al., 2011; Black et al., 2013). Vulnerability is inversely correlated with mobility, leading to those being most exposed and vulnerable to the impacts of climate change having the least capability to migrate. Therefore, climate change risks can be significant when they reduce and constrain opportunities to move (Black et al., 2013). Alternatively, the most vulnerable households are able to use migration to cope with environmental stress, but their migration is an emergency response that creates conditions of debt and increased vulnerability, rather

> than reducing them (Warner and Afifi, 2013). . . . It shows that some events lead to increased displacement of populations; while others lead to reduce mobility. . . . in many circumstances, members of a population will display differentiated migration outcomes on the basis of ethnicity, wealth or gender (Elliot and Pais, 2006; Gray and Mueller, 2012; Upton, 2012)."[94]

> Even in areas under threat from long-term climate change and rising sea-levels, observations show that populations at risk do not always choose to migrate. . . . In the Peruvian Andes, Adams and Adger (2013) found that cultural ecosystem services and place attachment shape decisions not to migrate and hence populations persist despite difficult environmental conditions. However, these studies also find that environmental risks directly affect perceptions of well-being, cultural integrity and economic opportunities. They conclude that the impacts of climate change may be a more significant driver of migration in the future.[95]

These more recent studies and our own suggest that while environmental refugees may not be the most urgent, short-term adaptive response to worsening climate conditions, the evidence indicates far more complicated patterns of behavior that will require finely tuned policy and legal tools. Importantly, these tools need to be properly tuned to local conditions and must consider evidence that: (1) has significant temporal depth (there are distinctly different patterns of responses when exposure to conditions is short-term (twelve months) or long-term (twenty-four months)), (2) accounts for the pre-existing institutional conditions that already influence human behavior (especially those already propelling people to migrate), or the land tenure or land policies that influence people's ties to the land, and (3) accounts for the differential behavior of subgroups in a population (in our case, men and women). With regard to the first point (temporal depth), more scientific evidence needs to be collated over longer time periods with finer resolution in order to link climate conditions to

94. IPCC 2014, p. 12

95. IPCC 2014, p. 14

human behavior. Our study moves this literature one small step closer to this goal. With regards to the third point, subgroups, much research in the field of environment or in-migration has already shown how gender is a distinct social category that differentiates human responses to environment or migration. Our study supports this larger literature. With regards to the second point, pre-existing institutional conditions, far less work has examined how much more of an impact climate conditions have on existing baseline patterns. In our case, climate conditions increase or lower migration probabilities by a small percentage, although they do so significantly. For the most part, people are already migrating—and migrating a lot—in the Thai context as well as in many other parts of the world.

The more general point is that models of climate impact should estimate the net effects of baseline patterns to more accurately evaluate the size of their impact. Furthermore, institutional contexts are important and a likely policy or legal lever to address climate adaptation or mitigation responses. One such realm might be in the land tenure arena because landless people are far more vulnerable to worsening climate conditions, especially in rural agrarian settings like northeastern Thailand.