How Do Environmental Changes and Variations Influence Migration

A Meta-regression Analysis of the Environmental Migration Literature

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Introduction

Global temperature increase of 1.5℃ above pre-industrial levels will impose devastating impacts on human beings and the entire ecosystems (IPCC, 2018)

Climate changes have been influencing population distribution over the world (Black, Stephen, et al. 2011; Piguet, Kaenzig, and Guélat 2018). By 2050, 200 million people will be displaced globally because of climate change (Myers, 1997; Myers, 2002)

However, previous findings on the environmental effects on migration are contradictory

Objectives

Demonstrate the trend of environmental migration studies over the past two decades

Obtain the average effect sizes in terms of the environmental impacts on migration

Explore the covariates that are influential in determining the heterogeneity in the literature

Investigate under what circumstances do environmental factors trigger out-migration

The measures of migration affect environmental migration

- Hauer, Holloway, and Oda (2020) found that temporary migrants prefer short-distance migration after the Japan earthquake and tsunami, while permanent migrants are following preexisting social ties regardless of the moving distance

- Beauchemin (2004) found that long-term migration are positively associated with temporary rainfall shortage while short-term migration are negatively associated with temporary rainfall shortage

- Gray and Bilsborrow (2013) distinguished local, internal, and international migration and found that environmental factors are the least important in determining internal migration but are most influential for international migration

The measures of environmental factors affect environmental migration

- Rapid-onset extreme disasters such as floods, tsunamis, and hurricanes are closely associated with out-migration, but those migrations tend to be short-distance and usually followed by a return migration after the disaster (Black, Adger, et al. 2011; Groen and Polivka 2010; Warner et al. 2010)

- Slow-onset environmental changes such as drought, desertification, and land degradation tend to incur short-distance and temporary migration as well, but the main purpose of migration under those conditions is to diversify livelihood strategies rather than escape from the environmental stressors; therefore, the process could be selective on socio-demographic characteristics (Findlay 2011; Fussell et al. 2014)

- Cutter (2016) suggested that the choice between environmental indicators and indices may also make a difference in terms of their effects on migration because multiple indicators can provide more information than indices that are derived from aggregating multiple indicators

Methodological approaches and environmental migration

- Qualitative studies help identify the challenges that environmental stressors bring to certain places and population and identify the multicausality of environmental migration (Borderon et al. 2019; Piguet 2010)

- Quantitative studies help quantify the effect of various environmental factors on migration. However, their findings are subject to the methodological approaches

1) Multiple regression and multilevel analysis. Henry, Schoumaker, and Beauchemin (2004) and Ezra and Kiros (2001) find that out-migration from environmentally unfriendly areas is not sensitive to the environmental stressors themselves; rather, out-migration is more likely to be related to individual, household, and contextual characteristics

Methodological approaches and environmental migration (Cont.)

2) Agent-based model (ABM) can account for people's agency and volition and is useful in capturing dynamic, interactive, and nonlinear relationships within the environment-migration linkage (Hunter et al. 2015; Piguet 2010). Using ABM, Entwisle, Williams, and Verdery (2020) found that environmental stressors have little impact on out-migration but have a markedly negative effect on return migration in Nang Rong, Thailand

3) Spatial analysis can capture spatial heterogeneity and spatial autocorrelation embedded in the migration process, which are difficult to measure or control with nonspatial methods

Place-specific characteristics affect environmental migration

- Pending modification (Antwi-Agyei, Stringer, and Dougill 2014; Dallmann and Millock 2017; Laube, Schraven, and Awo 2012)
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Meta-regression analysis

Meta-analysis is a statistical and quantitative synthesis of research results. The purpose of a meta-analysis is to compare and statistically inquire into the factors that cause the heterogeneity of the effects of independent variables on the dependent variable

$$PCC_{ij} = \beta_0 + \sum \beta_k z_{kij} + \beta_1 se_{ij} + \varepsilon_{ij}$$

Where:

PCC_{ij} = Partial Correlation Coefficient

Z_{kij} =

se_{ij} =

ε_{ij} =

Meta-regression analysis (Cont.)

To correct for the importance of the study, we applied the following weight to the analyses:

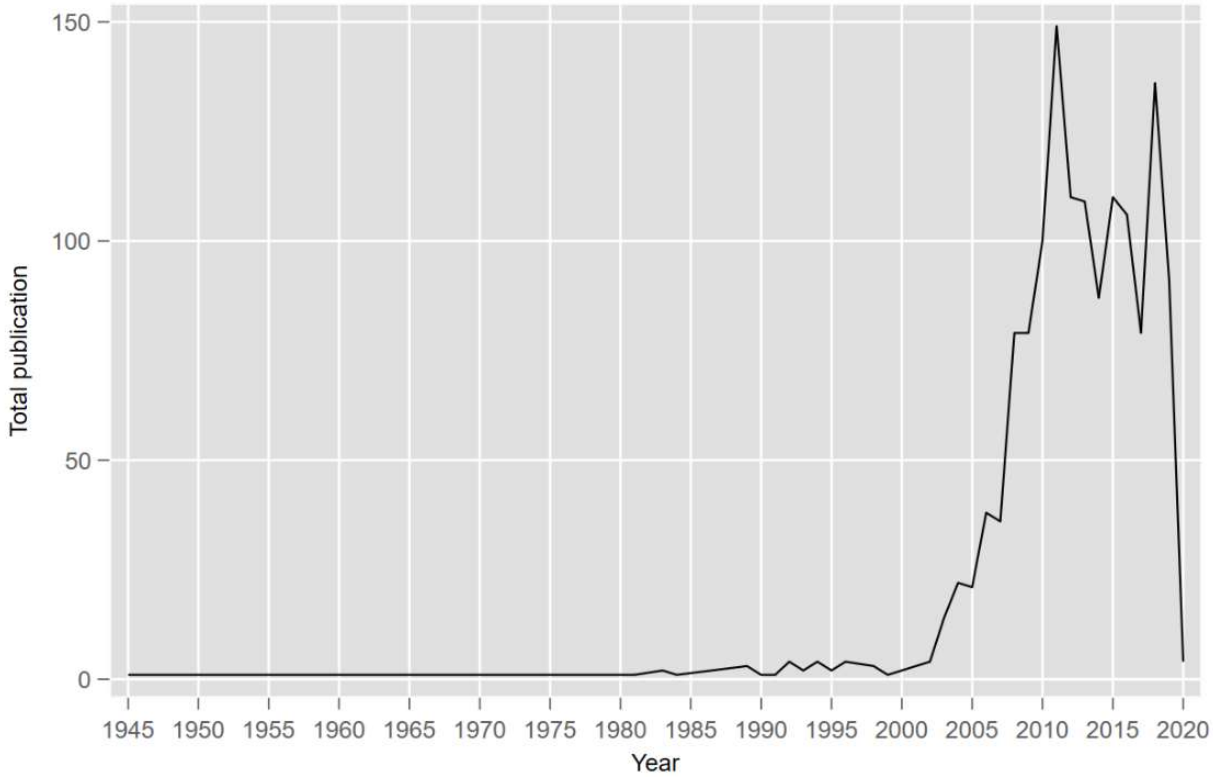
$$W_i = \frac{1}{{SE_{PCC_i}}^2}$$

To correct for endogeneity resulted from selecting literature and omitting variables, we applied instrumental variables:

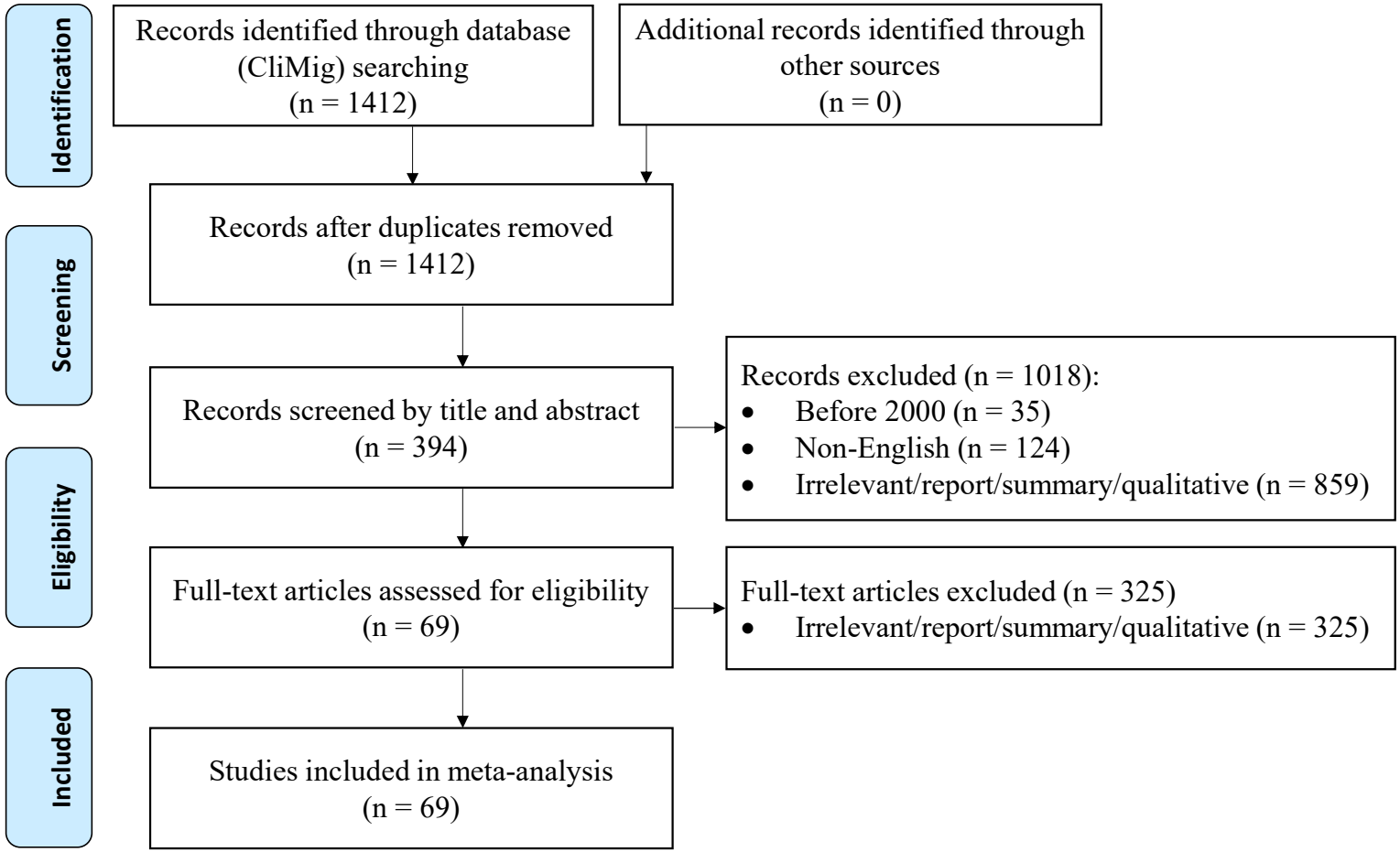
$$Instrumental\ Variable = \frac{1}{\sqrt{df}}$$

Data

CliMig database (See Piguet, Kaenzig, & Guélat, 2018)



PRISMA flow diagram



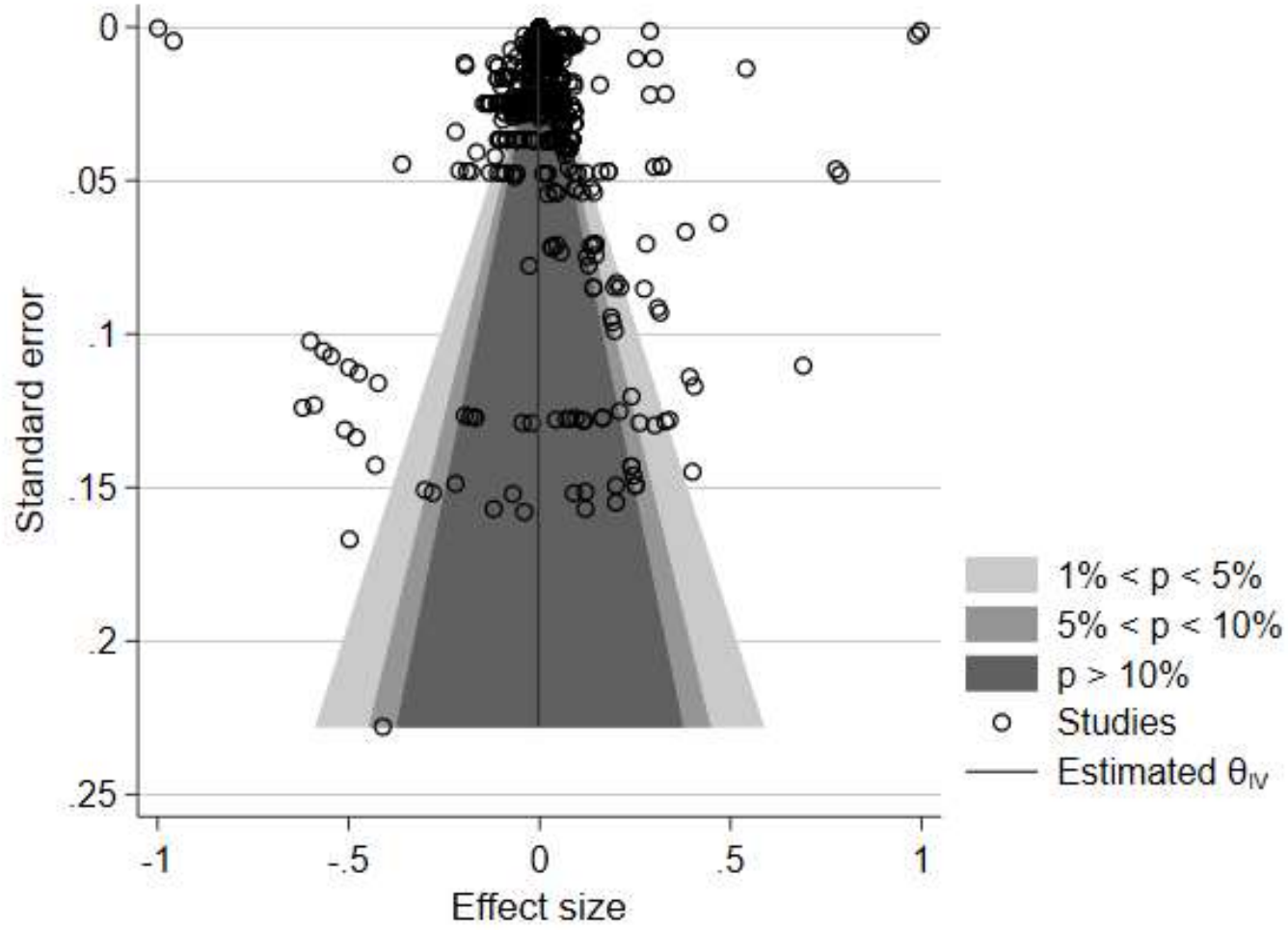
Environmental factors across study settings

Unweighted and weighted PCC

	Environmental stressors	Mean	Standard error	95% CI
Unweighted average	Overall	0.056	0.003	0.050, 0.063
	Sub-group: Disaster-related	0.042	0.005	0.032, 0.051
	Sub-group: Economic loss	0.148	0.023	0.101, 0.194
	Sub-group: Index	0.070	0.033	0.000, 0.139
	Sub-group: Land-related	0.068	0.012	0.043, 0.093
	Sub-group: Rainfall-related	0.041	0.004	0.033, 0.048
	Sub-group: Temperature-related	0.061	0.008	0.046, 0.076
	Sub-group: Weather-related	0.173	0.039	0.090, 0.256
	Sub-group: Rapid-onset	0.036	0.004	0.029, 0.043
	Sub-group: Slow-onset	0.061	0.004	0.053, 0.070
Weighted average	Overall	0.035	0.000	0.035, 0.035
	Sub-group: Disaster-related	0.035	0.000	0.035, 0.035
	Sub-group: Economic loss	0.116	0.012	0.021, 0.070
	Sub-group: Index	0.071	0.001	0.068, 0.073
	Sub-group: Land-related	0.083	0.001	0.081, 0.085
	Sub-group: Rainfall-related	0.032	0.000	0.032, 0.032
	Sub-group: Temperature-related	0.044	0.000	0.043, 0.044
	Sub-group: Weather-related	0.021	0.000	0.021, 0.021
	Sub-group: Rapid-onset	0.031	0.000	0.030, 0.031
	Sub-group: Slow-onset	0.036	0.000	0.035, 0.036

Note. For the weighted average of the PCC, the square root of the sample size is used as the weight.

Publication bias



Heterogeneity analysis

	Non weighted		Weighted by precision	
	OLS	IV regression	OLS	IV regression
Environmental stressors				
Economic loss-related	-0.175***	-0.173***	0.174+	0.163+
	(0.027)	(0.026)	(0.092)	(0.088)
Index-related	0.036	0.037	-0.422**	-0.435**
	(0.034)	(0.033)	(0.145)	(0.145)
Land-related	0.017	0.018	-0.249+	-0.266*
	(0.025)	(0.025)	(0.133)	(0.127)
Precipitation-related	-0.018	-0.018	-0.232**	-0.246***
	(0.019)	(0.019)	(0.070)	(0.072)
Temperature-related	-0.023	-0.023	-0.231**	-0.244***
	(0.021)	(0.021)	(0.070)	(0.071)
Weather-related	-0.179***	-0.174***	-0.120	-0.130
	(0.036)	(0.036)	(0.096)	(0.098)
Rapid/slow-onset				
Rapid-onset	-0.013	-0.014	-0.113	-0.120
	(0.017)	(0.017)	(0.080)	(0.079)
Study characteristics				
Panel data	-0.040**	-0.040**	-0.034	-0.031
	(0.013)	(0.013)	(0.057)	(0.058)
Probability sample	0.052***	0.052***	-0.192***	-0.169**
	(0.012)	(0.012)	(0.056)	(0.060)
Spatial analysis	-0.023	-0.024	0.008	0.022
	(0.020)	(0.020)	(0.062)	(0.062)
Household level data analysis	-0.017	-0.017	0.369***	0.369***
	(0.012)	(0.012)	(0.073)	(0.073)
Aggregated level data analysis	0.031*	0.032*	0.268***	0.325***
	(0.013)	(0.013)	(0.055)	(0.083)
Non-OECD countries	0.004	0.004	0.011	0.035
	(0.011)	(0.011)	(0.047)	(0.045)
Multi-countries	0.023+	0.022+	0.321***	0.316***
	(0.013)	(0.013)	(0.068)	(0.068)
Dataset time period				
Data from 1980s	0.055**	0.057**	0.445***	0.450***
	(0.020)	(0.020)	(0.129)	(0.122)
Data from 1990s	0.010	0.011	-0.015	-0.011
	(0.013)	(0.013)	(0.018)	(0.019)
Data from 2000s	0.009	0.011	0.234***	0.241***
	(0.017)	(0.016)	(0.067)	(0.072)
Data from 2010s	-0.034	-0.031	0.170	0.265*
	(0.029)	(0.028)	(0.107)	(0.117)
Internal/international migration				
International migration	-0.019+	-0.018+	-0.338***	-0.356***
	(0.011)	(0.011)	(0.061)	(0.070)
Publication characteristics				
Journal article	-0.021	-0.020	-0.105+	-0.161+
Standard error of PCC	0.498***	0.441**	10.509**	1.725
	(0.150)	(0.150)	(3.465)	(5.620)
Observations	1,026	1,026	1,026	1,026
R-squared	0.127	0.127	0.805	0.800

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Subgroup analysis: internal and international migration

	Internal migration		International migration	
	OLS	IV regression	OLS	IV regression
Data from 1980s	0.136	1.023	-0.155***	0.012
	(0.122)	(0.624)	(0.044)	(0.025)
Data from 1990s	-0.235+	0.546	0.044*	-0.032**
	(0.135)	(0.375)	(0.022)	(0.012)
Data from 2000s	-0.251+	0.648	0.531***	0.539***
	(0.145)	(0.429)	(0.128)	(0.142)
Data from 2010s	-0.119	0.194	-0.091***	-0.004
	(0.076)	(0.168)	(0.015)	(0.009)
Non-OECD countries	0.051+	-0.003	0.290**	0.239*
	(0.027)	(0.031)	(0.101)	(0.095)
Multi-countries	-0.022	0.130+	0.749***	0.780***
	(0.018)	(0.078)	(0.132)	(0.173)
Standard error of PCC	-8.436+	20.858	33.122***	-6.756
	(4.385)	(13.845)	(6.133)	(4.123)
Constant	0.259+	-0.680	-0.887***	-0.744***
	(0.148)	(0.452)	(0.153)	(0.168)
Observations	550	550	476	476
R-squared	0.392	0.179	0.762	0.675

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10.

Subgroup analysis: slow- and rapid-onset

	Slow-onset		Rapid-onset	
	OLS	IV regression	OLS	IV regression
Data from 1980s	0.894**	0.793**	-0.034***	-0.034***
	(0.276)	(0.275)	(0.007)	(0.007)
Data from 1990s	0.054*	-0.033	0.010***	0.010***
	(0.026)	(0.039)	(0.001)	(0.001)
Data from 2000s	0.640**	0.545**	0.021***	0.022***
	(0.200)	(0.168)	(0.005)	(0.005)
Data from 2010s	-0.016	0.039	-0.041*	-0.042**
	(0.023)	(0.043)	(0.016)	(0.016)
Non-OECD countries	0.206**	0.260**	-0.028***	-0.027***
	(0.064)	(0.092)	(0.007)	(0.007)
Multi-countries	0.708***	0.679**	-0.015*	-0.015*
	(0.213)	(0.215)	(0.007)	(0.007)
Standard error of PCC	14.888*	-5.033	1.473***	1.511***
	(6.393)	(8.646)	(0.329)	(0.331)
Constant	-0.765**	-0.645***	0.006	0.005
	(0.237)	(0.196)	(0.008)	(0.008)
Observations	811	811	215	215
R-squared	0.659	0.636	0.290	0.290

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10.

Subgroup analysis: OECD and non-OECD countries

	Non-OECD countries		OECD countries	
	OLS	IV regression	OLS	IV regression
Data from 1980s	0.212	1.247+	1.329***	-2.204**
	(0.141)	(0.700)	(0.380)	(0.754)
Data from 1990s	-0.194+	0.689	1.128**	-2.050**
	(0.106)	(0.427)	(0.350)	(0.701)
Data from 2000s	-0.214+	0.817+	1.917***	-1.271*
	(0.120)	(0.496)	(0.412)	(0.576)
Data from 2010s	-0.082	0.394+		
	(0.071)	(0.237)		
Rapid-onset	-0.029	-0.002	0.143+	1.212***
	(0.022)	(0.030)	(0.080)	(0.335)
Standard error of PCC	-7.420*	23.308	62.066***	-41.876*
	(3.762)	(14.859)	(10.818)	(17.913)
Constant	0.264+	-0.866	-2.002***	1.332*
	(0.139)	(0.546)	(0.425)	(0.600)
Observations	449	449	233	233
R-squared	0.366	0.142	0.747	0.421

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10.

Takeaways

- Environmental migration is increasing, the effect of environmental change on migration is relatively small
- There is a publication bias towards positive relations between environmental change and migration
- There are spatial-temporal variations in the effect of environmental change on migration

Thanks

Questions and suggestions?

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Appendix A. Environmental stressors by type and velocity

Environmental stressors by type:

- Weather-related stressors: drought, flood, monsoon, precipitation, temperature, air, humidity, wind, and sea-level rise
- Disaster-related stressors: earthquake, fire, hurricane, landslide, storm, tsunami
- Land-related stressors: deforestation, desertification, land and soil salinity
- Economic loss: crop and economic loss and property damage from environmental factors
- Index: Environmental/Climate Change Impact Index, Normalized Difference Vegetation Index (NDVI), Standardized Precipitation-Evapotranspiration Index (SPEI)

Environmental stressors by velocity:

- Slow-onset: air, deforestation, desertification, drought, temperature, precipitation, wind, humidity, index, land and social salinity, crop and economic loss, monsoon, sea-level rise
- Rapid-onset: the remaining environmental factors that are not slow-onset stressors

Appendix B. Studies included in the meta-analysis

See online appendix:
https://github.com/shuai-zhou/PaperDocs/blob/main/EnvMigMetaAnalysis_Appendix%20B.pdf