EDeN Environmental Demography Network

Migratory Responses to Environmental Variability in the United States

A Multilevel-level Analysis of Microdata from the American Community Survey, 2010 – 2020

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Introduction

- Intergovernmental Panel on Climate Change (IPCC, 2022) warns we are approaching the 1.5°C level above pre-industrial temperature
- 150-300 million people will be displaced by environmental changes by 2050 (Gemenne 2011)
- The US suffers from sea-level rise, earthquake, hurricane, and other environmental disasters

Previous studies and knowledge gap

- Globally, previous studies primarily focused on rapid-onset environmental changes in the developing world

- In the US, studies on slow-onset environmental variabilities used aggregated data at the regional level or crude level

  Gutmann et al. (2005): Great Plains region, 1930-1990
  Feng et al. (2012): Corn belt region, 1970-2009
  Poston et al. (2009): The entire US at the state level, 1995-2000

- There is a knowledge gap regarding the impact of slow-onset environmental variabilities on migration at the individual level in developed setting

Research objectives

- Explore individuals' migratory responses to slow-onset environmental variabilities (precipitation, temperature, air quality, and environmental amenity)

- Examine the heterogeneous environmental impacts on migration across age groups (age group 15-64 and age group 65+)

Data

- The American Community Survey (ACS) Microdata
- The Parameter-elevation Regressions on Independent Slopes Model (PRISM)
- The Atmospheric Composition Analysis Group (ACAG)
- The National Oceanic and Atmospheric Administration (NOAA)

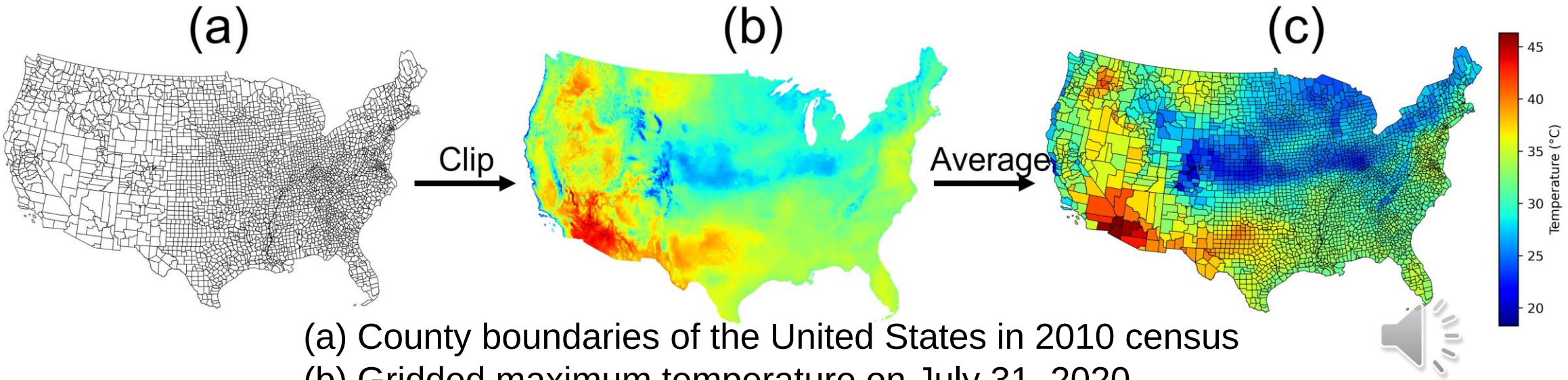
Measurement

- Migration: Whether individuals moved across counties between ACS years
- $Climate\ anomaly_{i,t} = \frac{Level_{i,t} - \mu_i^{LR}}{\sigma_i^{LR}}$

$Level_{i,t}$ = Climate measure in county *i* at time *t*

μ_i^{LR} = Long-run (30-year, 1980-2009) average in county *i*

σ_i^{LR} = Long-run (30-year, 1980-2009) standard deviation in county *i*



(a) County boundaries of the United States in 2010 census
(b) Gridded maximum temperature on July 31, 2020
(c) County-level maximum temperature on July 31, 2020

Analytical approach

<u>Two-level logistic regression:</u>

$$Logit\left(\Pr\left(Y_{ij} = 1\right)\right)$$
$$= \alpha_0 + \alpha_{0j} + \alpha_1 X_{1ij} + \cdots + \alpha_k X_{kij} + \beta_1 Z_{1j} + \cdots + \beta_m Z_{mj}$$

where X_{1ij} through X_{kij} denote the level-1 variables

Z_{1j} through Z_{mj} denote the level-2 variables

<u>Level-1 (individual) variables:</u>

Age, personal income, gender, marital status, race, education

<u>Level -2 (county) variables:</u>

Precipitation, temperature, PM2.5, Normalized Difference Vegetation Index (NDVI)
Household income, housing price, employment rate, homeownership, metro status

Descriptive statistics

	N	Mean	SD	Min	Max
Dependent variable					
Migration status	2,243,336	0.42	0.49	0	1
Level-1 variables					
Age	2,243,336	37.52	17.78	15	96
Personal income ($1,000)	2,243,336	32.45	52.97	-14.10	1,378.00
Gender	2,243,336	0.50	0.50	0	1
Marital status	2,243,336	0.33	0.47	0	1
Race	2,243,336	0.59	0.49	0	1
Education	2,243,336	0.53	0.50	0	1
Level-2 variables					
Precipitation anomaly	2,243,336	0.09	0.34	-0.84	1.55
Temperature anomaly	2,243,336	0.06	0.11	-0.40	0.48
PM2.5 anomaly	2,243,336	-1.07	0.46	-2.12	1.13
NDVI anomaly	2,243,336	-0.01	0.17	-1.12	0.53
Household income ($1,000)	2,243,336	89.47	20.94	48.97	178.22
Housing price ($1,000)	2,243,336	296.00	181.35	81.88	1,111.50
Employment rate	2,243,336	91.95	2.48	81.49	97.58
Homeownership	2,243,336	61.25	10.88	18.97	87.44
Metropolitan status	2,243,336	0.99	0.09	0	1

Note: Distribution of race: Non-Hispanic White (59%), Non-Hispanic Black (14%), Hispanics (17%), Others (10%).

General environmental migration model

	Model 1	*Model 2*	*Model 3*
Level-1 variables			
Age		-0.010***	-0.010***
Personal income		-0.000***	-0.001***
Gender, Male (Ref. = Female)		0.093***	0.097***
Marital status, Married (Ref. = Unmarried)		-0.078***	-0.071***
Race, NHB (Ref. = NHW)		-0.222***	-0.209***
Race, Hispanics (Ref. = NHW)		-0.326***	-0.335***
Race, Others (Ref. = NHW)		0.050***	0.022***
Education, College and above (Ref. = Below college)		0.172***	0.170***
Level-2 variables			
Precipitation anomaly			0.017**
Temperature anomaly			0.075***
PM2.5 anomaly			-0.006***
NDVI anomaly			-0.249***
Household income			0.010***
Housing price			0.001***
Employment rate			-0.047***
Homeownership			0.004***
Metro county (Ref. = Nonmetro county)			0.132***
Constant	0.170	0.513***	3.115***

Note: *** p<0.001, ** p<0.01, * p<0.05. NHB=Non-Hispanic Black, NHW=Non-Hispanic White. Model diagnostics are not show.

Age-specific environmental migration models

	$Mig_{15\text{-}64}$	Mig_{65+}
Level-1 variables		
Age	-0.014***	-0.015***
Personal income	-0.001***	0.001***
Gender, Male (Ref. = Female)	0.104***	-0.007
Marital status, Married (Ref. = Unmarried)	-0.068***	0.083***
Race, NHB (Ref. = NHW)	-0.192***	-0.237***
Race, Hispanics (Ref. = NHW)	-0.331***	-0.227***
Race, Others (Ref. = NHW)	0.029***	-0.027
Education, College and above (Ref. = Below college)	0.170***	0.231***
Level-2 variables		
Precipitation anomaly	0.016**	0.033
Temperature anomaly	0.093***	-0.127*
PM2.5 anomaly	-0.092***	-0.001
NDVI anomaly	-0.247***	-0.193***
Household income	0.009***	0.011***
Housing price	0.001***	0.001***
Employment rate	-0.048***	-0.042***
Homeownership	0.006***	-0.020***
Metro county (Ref. = Nonmetro county)	0.160***	-0.128
Constant	3.123***	4.823***

Note: *** p<0.001, ** p<0.01, * p<0.05. NHB=Non-Hispanic Black, NHW=Non-Hispanic White. Model diagnostics are not show.

Findings

- Being male, non-Hispanic white, and highly educated increased migration probability
- Overall, precipitation and temperature anomalies increased migration probability, while PM2.5 and NDVI anomalies decreased migration probability
- The younger generation (age group 15-64) was responsive to all environmental measures, while the elder generation was only responsive to temperature and environmental amenity

Takeaways

1. Slow-onset environmental variabilities affect migration in the United States, even after controlling for sociodemographic factors

2. There exist age-specific environmental migration patterns under slow-onset environmental variability, with the elder generation being responsive to temperature and environmental amenity while the younger generation being responsive to all environmental factors

Thanks

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