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 (Chi, xxxx)

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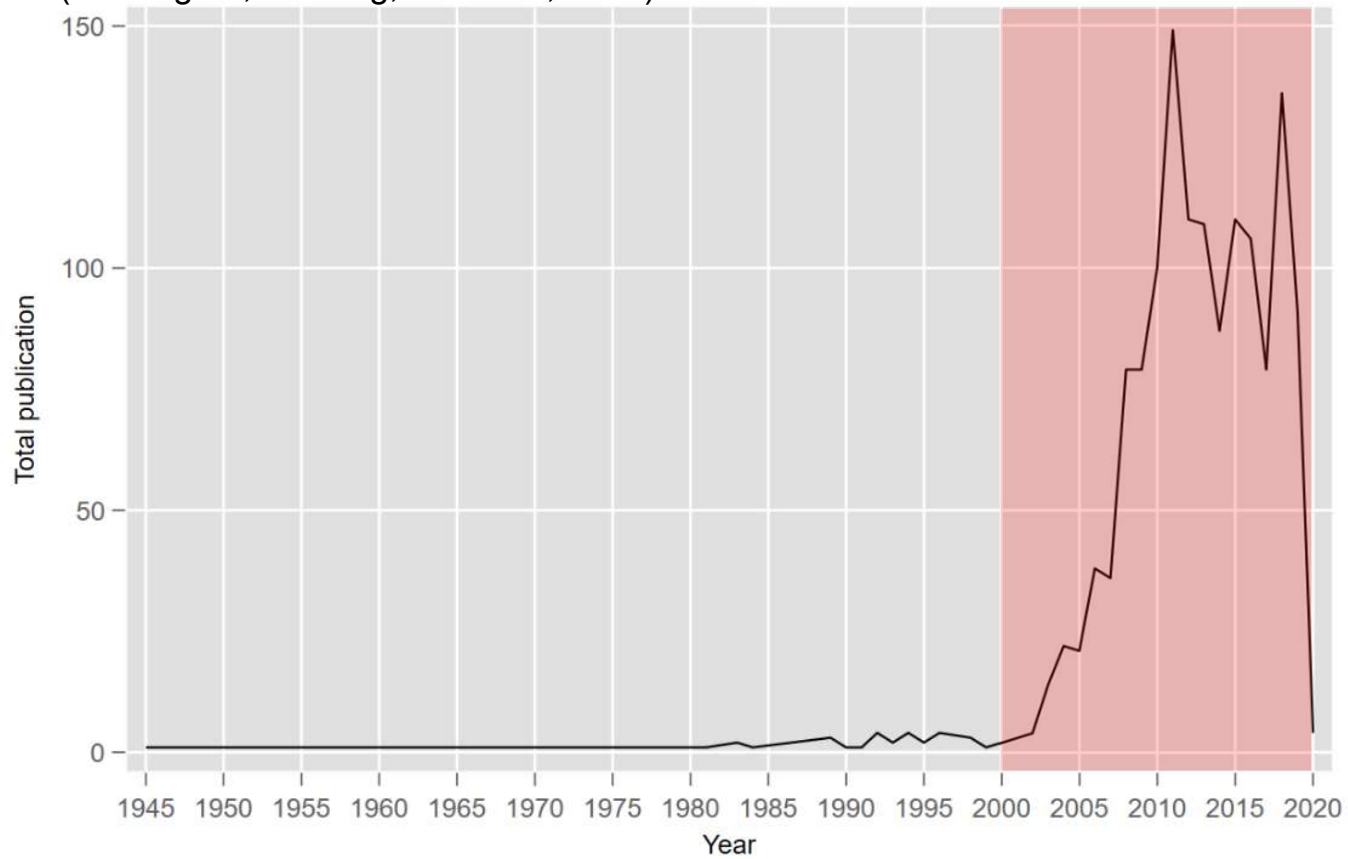
$$W_i = \frac{1}{SE_{PCC_i}{}^2}$$

To correct for endogeneity resulted from selecting literature and omitting variables, we applied instrumental variables:
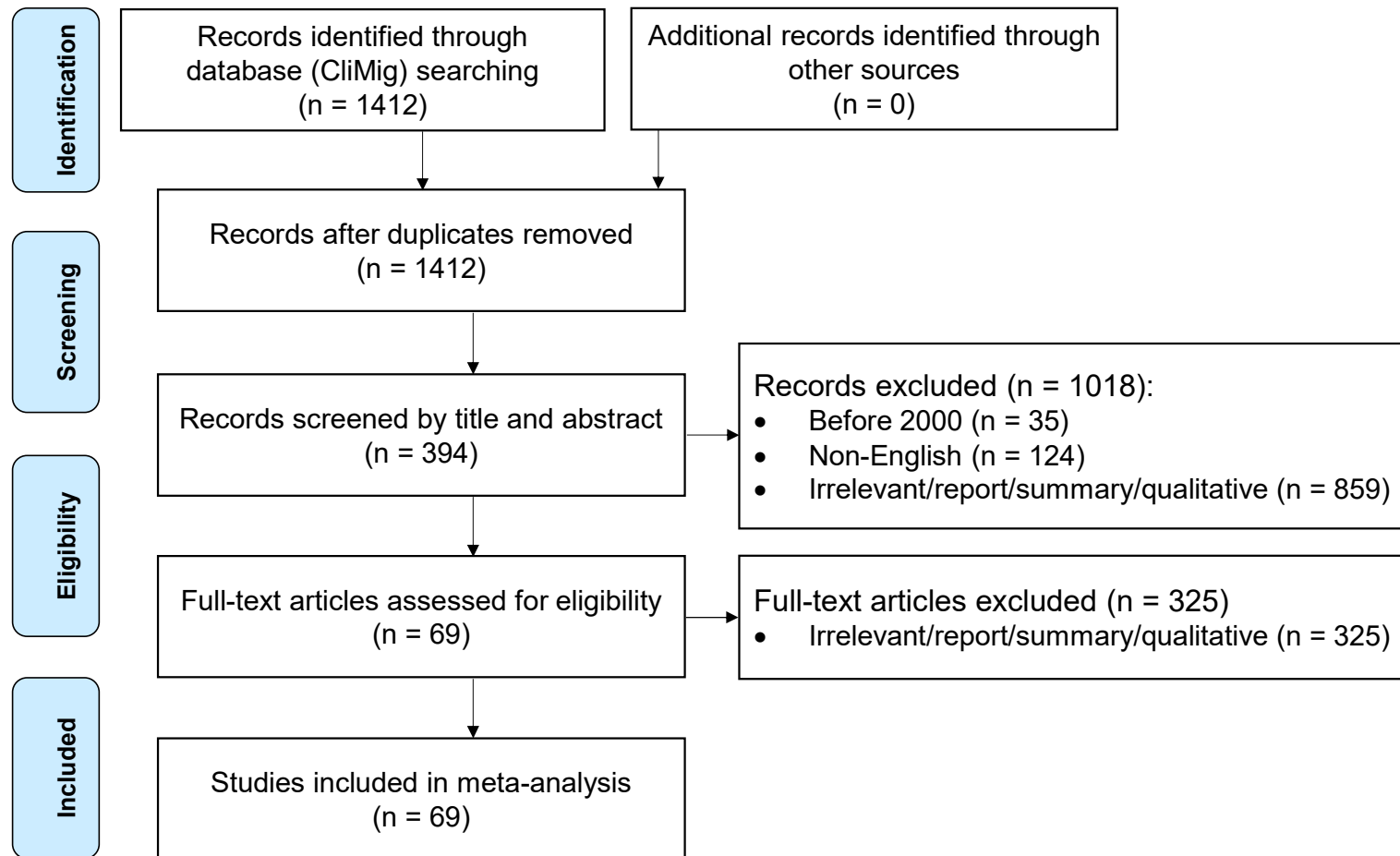
$$Instrumental\ Variable = \frac{1}{\sqrt{df}}$$

Data

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

PRISMA flow diagram

| Identification | Records identified through database (CliMig) searching (n = 1412) | Additional records identified through other sources (n = 0) |

| Screening | Records after duplicates removed (n = 1412) | |

| Screening | Records screened by title and abstract (n = 394) | Records excluded (n = 1018):
• Before 2000 (n = 35)
• Non-English (n = 124)
• Irrelevant/report/summary/qualitative (n = 859) |

| Eligibility | Full-text articles assessed for eligibility (n = 69) | Full-text articles excluded (n = 325)
• Irrelevant/report/summary/qualitative (n = 325) |

| Included | Studies included in meta-analysis (n = 69) | |

Overall trend in the environmental migration literature

|	Out-migration	In-migration	Net migration
Insignificant	564 (64.16%)	8 (29.63%)	71 (56.35%)
Significant	315 (35.84%)	19 (70.37%)	55 (43.65%)
Positive	191 (60.63%)	4 (21.05%)	21 (38.18%)
Negative	124 (39.37%)	15 (78.95%)	34 (61.82%)
Total	879	27	126

Environmental factors across study settings
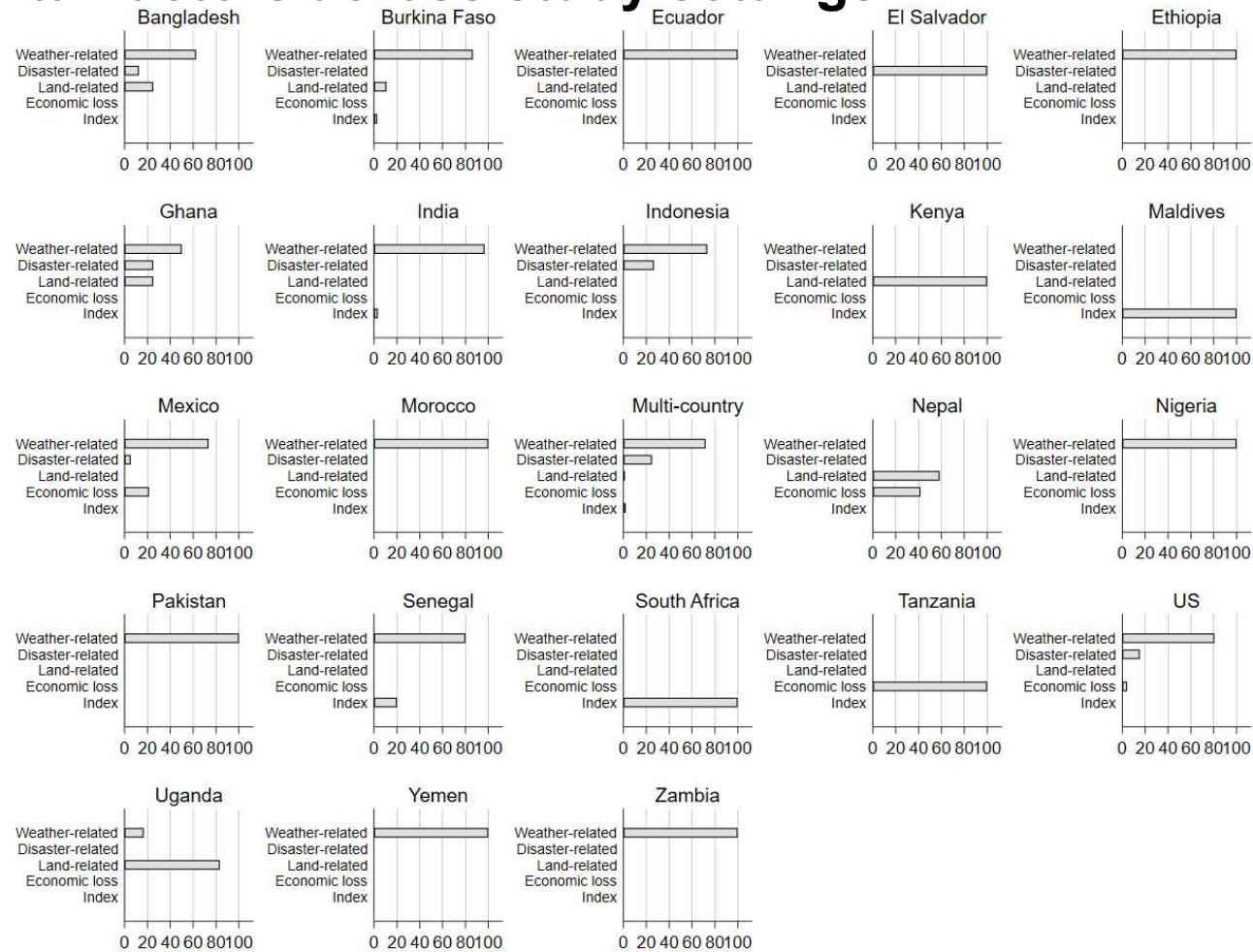
Unweighted and weighted PCC

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

Publication bias

RSS 2021
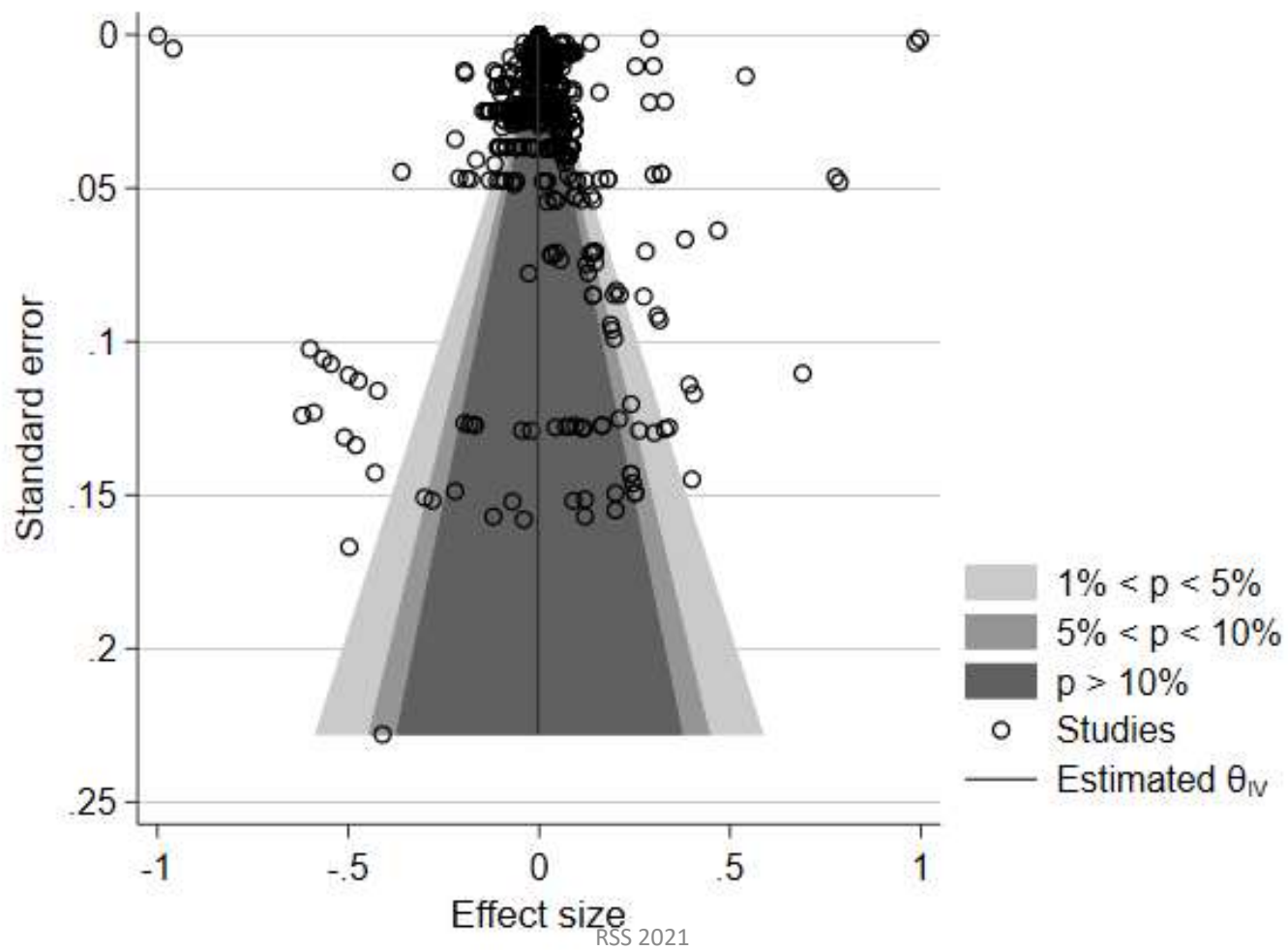
Heterogeneity analysis

	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

	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

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

Environmental stressors by velocity:
- <u>Slow-onset</u>: air, deforestation, desertification, drought, temperature, precipitation, wind, humidity, index, land and social salinity, crop and economic loss, monsoon, sea-level rise
- <u>Rapid-onset</u>: 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