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 and environmental migration

- Temporary migrants prefer short-distance migration, while permanent migrants are following preexisting social ties regardless of the moving distance (Hauer, Holloway, and Oda 2020)

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

- Environmental factors are the least important in determining internal migration but are most influential for international migration (Gray and Bilsborrow 2013)

The measures of environmental factors and environmental migration

- Rapid-onset extreme disasters tend to trigger 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 tend to incur short-distance and temporary migration, but the main purpose of migration is to diversify livelihood strategies (Findlay 2011; Fussell et al. 2014)

- Using environmental indicators or indices makes a difference because they provide different types/levels of information (Cutter 2016)

Methodological approaches and environmental migration

1. Qualitative studies help identify the environmental challenges and identify the multicausality of environmental migration (Borderon et al. 2019; Piguet 2010)

2. Quantitative studies help quantify the effect of various environmental factors on migration

    1) Multivariate regression and multilevel analysis

    2) Agent-based model (ABM)

    3) Spatial method

Place-specific characteristics and environmental migration

- In developing countries, environmental migration is primarily economic-driven, while environmental factors play a secondary role (Codjoe et al. 2017; Bohra-Mishra, Oppenheimer, and Hsiang 2014)

- Environmental migration is also related to place-specific migration networks (Hunter, Murray, and Riosmena 2013) and natural and social capital (Hunter et al. 2017; Gray 2009)

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 (a standardized effect size)

Z_{kij} = Covariate vectors

se_{ij} = Standard error of the PCC_{ij}

ε_{ij} = Error term

Meta-regression analysis (Cont.)

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

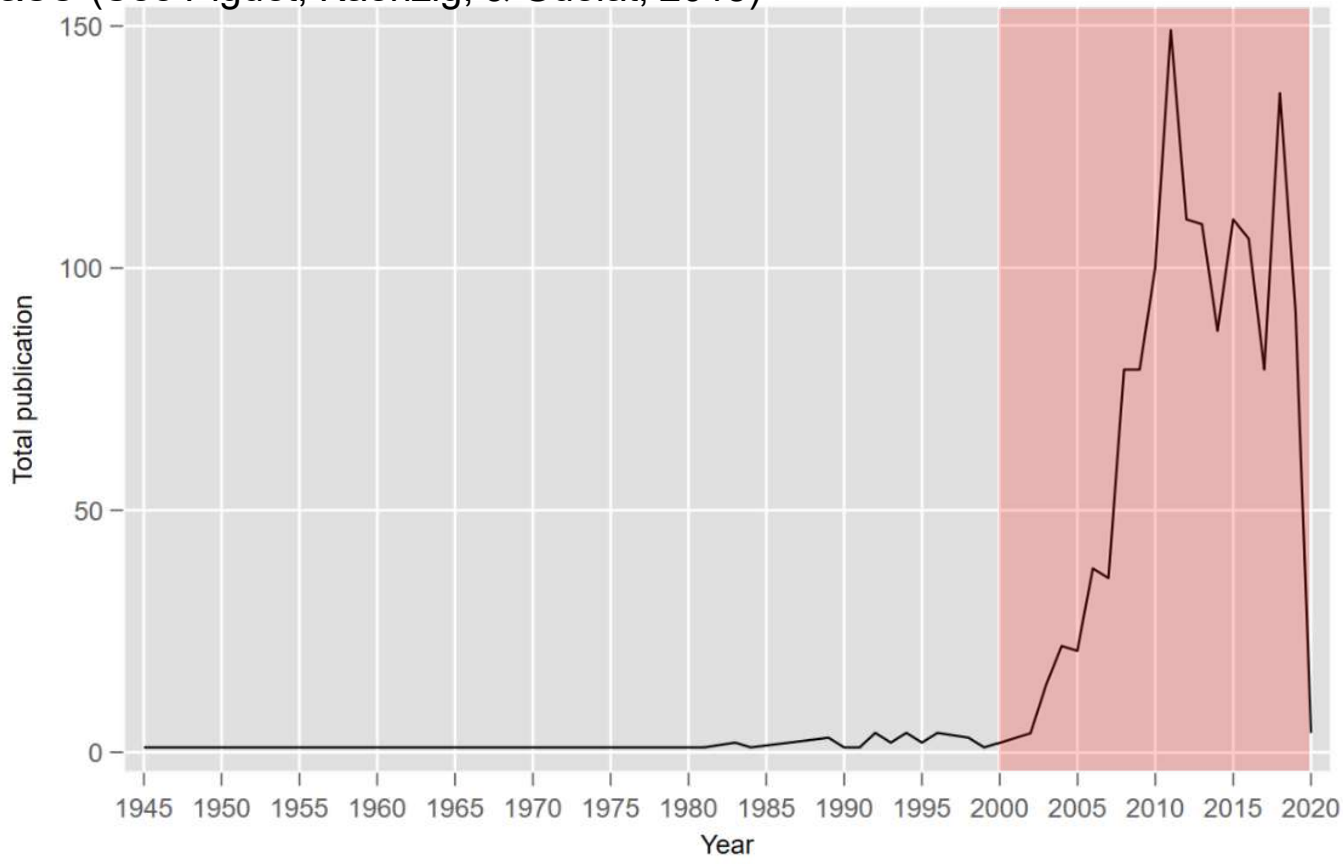
$$W_i = \frac{1}{{SE_{PCC_i}}^2}$$

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

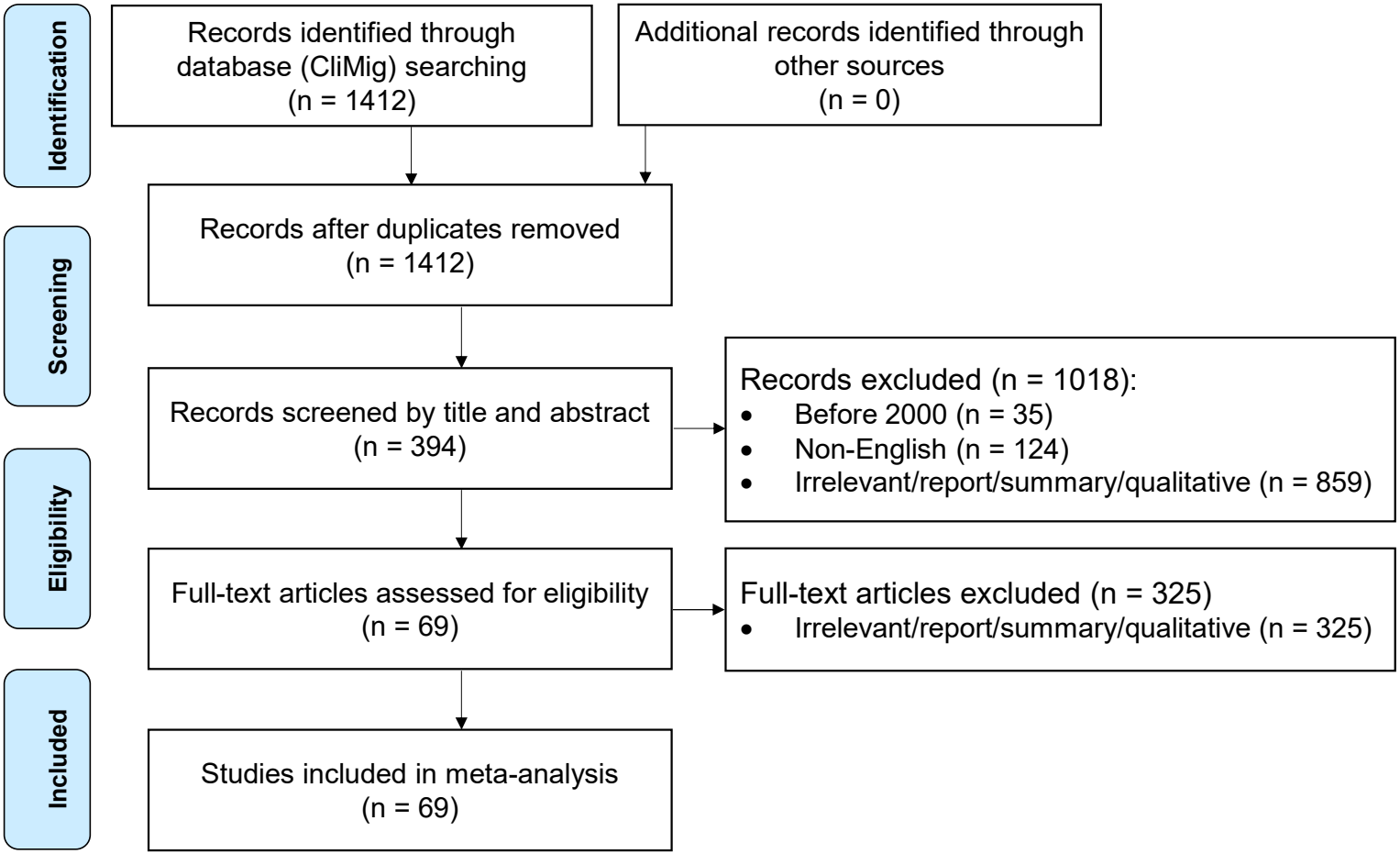
$$Instrumental\ Variable = \frac{1}{\sqrt{df}}$$

Data

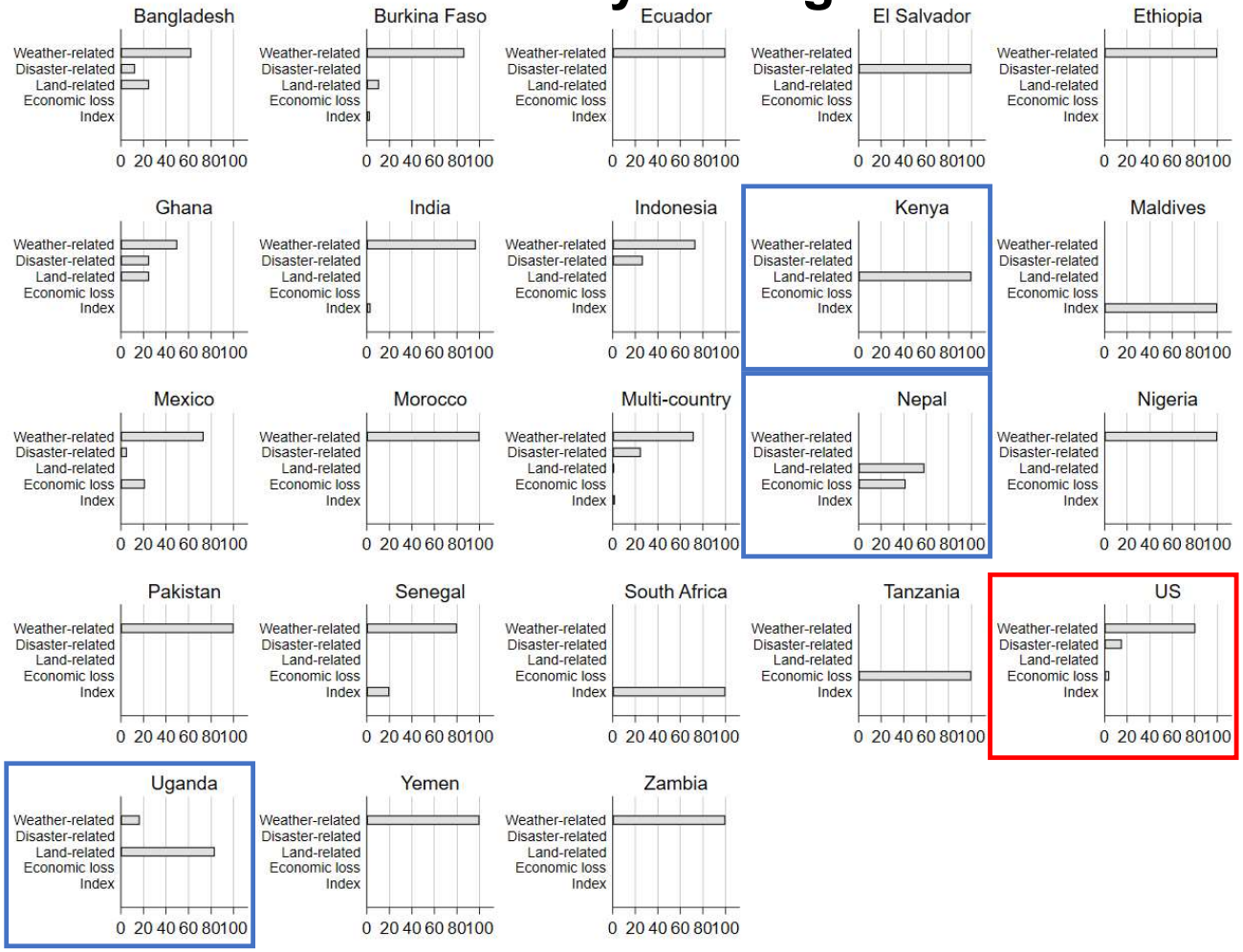
CliMig database (See Piguet, Kaenzig, & Guélat, 2018)



PRISMA flow diagram



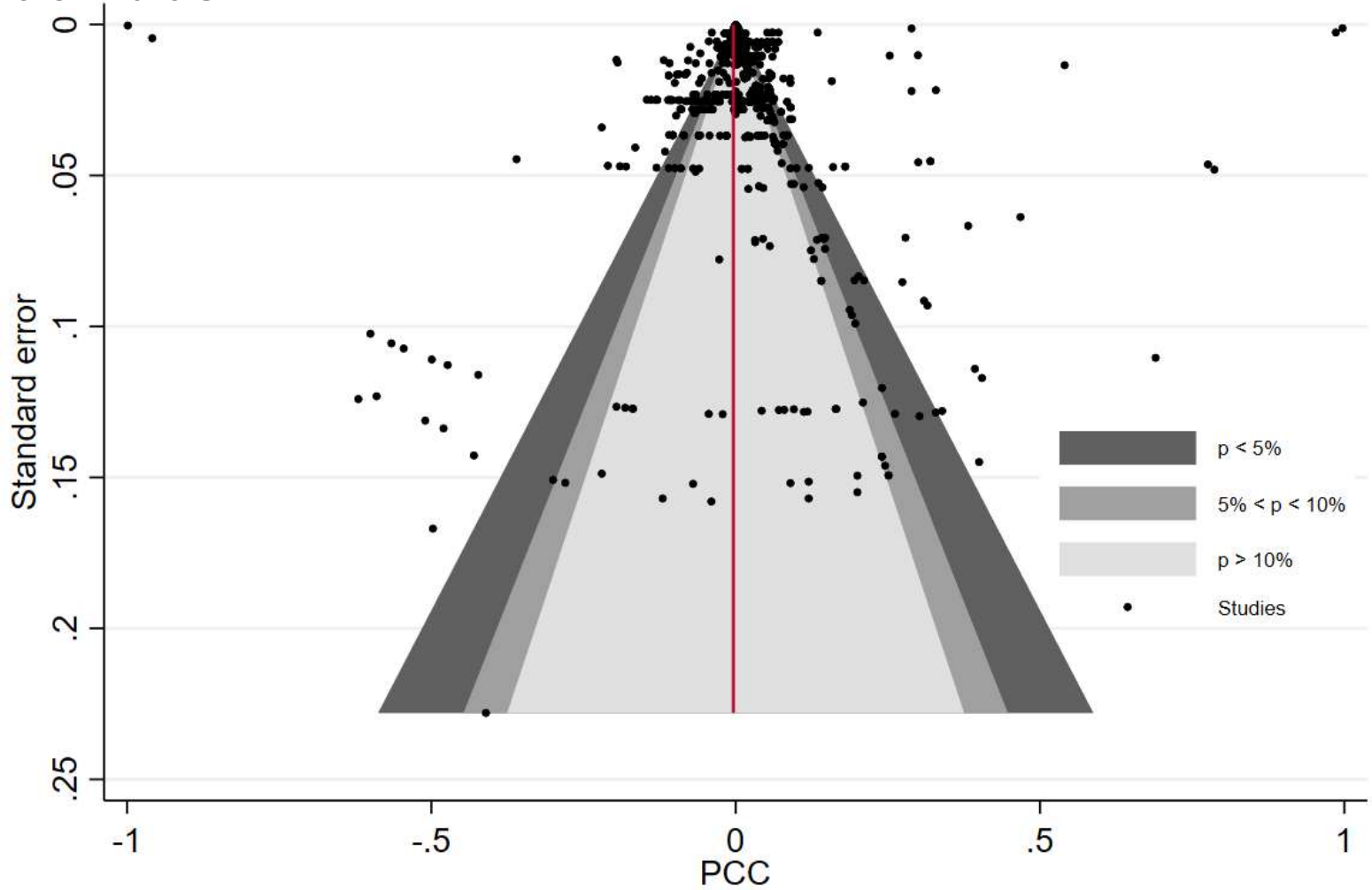
Environmental factors across study settings



Overall trend in the environmental migration literature

	Out-migration	In-migration	Net migration
Insignificant	564	8	71
Significant	315	19	55
Positive	191 (60.63%)	4 (21.05%)	21 (38.18%)
Negative	124 (39.37%)	15 (78.95%)	34 (61.82%)
Total	879	27	126

Publication bias



Unweighted and weighted absolute value of PCC

Environmental stressors	Unweighted average PCC	Weighted average PCC
Overall	0.055	0.006
Subgroup by types		
Weather related	0.052	0.006
Disaster related	0.037	0.005
Land related	0.068	0.015
Economic loss	0.142	0.016
Index	0.070	0.011
Subgroup by velocity		
Rapid onset	0.061	0.006
Slow onset	0.033	0.005

Heterogeneity analysis

	Non-weighted		Weighted by precision	
	OLS	2SLS	OLS	2SLS
Weather-related	–0.057*	–0.057*	0.204**	0.211*
Disaster-related	–0.041	–0.041	0.333**	0.359**
Land-related	–0.013	–0.013	0.201+	0.202+
Economic loss	–0.180***	–0.180***	0.648***	0.655***
Rapid-onset	–0.009	–0.010	–0.086	–0.098
International migration	–0.011	–0.010	–0.343***	–0.361***
Net migration	0.010	0.010	–0.690***	–0.584**
Out migration	–0.004	–0.005	–0.167*	–0.142+
Panel data	–0.039**	–0.039**	0.015	0.006
Probability sample	0.052***	0.052***	–0.148**	–0.124*
Spatial analysis	–0.020	–0.022	0.166**	0.166**
Household level data	–0.015	–0.015	0.407***	0.403***
Aggregated level data	0.032*	0.033**	0.225***	0.289***
OECD countries	–0.032*	–0.030+	–0.369***	–0.363***
Non-OECD countries	–0.017	–0.016	–0.420***	–0.381***
Dataset from 1980s	0.068***	0.070***	0.581***	0.567***
Dataset from 1990s	0.018	0.020	–0.053*	–0.047*
Dataset from 2000s	0.019	0.021	0.244***	0.252***
Dataset from 2010s	–0.019	–0.016	0.076	0.189*
Peer-reviewed journal article	–0.003	–0.002	–0.051	–0.104+
Standard error of the PCC	0.241	0.185	14.396***	4.166
N	1,032	1,032	1,032	1,032
R-squared	0.100	0.099	0.819	0.814

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, +$p < 0.10$

Subgroup analysis: environmental impacts on out-migration

- Rapid-onset environmental factors are more likely to trigger out-migration
- Environmental effects on out-migration varied from the 1980s to 2010s
- Environmental factors are more likely to trigger internal migration than international migration
- Developed countries are less likely to experience environmental migration

	OLS	2SLS
Rapid onset	0.115**	0.116**
Dataset from 1970s	—	—
Dataset from 1980s	0.724**	0.683**
Dataset from 1990s	–0.103**	–0.137**
Dataset from 2000s	0.366***	0.334***
Dataset from 2010s	–0.165**	–0.076
International migration	–0.219***	–0.201***
Multi-country	—	—
OECD countries	–0.118**	–0.160**
Multi-countries	0.434***	0.387***
Standard error of the PCC	19.576***	6.025
N	879	879
R-squared	0.724	0.712

***p < 0.001, **p < 0.01, *p < 0.05, +p < 0.10

Takeaways

- The environmental impact on migration is small
- The environmental effects on migration vary from the 1980s to 2010s
- Rapid-onset environmental stressors are more likely to trigger out-migration, and these migrations tend to be internal migration
- Developed countries are less likely to experience environmental migration compared to developing counties

Future directions

- Focus more on weather-related environmental stressors
- Collect longitudinal and representative data, and apply spatial methods
- Combat environmental changes, develop economy and new technologies, and build resilience toward environmental changes

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