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# Climate change, internal migration and depopulation: evidence from global census data

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**Wittgenstein Centre Conference 2021**

The causes and consequences of depopulation

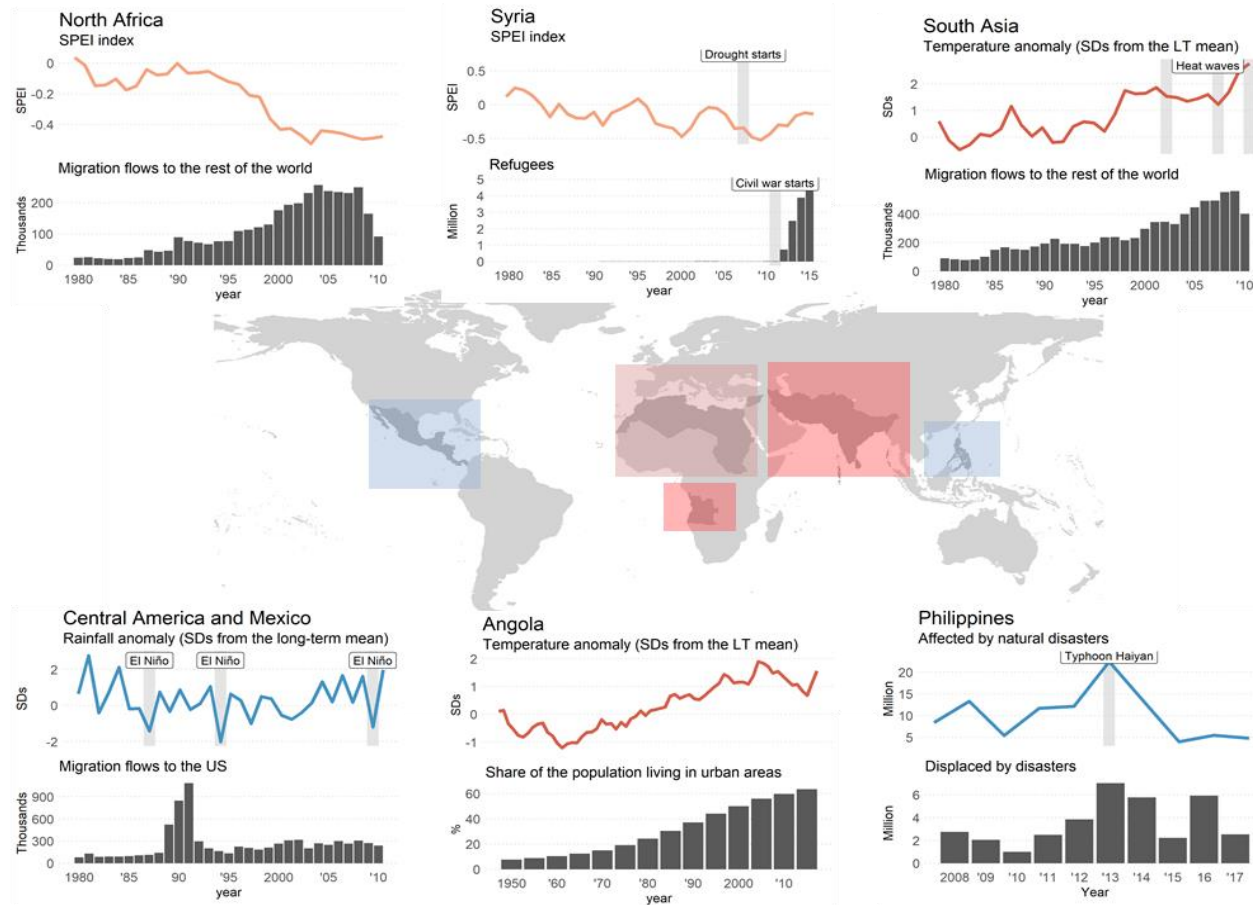
29th of November 2021

# Motivation



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In many regions of the world, changes in environmental and climatic conditions are linked to migration dynamics and human mobility

Strength and direction of the relationship depend on local conditions and type and intensity of the experienced environmental influences

Source: Hoffmann et al. (2020), Nature Climate Change

# Aims and contribution



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- ➔ Estimating the **impact of gradual aridification and desertification processes on internal migration** flows worldwide
- ➔ **Using novel data source on bilateral internal migration flows** from 68 countries based on harmonized IPUMS International census data
- ➔ **Exploring mechanisms and differences across contexts** to understand who migrates, under which conditions, and to which locations

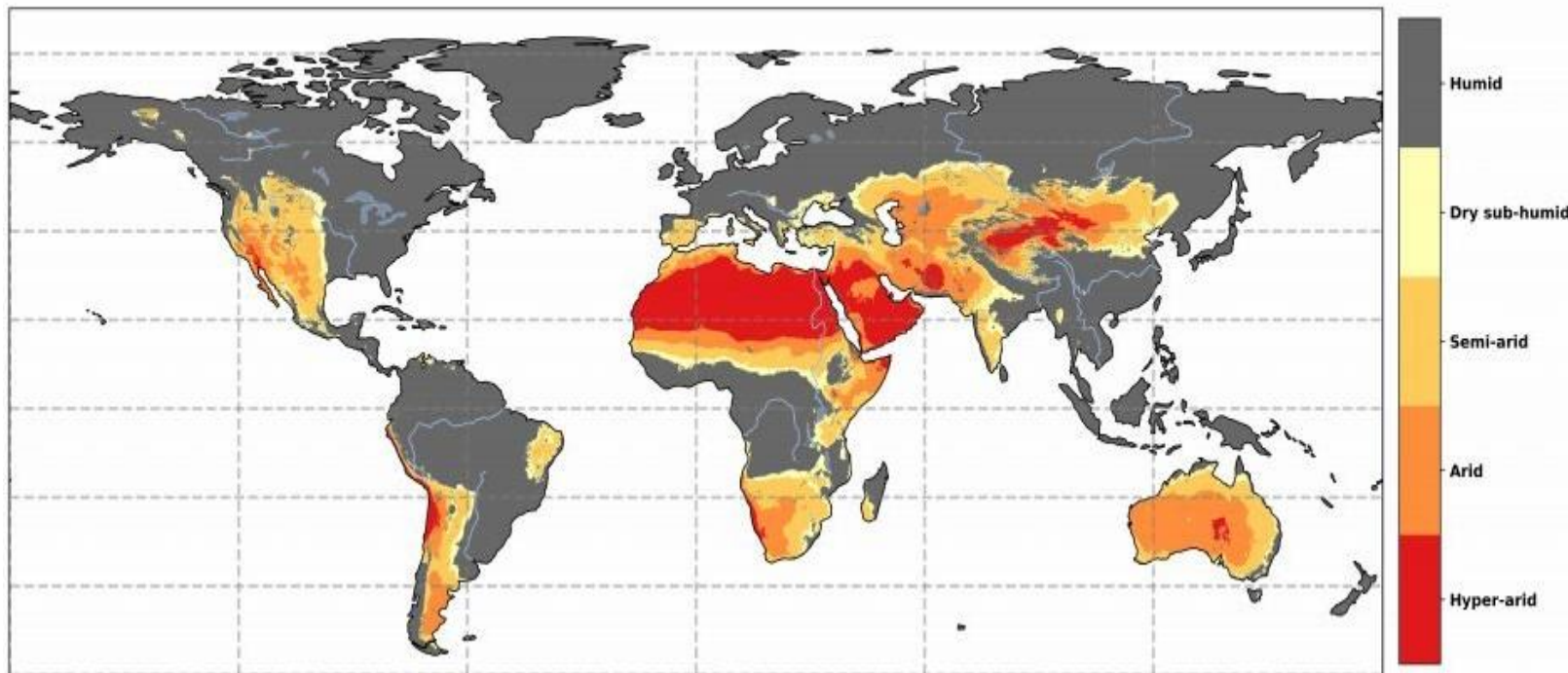
Approach closely related to Garcia et al. 2015: “Modeling internal migration flows in sub-Saharan Africa using census microdata”, Migration Studies

# Aridity and land degradation



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Already today, large parts of the world are characterized by aridity and high temporal and spatial rainfall variability

Drylands comprise more than **40% of the global terrestrial area** and are home to around 3 billion people or one third of the global population

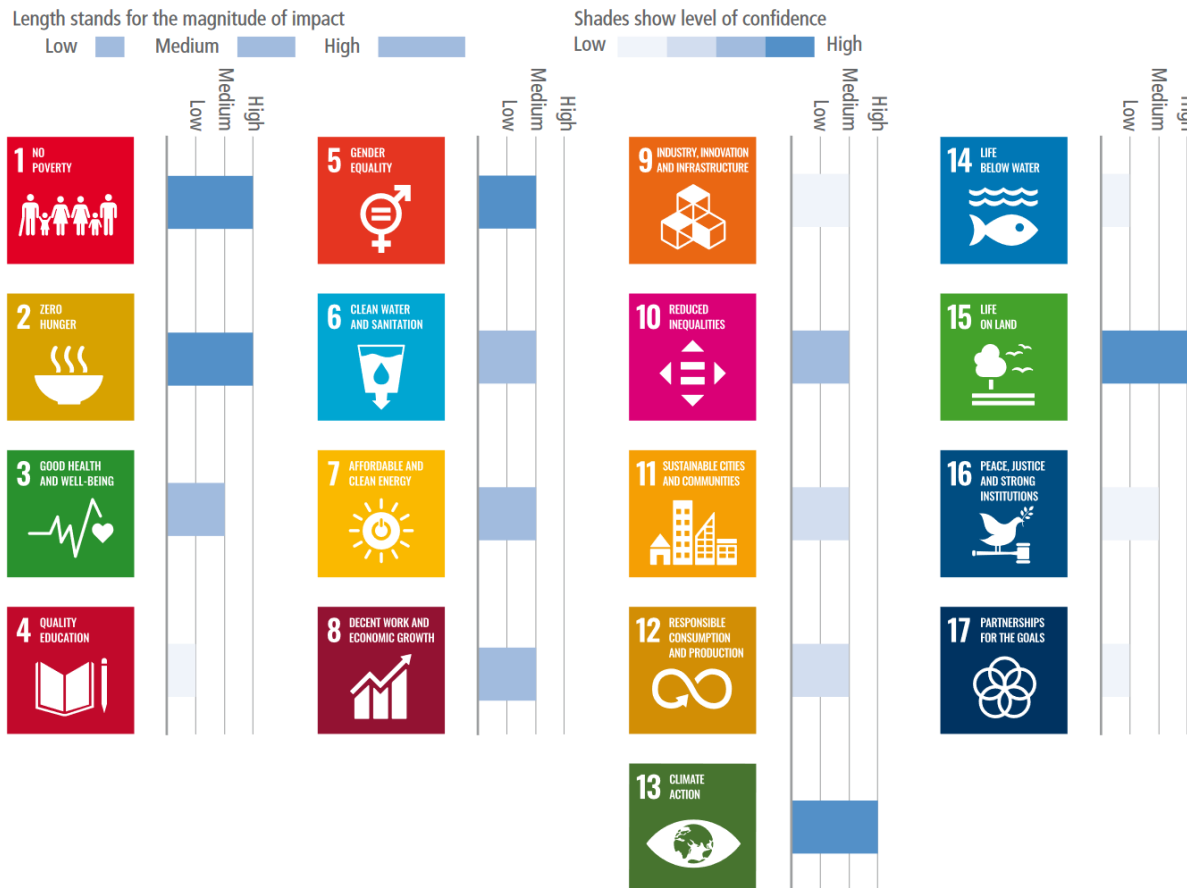
Source: IPCC (2019), Special Report on Climate Change and Land

# Potential socioeconomic impacts



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Climate change is **expected to further increase aridity**, potentially contributing to a further expansion of drylands (together with human factors)

Increased aridity and land degradation can have **severe socioeconomic impacts**

Strong impacts expected on **food security, poverty, and biodiversity** (all with high confidence)

Source: IPCC (2019), Special Report on Climate Change and Land



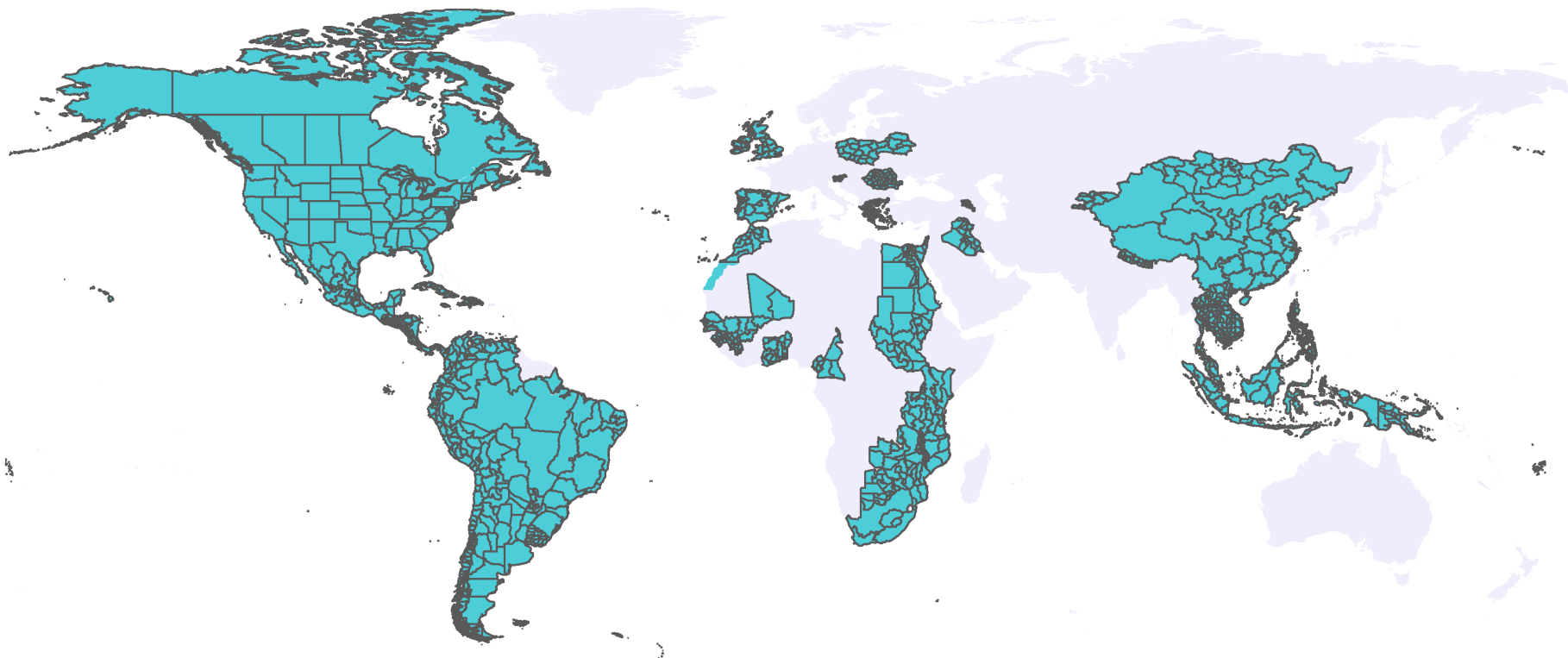
- **IPUMS International** as primary data source providing harmonized census data from more than 100 countries worldwide
- **Construction of migration measure:**
  - Information on subnational region of residence
  - Census question: Which region did you live in 1/5 years ago?
  - How many people have migrated from region A to B in past 1/5 years?
- **Unit of analysis:** Geo1 census regions over time
- **Climate data** on desertification trends from CGIAR, the Copernicus Programme, and CRU

# Regional sample



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**1284 Geo1 census regions**



68 countries

188 censuses

**Time series:**

Census data available from  
1960 to 2015

~98000 bilateral flows

Data availability  country not included  country included

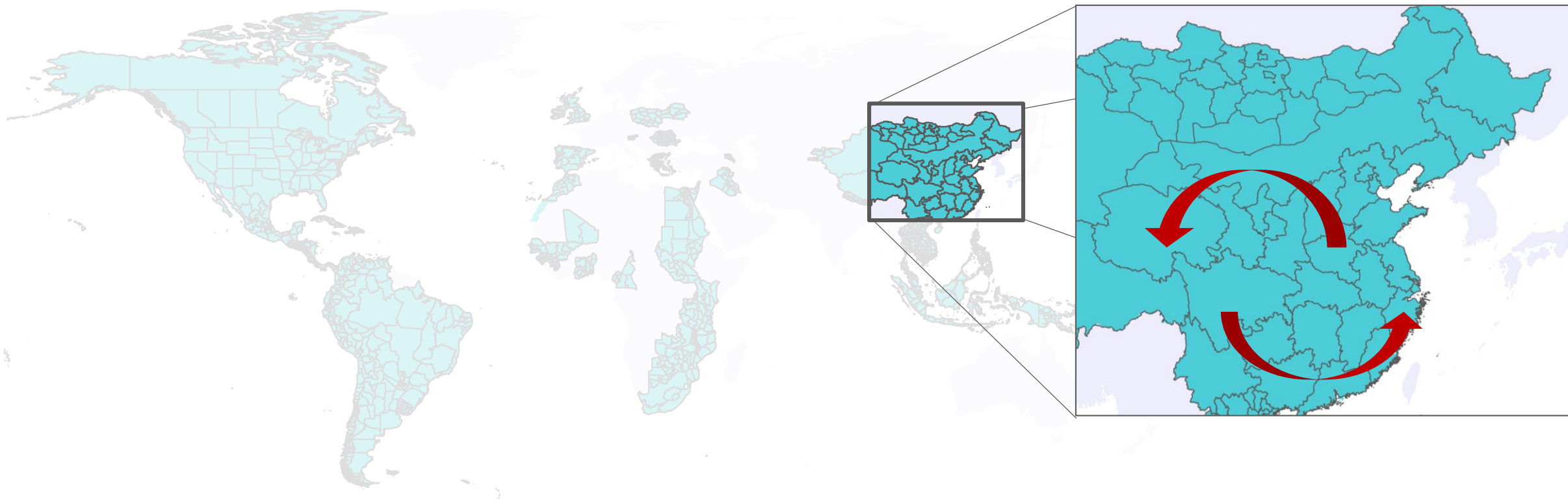




# Regional sample



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Data availability  country not included  country included

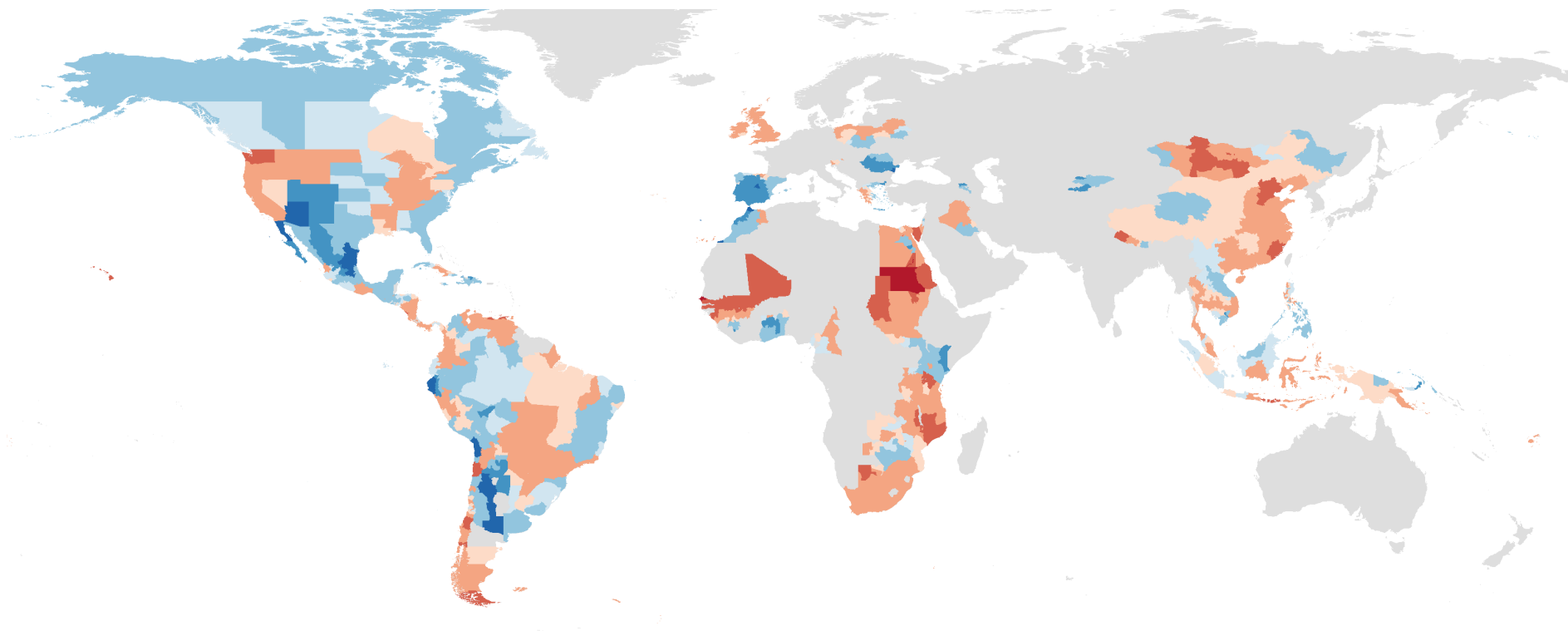


# Aridification trends



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Change in aridity in percent (1950-2010)

< -50%	-25% to -5%	0% to 5%	25% to 50%
-50% to -25%	-5% to 0%	5% to 25%	> 50%



- **Outcome:** Annual out-migration rate
- **Measures for aridification:**
  - Aridity Index (AI), average past 10 years
  - Normalized Density Vegetation Index (NDVI), average past 10 y
  - Standardised Precipitation Evapotranspiration Index (SPEI), average past 10 y
- **Controls:**
  - Population size (origin and destination)
  - Census interval for migration measurement (1 vs 5 years)

# Poisson fixed effects estimation (PPML)



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$$\ln \left( \frac{N_{ij,t}}{N_{ii,t}} \right) = \beta C_{it} + \theta C_{jt} + \gamma Z_{ij,t} + \alpha_i + \delta_j + \theta_t + \varepsilon_{ij,t}$$

$\frac{N_{ij,t}}{N_{ii,t}}$ : Annual outmigration rate (relative to origin population)

$C_{it}$ : Climatic conditions in origin in past 10 years (standardized)

$C_{jt}$ : Climatic conditions in destination in past 10 years (standardized)

$Z_{ij,t}$ : Further census specific controls

$\alpha_i$ : Origin fixed effects

$\delta_j$ : Destination fixed effects

$\theta_t$ : Time period effects (5 year intervals)

$\varepsilon_{ij,t}$ : Random error term

# Baseline PPML models



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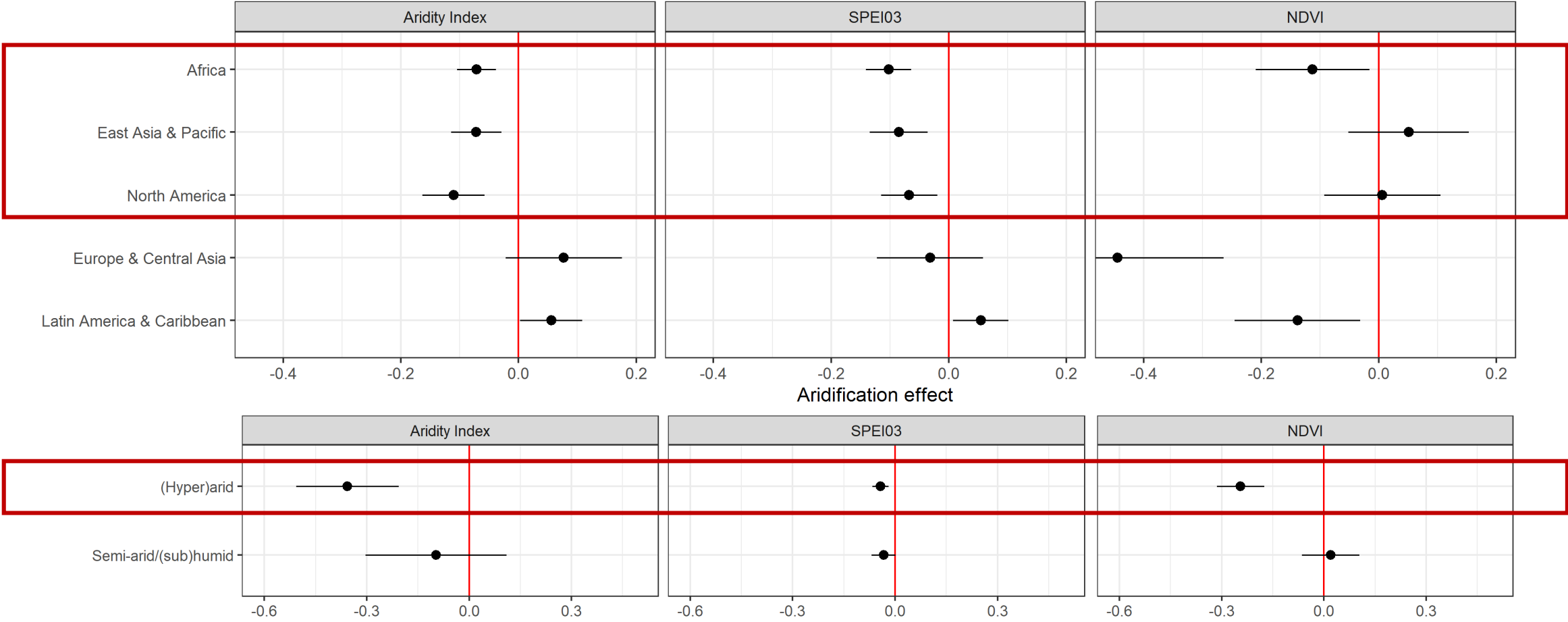
	Outcome: Annual out-migration rate			
	(1)	(2)	(3)	(4)
AI (mean past 10y)		-0.1456*** (0.03627)		
NDVI (mean past 10y)			-0.0001 (0.0001)	
SPEI (mean past 10y)			-0.0001 (0.0001)	
log(population origin)	-0.8452*** (0.0706)	-0.7934*** (0.0666)	-0.8452*** (0.0706)	-0.7934*** (0.0666)
log(population destin)	0.1872*** (0.0590)	0.1138** (0.0537)	0.1872*** (0.0590)	0.1138** (0.0537)
Census interval	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Origin FE	Yes	Yes	Yes	Yes
Destination FE	Yes	Yes	Yes	Yes
S.E.: Clustered	by: origin	by: origin	by: origin	by: origin
Observations	98,868	95,276	42,563	98,850
Pseudo R2	0.20017	0.16484	0.17398	0.16381
BIC	32,415.70	31,511.60	22,479.20	32,414.60

Significant and sizeable effects of aridification on outmigration

1 SD increase in aridity in a region leads to a 14.6% increase in the outmigration rate

Poisson Fixed effects models. Coefficients in cells with clustered standard errors in parentheses. \*\*\* p< 0.01, \*\* p<0.05, \* p<0.01

# Effect size heterogeneity

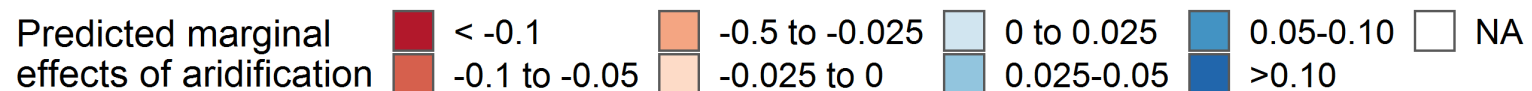
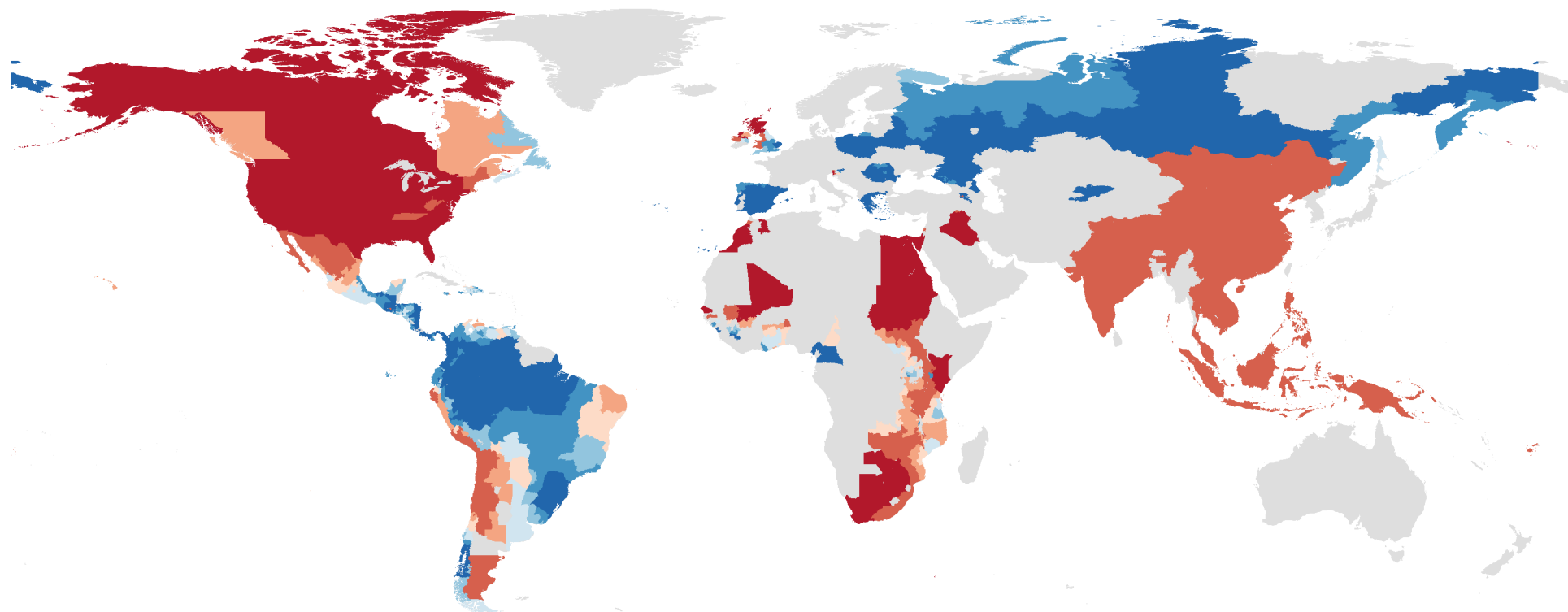


# Spatial patterns in relationships



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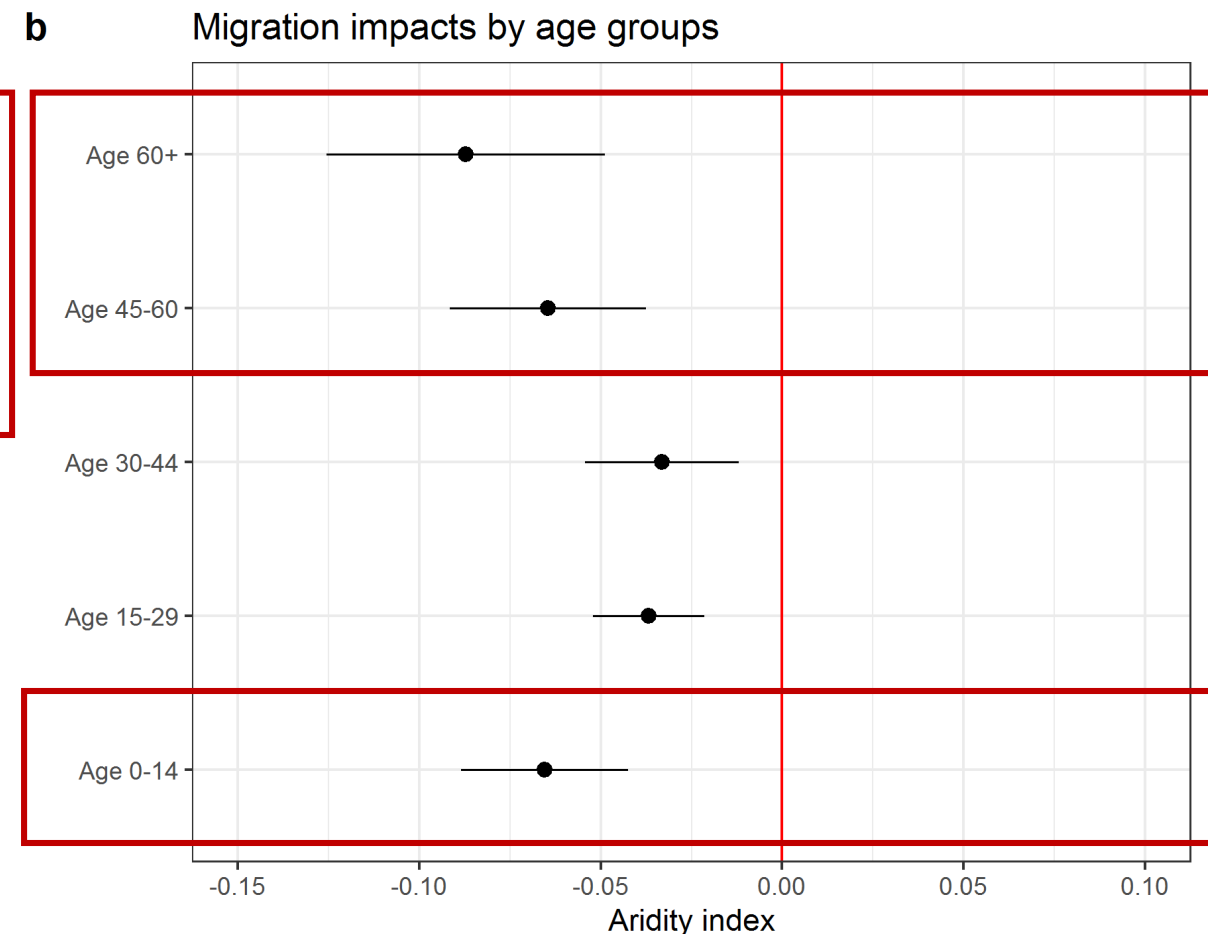
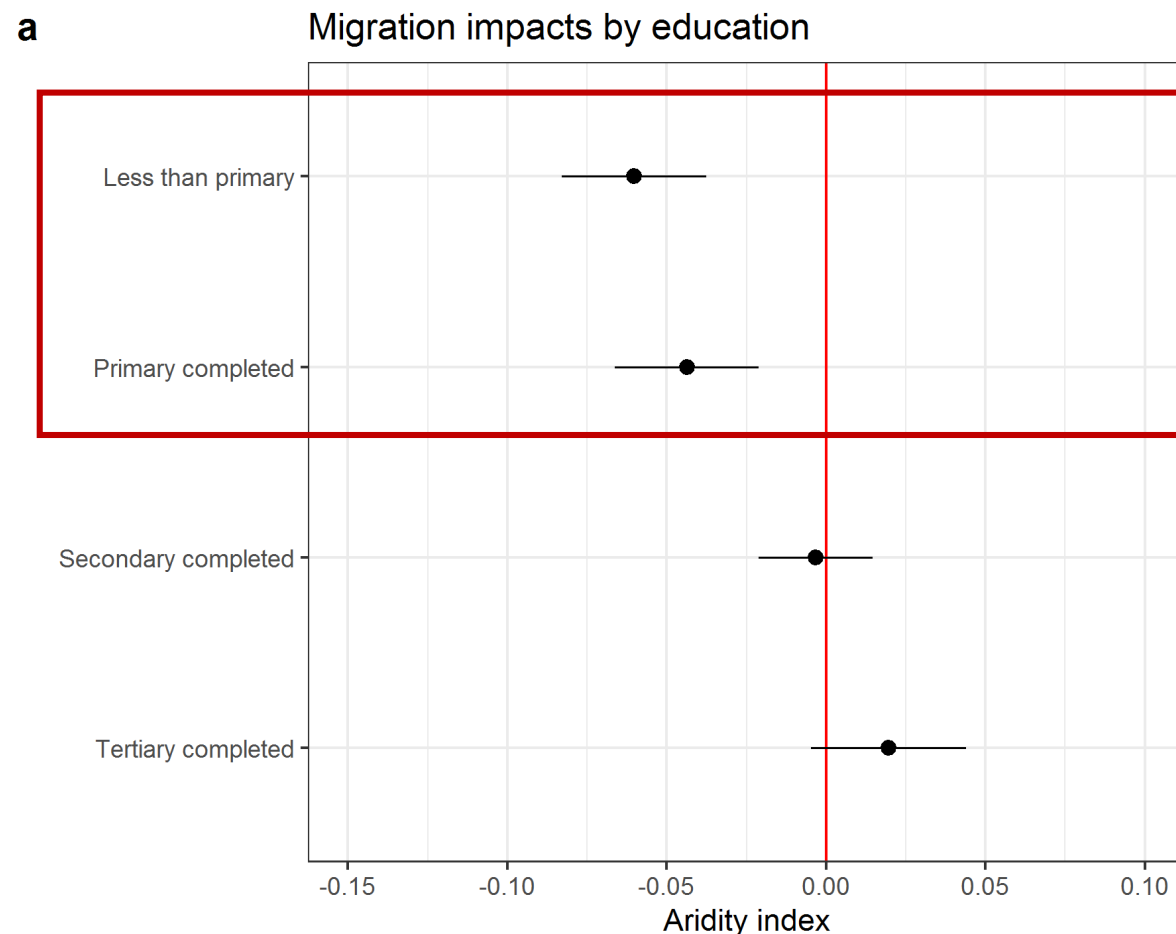


# Differential migration impacts



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- Study on impacts of aridification as gradual environmental change on internal migration using novel global data on bilateral internal migration flows
- Findings indicate **meaningful migration impacts**, but also considerable differences across regions depending on environmental and socio-economic conditions
- **Limitations:**
  - Broad migration measure
  - Not accounting for circular migration
  - International migration flows not captured
- **More comparative evidence** needed that allows understanding some of the underlying mechanisms of environmental migration and its impacts on depopulation



# Thank you for your attention!



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# Migration in Sub-Saharan Africa



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