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science for global insight

Global climate and development hotspots assessment: Asia under pressure

Dr Edward Byers

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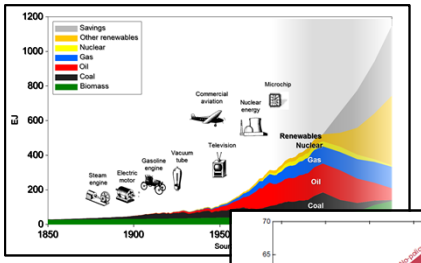
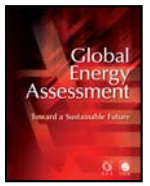
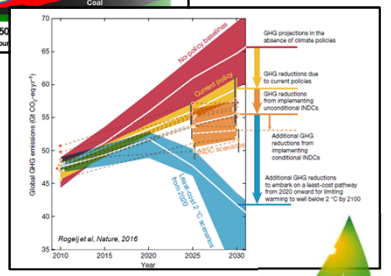
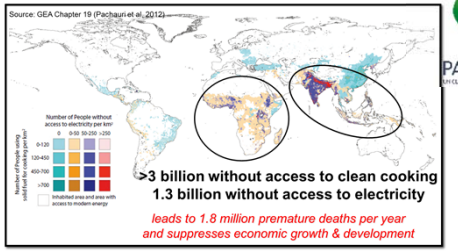
Energy Program Core Competencies

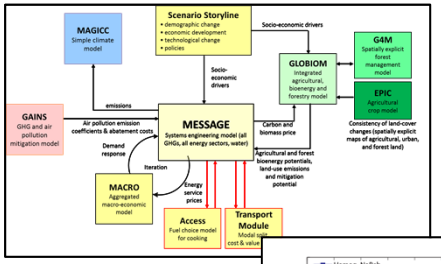
- Energy and climate policy analysis (scenarios)
  - Globally comprehensive, Multi-sector (all energy/industry + ag/forestry/land), Multi-GHGs/SLCFs
  - Paris Agreement (NDCs + below 2 °C)
  - Activities ranging from IPCC, IAMC, UNEP, RCPs+SSPs, Global Energy Assessment (GEA), CD-LINKS, TWI2050
- Energy linkages with other sustainability objectives (policy synergies & trade-offs)
  - (1) Water-Energy-Land nexus, (2) Air quality and health, (3) Poverty and inequality
- Combining both modeling and empirical work (greater tech. and social detail)
  - e.g., MESSAGE integrated assessment framework
  - Improving representation of consumer heterogeneity and behavior in end-use/demand (policy 'nudges')

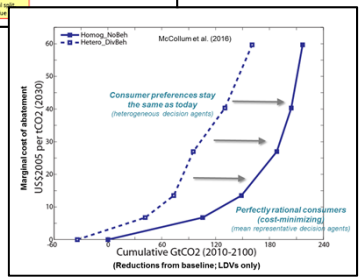












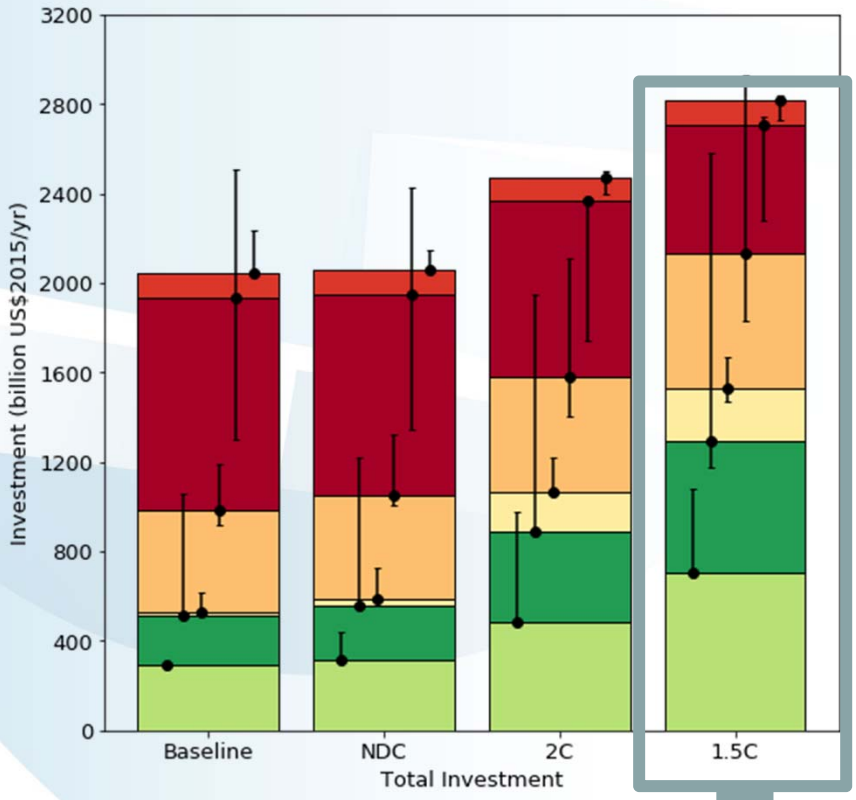

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Catalysing sustainable development via SDG7

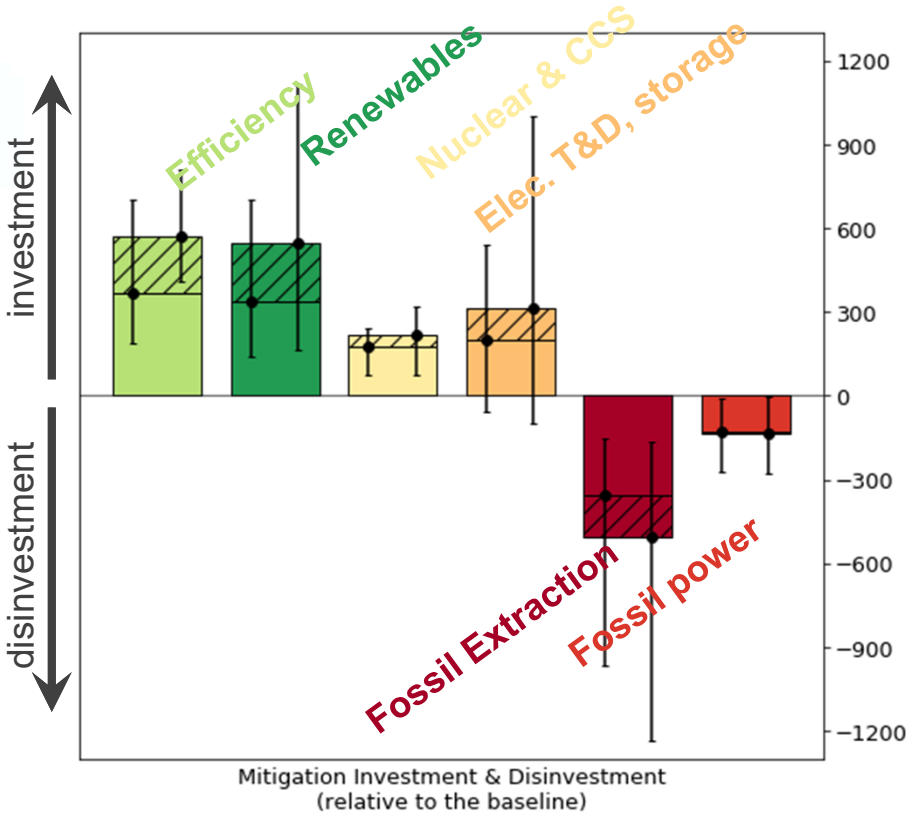
McCollum, D., et al., "Connecting the sustainable development goals by their energy interlinkages." *Env. Res. Lett.* (2018).

Global Investment Portfolios for 1.5 and 2 °C

[average annual investments, 2016-2050]



Bars = MESSAGEix-GLOBIOM
Whiskers = model ranges (n = 6)



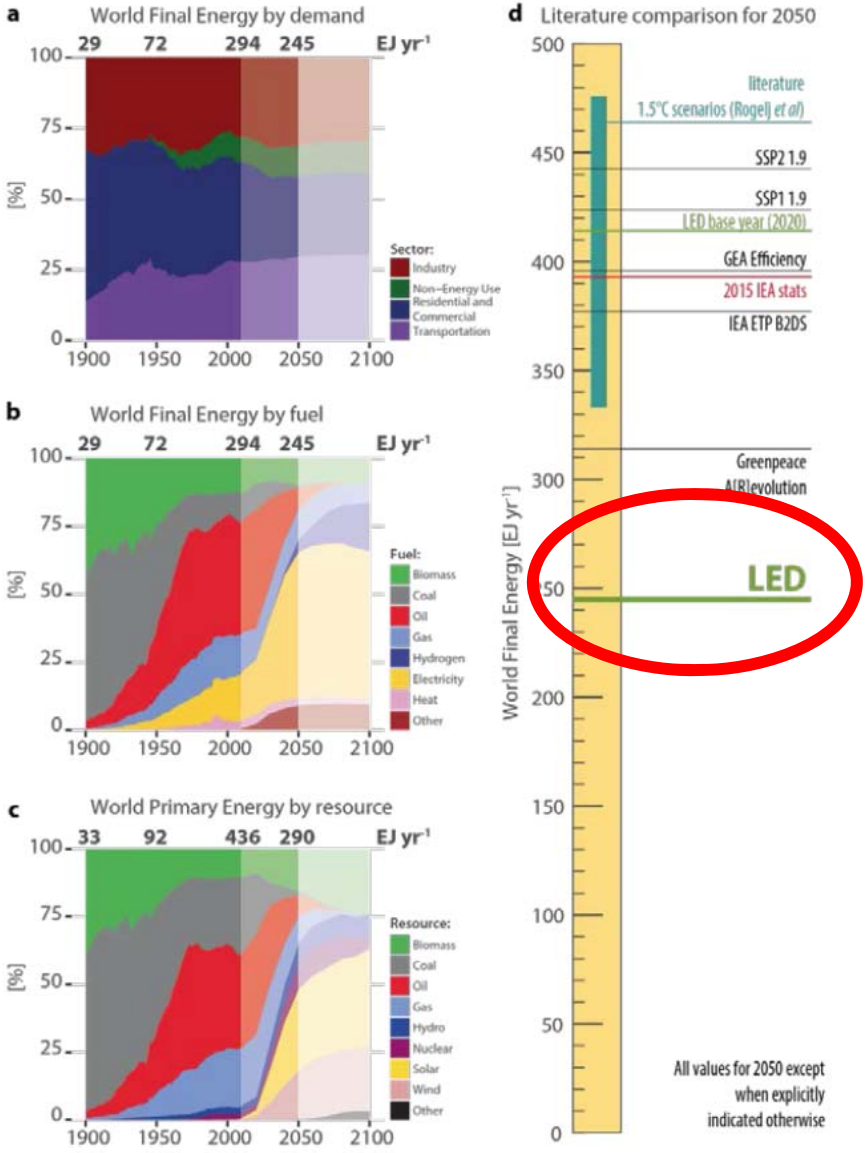
Bars = model means (n = 6)
Whiskers = model ranges (n = 6)

1.5 °C compared to baseline

McCollum, Zhou et al. Nature Energy 2018.

Low Energy Demand to achieve 1.5°C*

**without negative emissions technologies!*



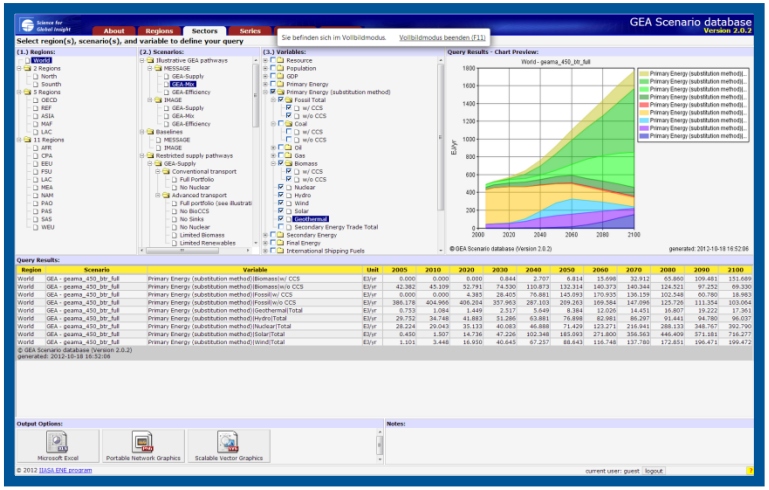
1. Thermal comfort
2. **Consumer goods**
3. Mobility
4. Food

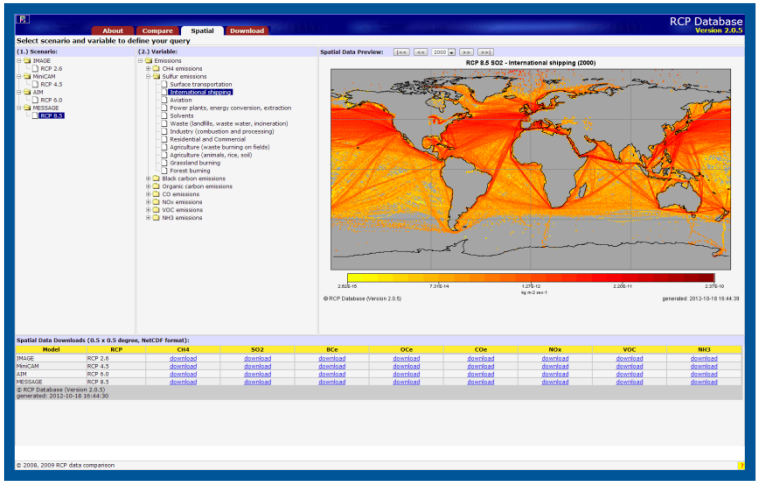
Grubler, A., et al., *Nature Energy* 2018

ENE Community Services and Data Repositories

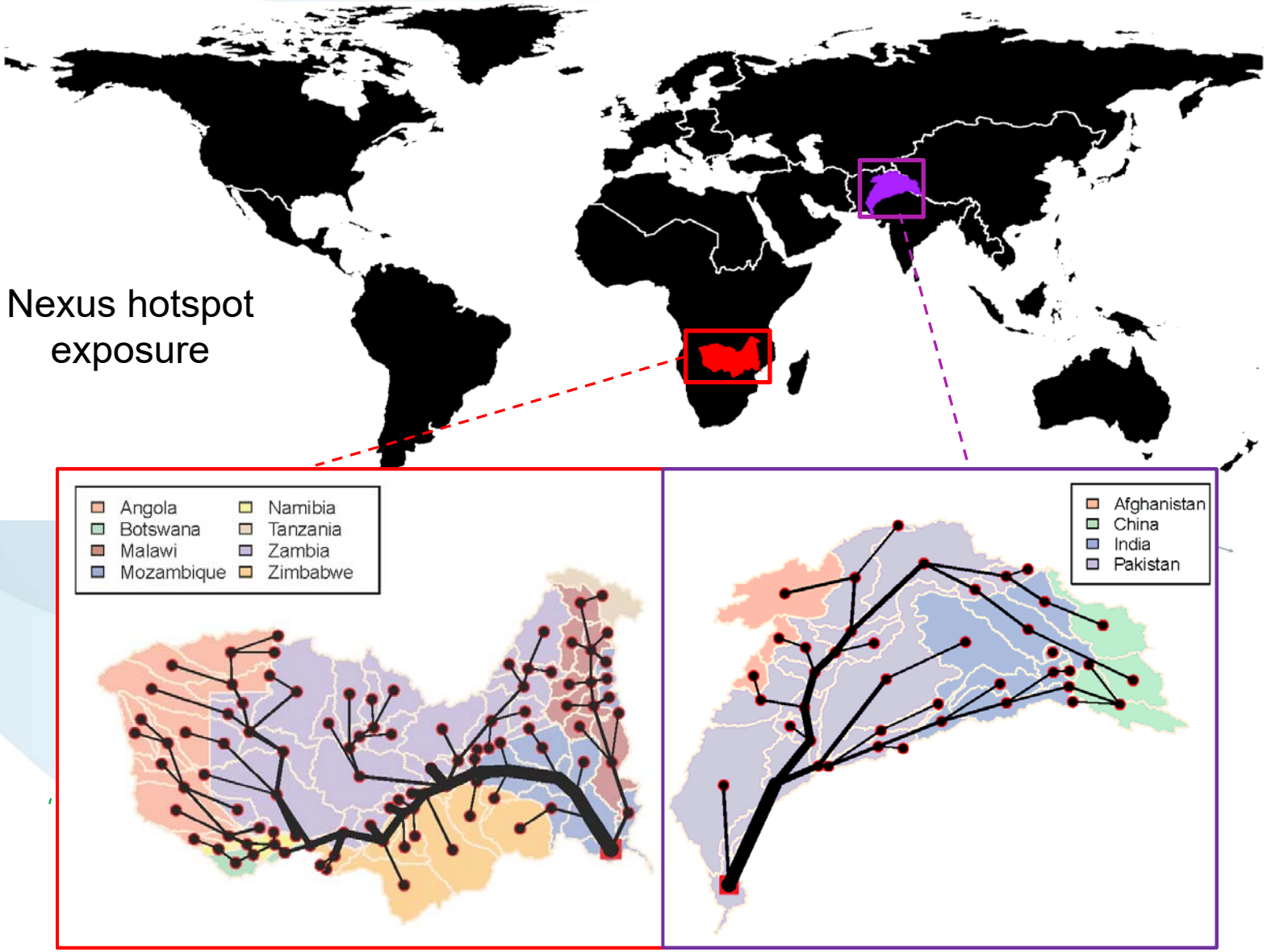
- IPCC Working Group III (AR5)
- Representative Conc. Pathways (RCPs)
- Shared Socio-economic Pathways (SSPs)
- Energy Modeling Forum
  (EMF24, EMF27, EMF28)
- Global Energy Assessment (GEA)
- AMPERE (EU-FP7 project)
- LIMITS (EU-FP7 project)
- Asian Modeling Exercise (AME)
- Latin American Modeling Project (LAMP)

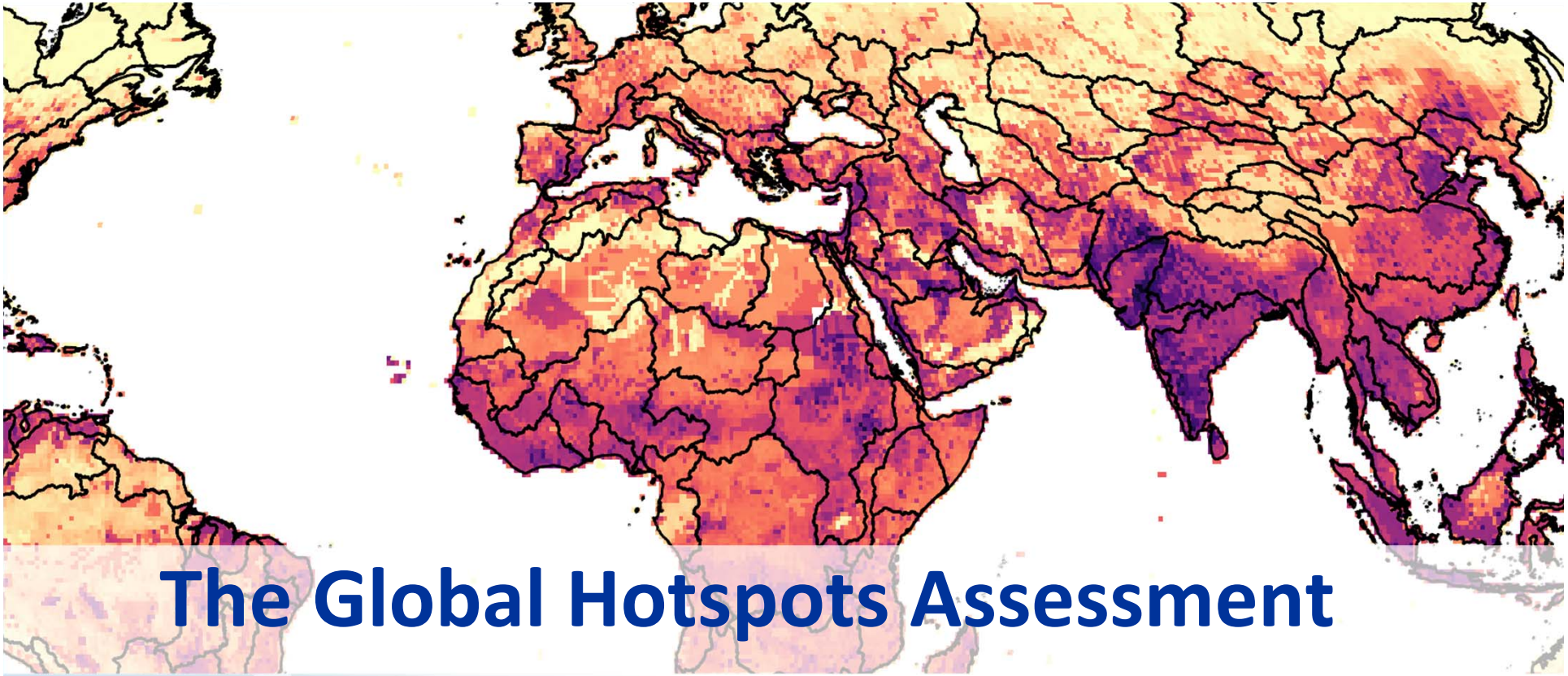
http://www.iiasa.ac.at/web/home/research/modelsData/models-tools-data.html





The Energy-Water-Land Nexus: Global to local





The Global Hotspots Assessment

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

A flexible global vulnerability hotspots framework

Understanding the underlying challenges

i. multiple development-climate pressures across multiple sectors
ii. Impacting vulnerable people, and/or large populations
iii. i + ii = *vulnerability hotspots*

…from multiple perspectives

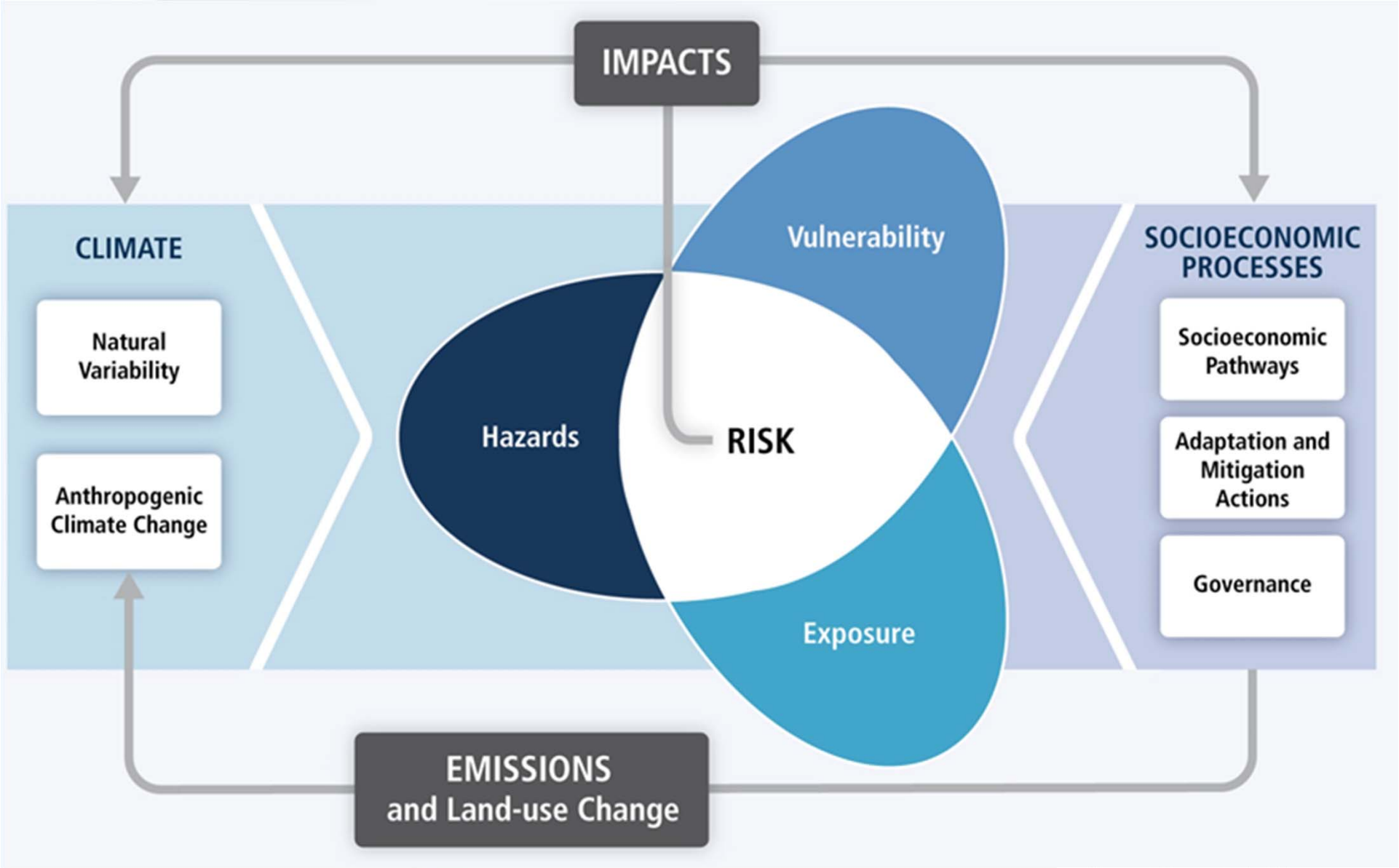
Global
IPCC regions
River basins

- **Answering diverse questions**
  - Sectoral assessment and comparison
  - Subset indicators and sectors
  - Low income, high vulnerability and the low-latitude nexus
  - Climate extremes and hydroclimate complexity
  - Rural and urban, drivers of migration
  - MEAs (SDGs, Sendai, Paris, etc.)

Dissemination, building capacity and increasing impact

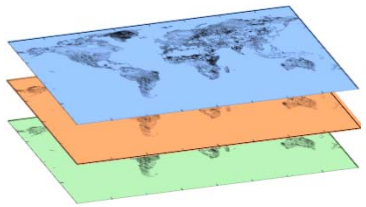
- Development funders and knowledge institutions
- Practitioners and stakeholders
- From scientist… to student

Hazards Exposure Vulnerability



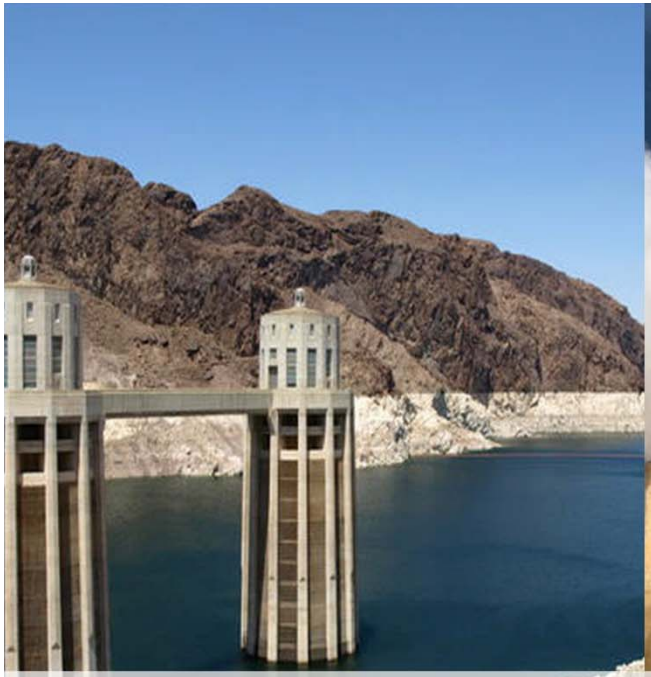
IPCC

Indicator dataset development



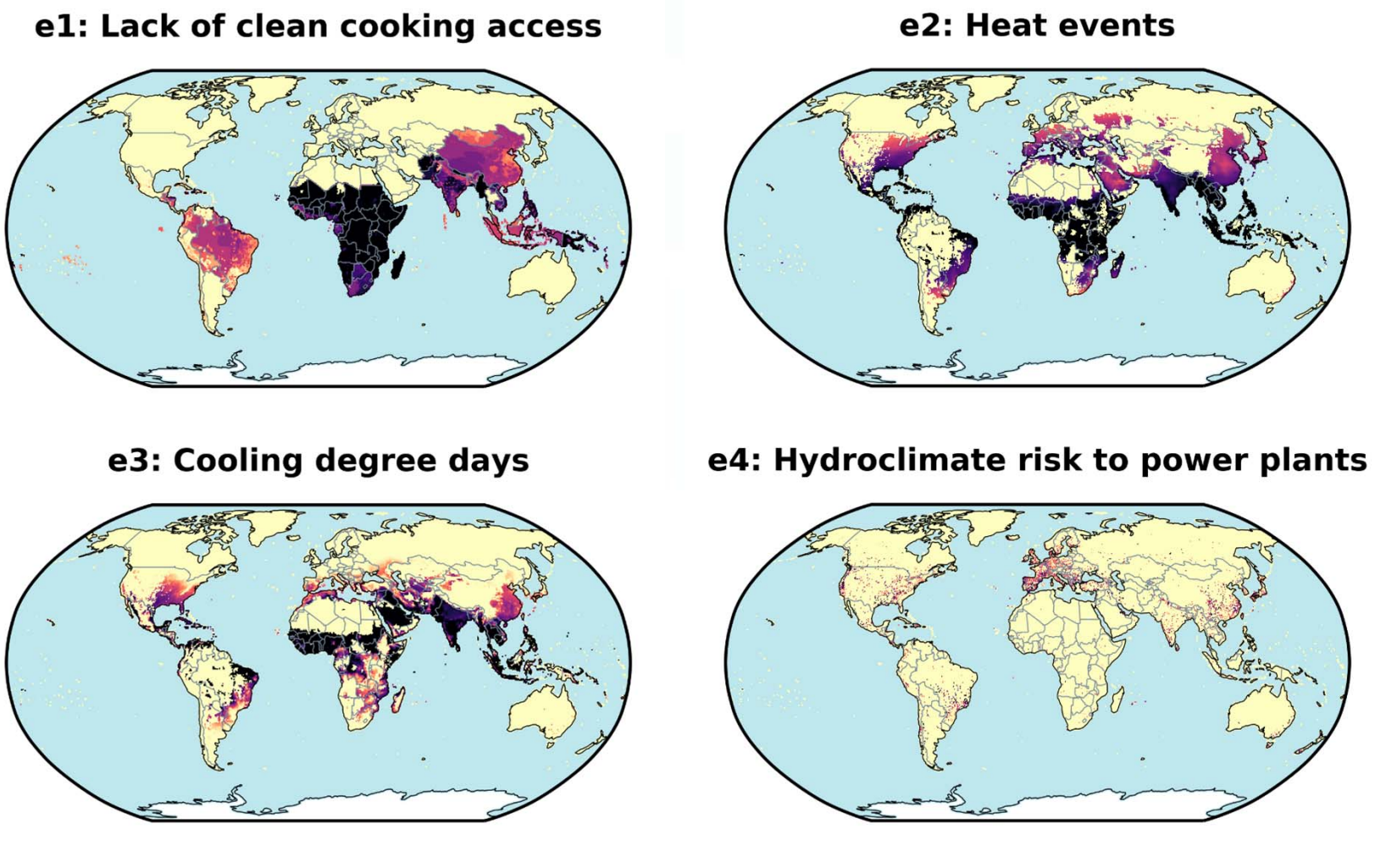
- Global coverage of 14 development and biophysical indicators at 0.5° resolution (~50km)
- 3 socioeconomic development scenarios – SSPs 1,2 &3
- 3 climate change scenarios – 1.5, 2.0 and 3.0°C

Water	***Energy***	***Land***	***$ Socioeconomics***
Water stress index	Clean cooking access	Crop yield change	Population density
Non-renewable GW abstraction	Heat event exposure	Environmental flow exploitation	Income levels
Drought intensity	Cooling demand growth	Habitat degradation	
Peak flows risk	Hydroclimate risk to power	Nitrogen leaching	
Seasonality			
Inter-annual variability			
GCMs, GHMs	GCMs, MESSAGE	GCMs GHMs, GLOBIOM, EPIC	



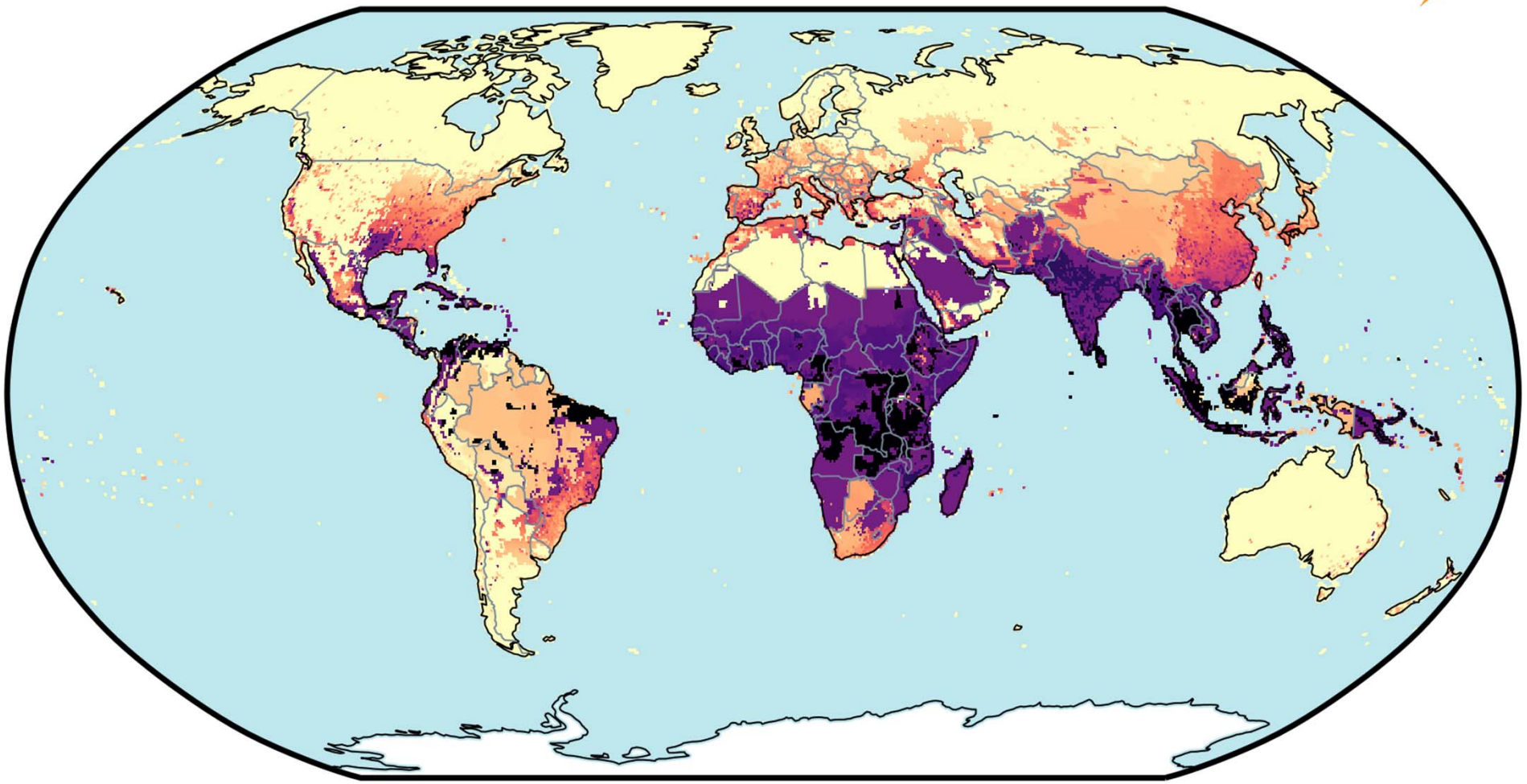
Sectoral analysis

Energy



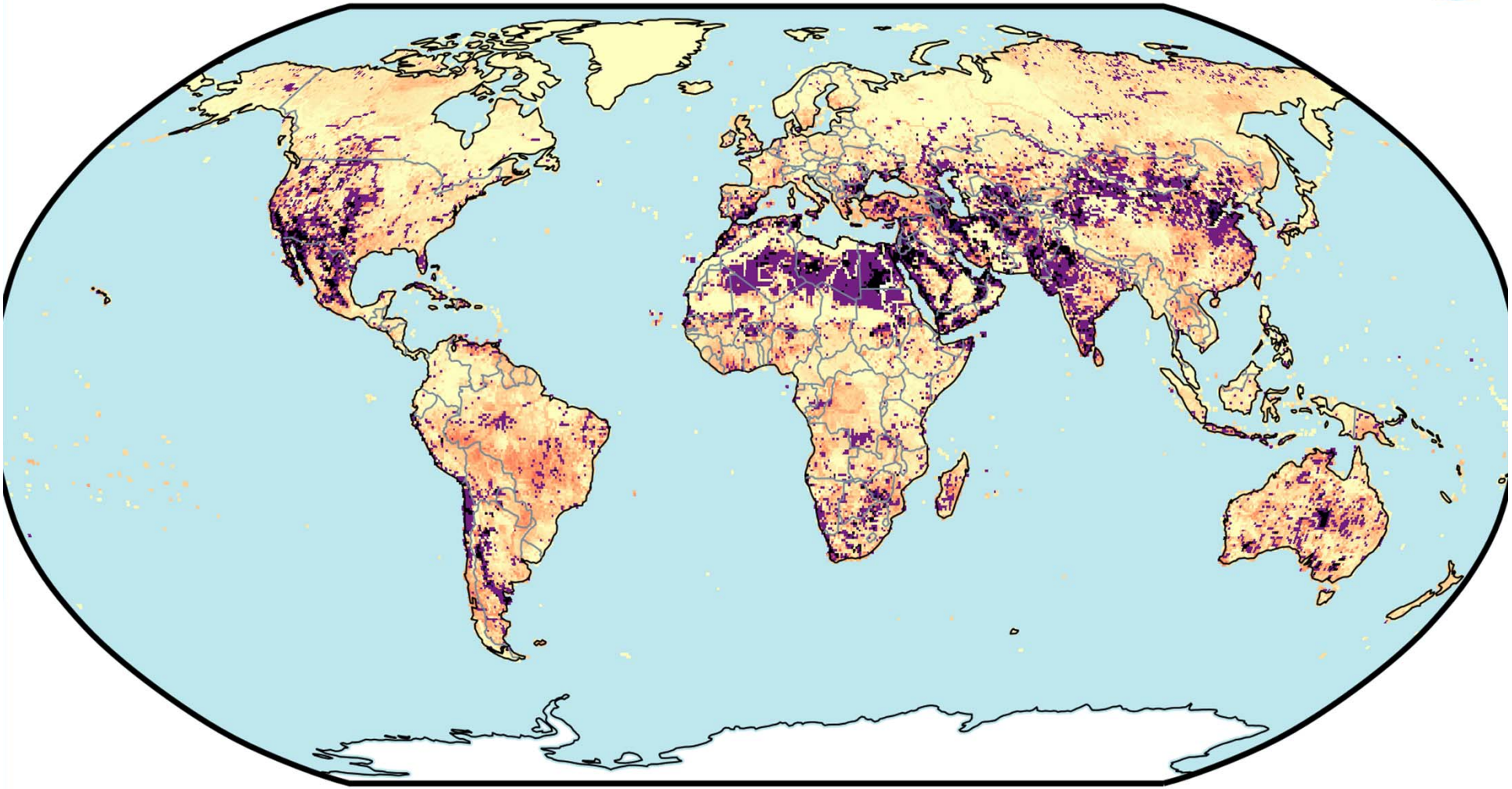
Byers et al.
(2018, ERL)

Energy impacts: 2.0° SSP2



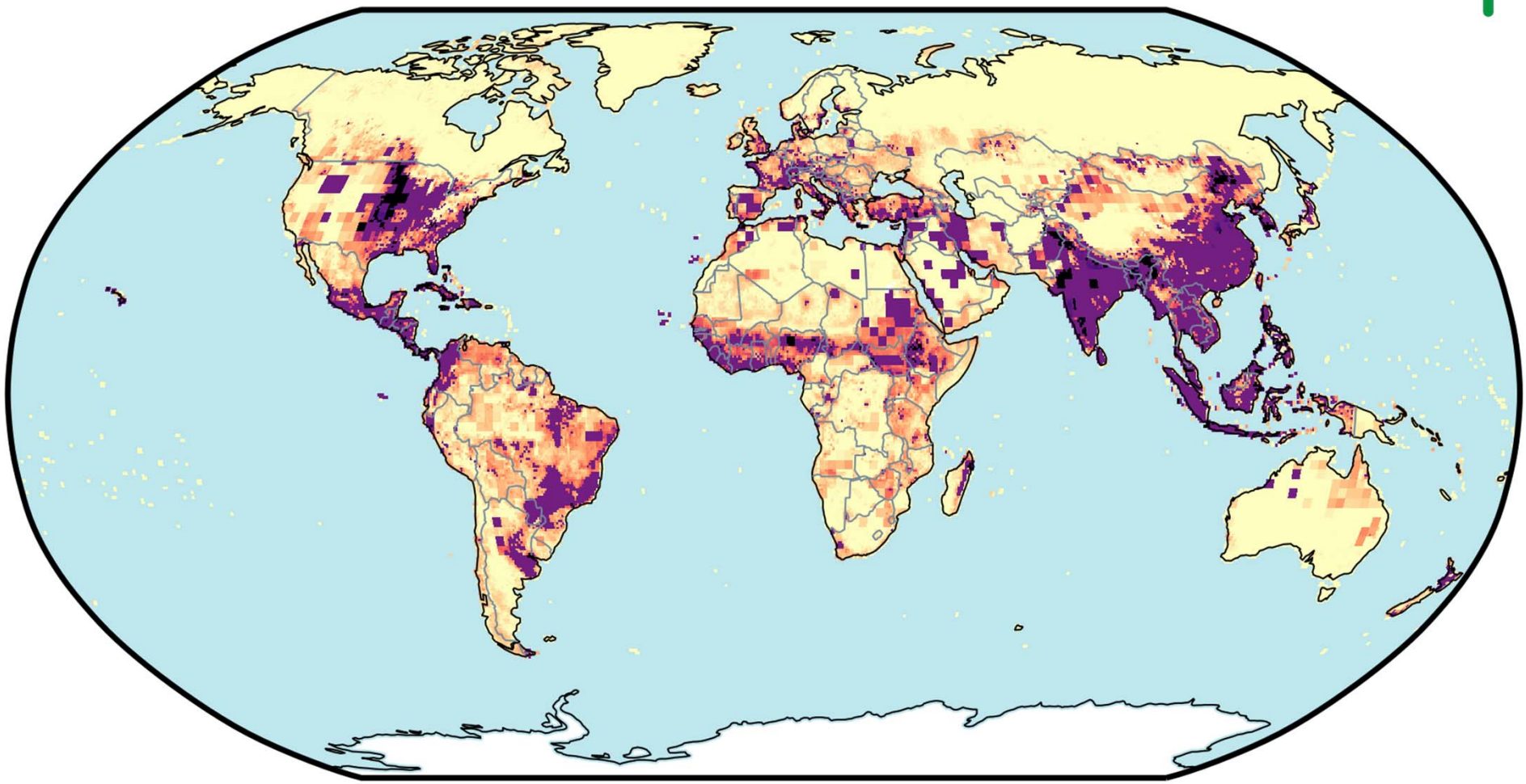
Byers et al.
(2018, ERL)

Water impacts: 2.0° SSP2



Byers et al. (2018, ERL)

Land impacts: 2.0° SSP2

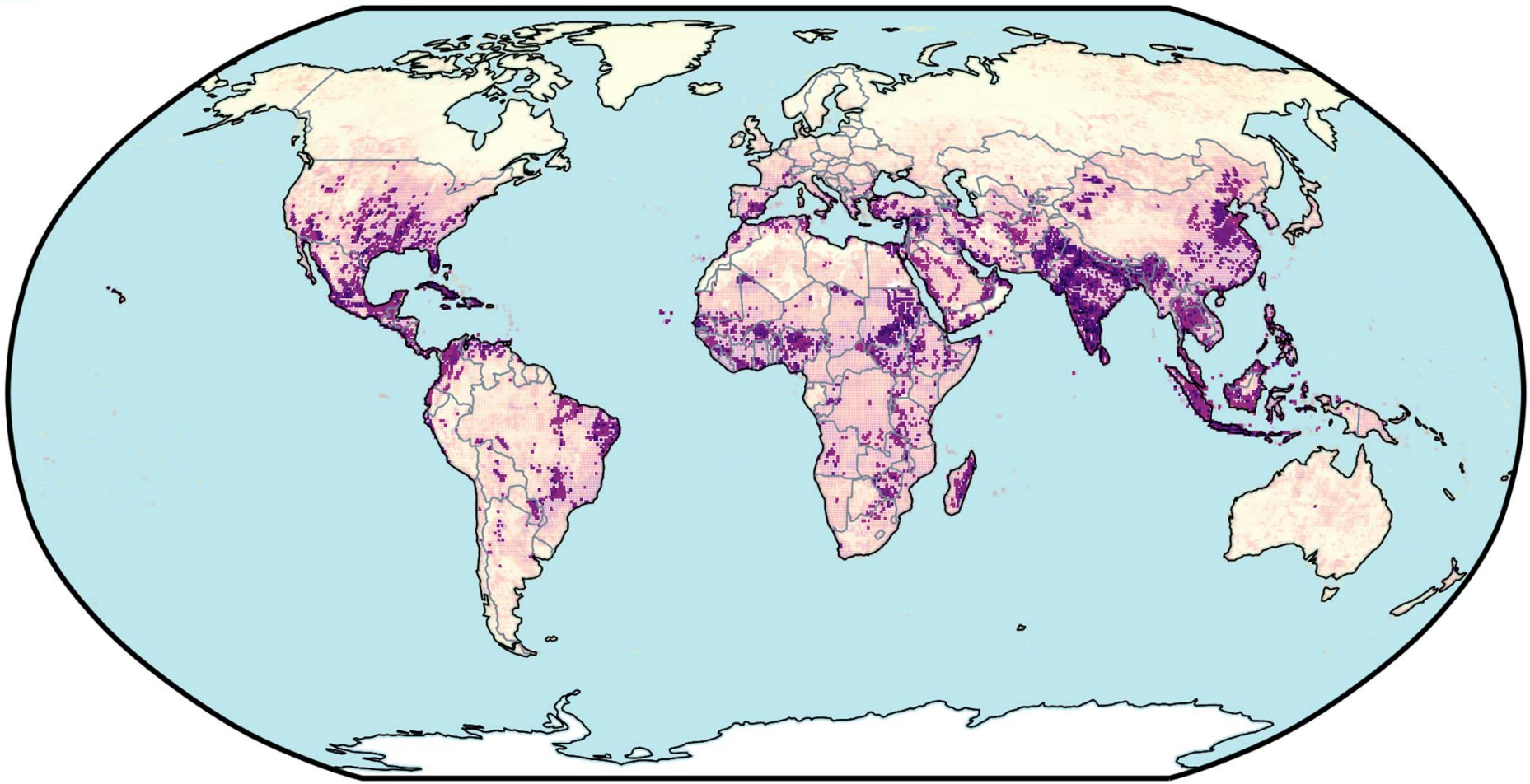


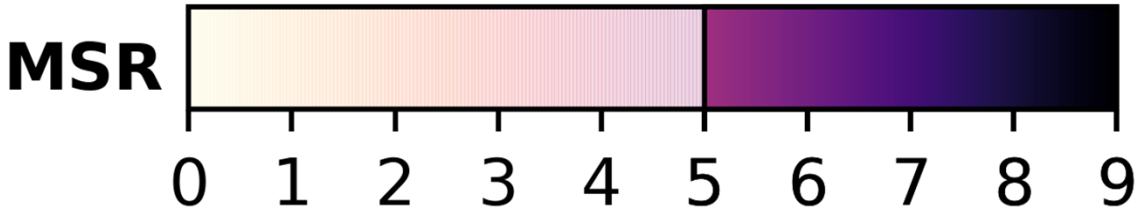
Byers et al. (2018, ERL)

Multi-sector hotspots

Global hotspot exposure

3.0 °C





Byers et al. (2018, ERL)

Incorporating vulnerability

Vulnerability

Vulnerable to Poverty

*"**lack** the economic **stability and resilience to shocks** that characterizes middle-class households"*
Lopez-Calva & Ortiz-Juarez, World Bank, 2011

Poverty numbers

< $10 2.2 bi
< $5 1.3 bi
< $2 0.7 bi

Vulnerable to poverty

Extreme poverty

Poverty fluxes

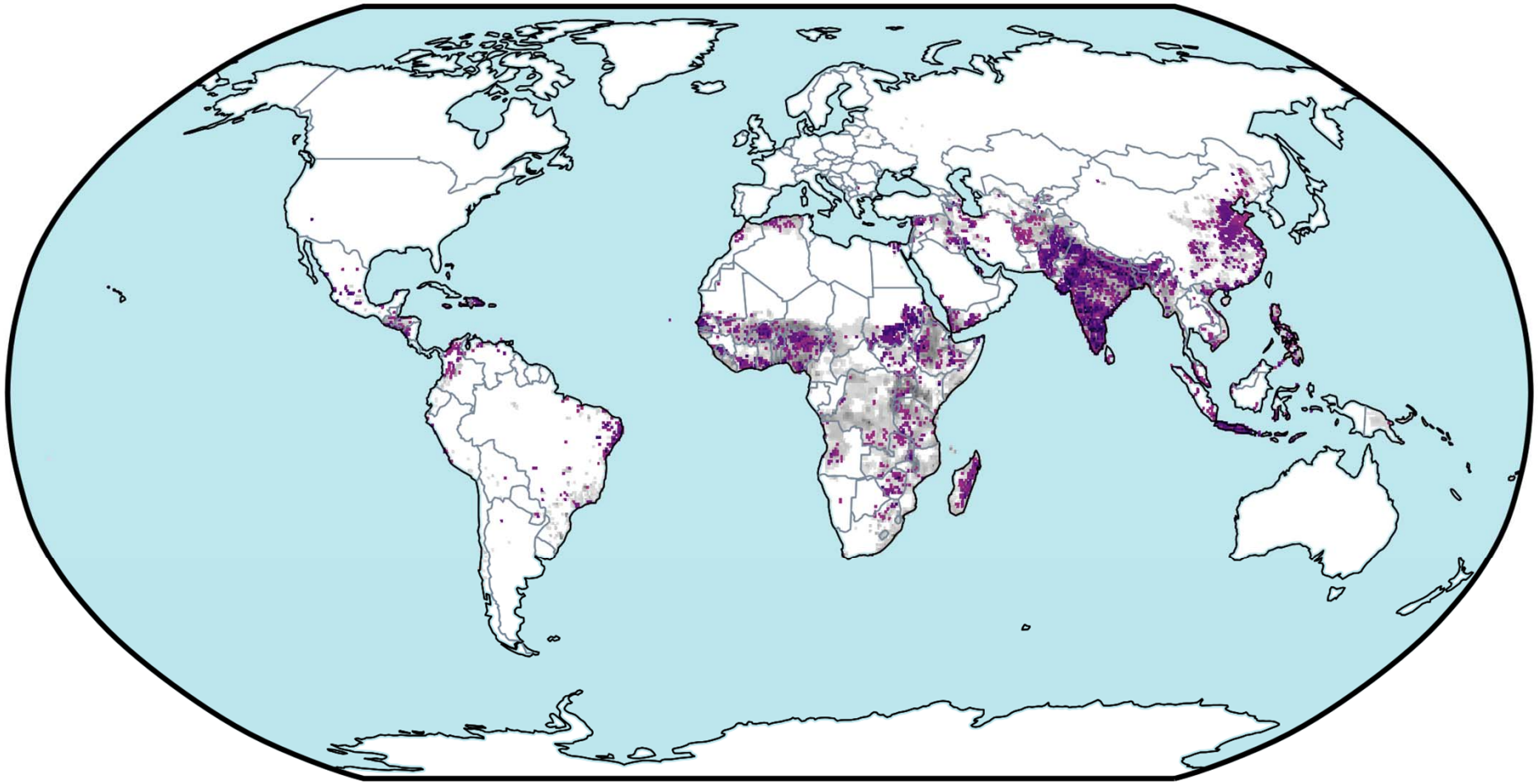
Net annual poverty reduction 2% per annum

Came out of poverty 15%
Fell in to poverty 13%

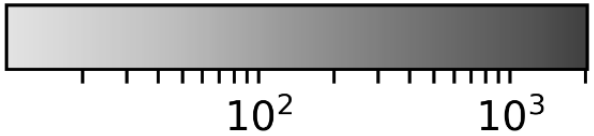
Anindito Mukherjee/Reuters
The Nation, Thailand

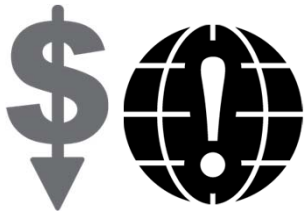
Hot and vulnerable

3.0 °C



Vuln. pop. / km^2
income < $10 /day
MSR > 5.0

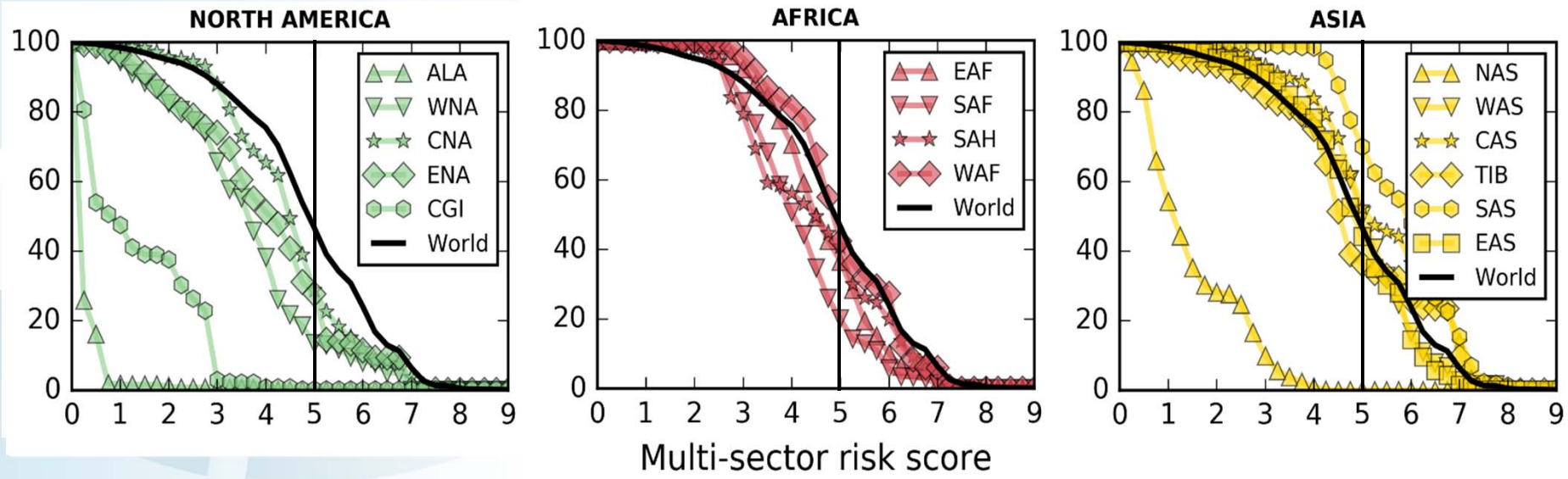




Byers et al.
(2018, ERL)

Regional impacts

3.0 °C

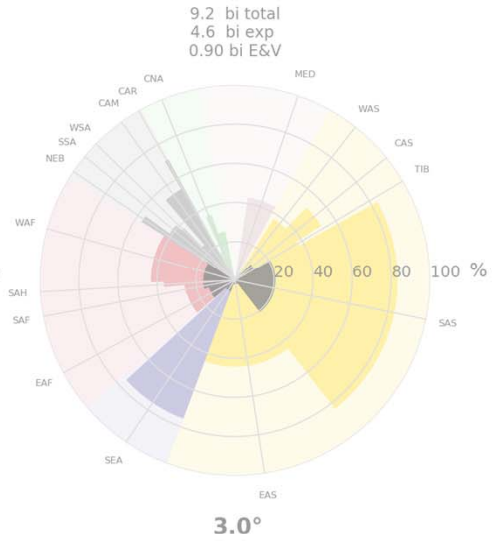


- **Northern hemisphere regions have better than average impacts**
- **Most Asian and southern regions are on/worse than average**

Byers et al. (2018, ERL)

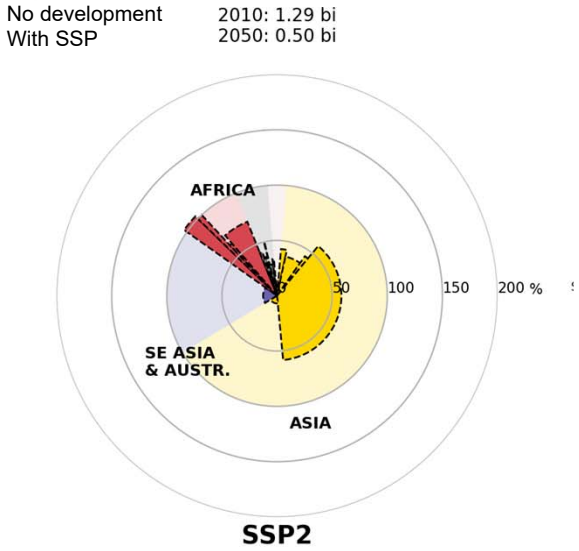
Exposure & vulnerability (27 regions)

2050
Exposed



b)

Exposed & Vul.

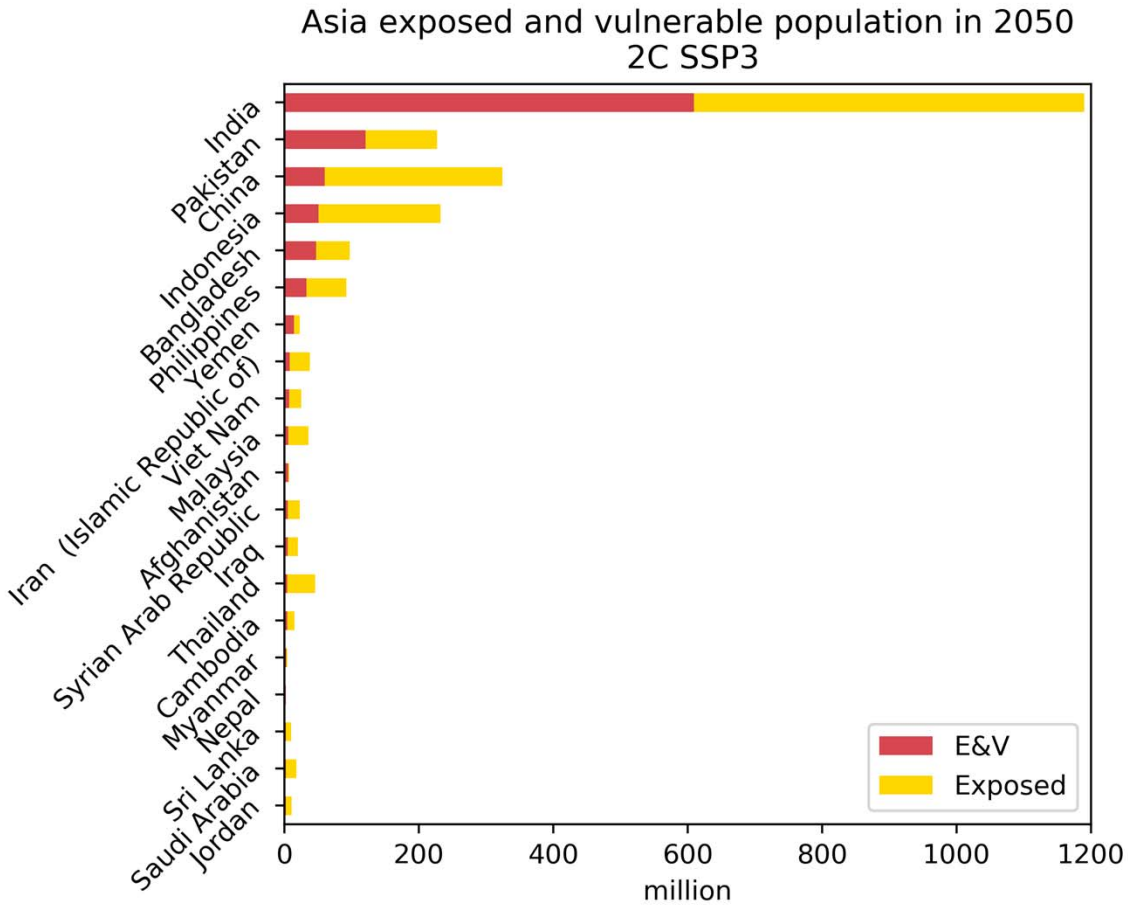


Byers et al. (2018, ERL)

Sustainability | **Middle of the road** | **Rocky road**

Asian exposure

- Which countries have most people exposed and vulnerable, *in absolute numbers?*



Sustainability

Ranked by Exposed & Vulnerable (red)

Asian sectoral exposure contributions

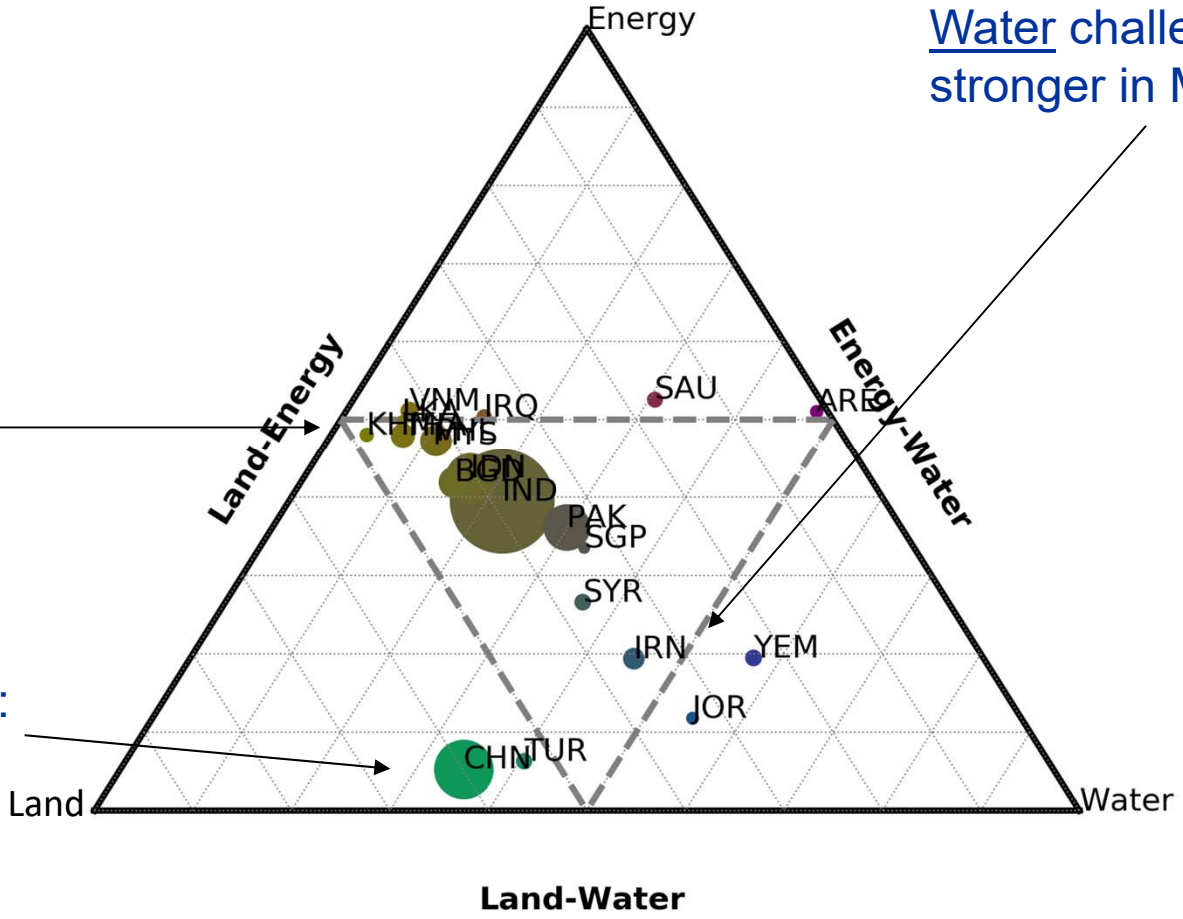
How do Asian countries compare by types of risk?

Most countries exposed quite evenly

SE Asia: Land-Energy

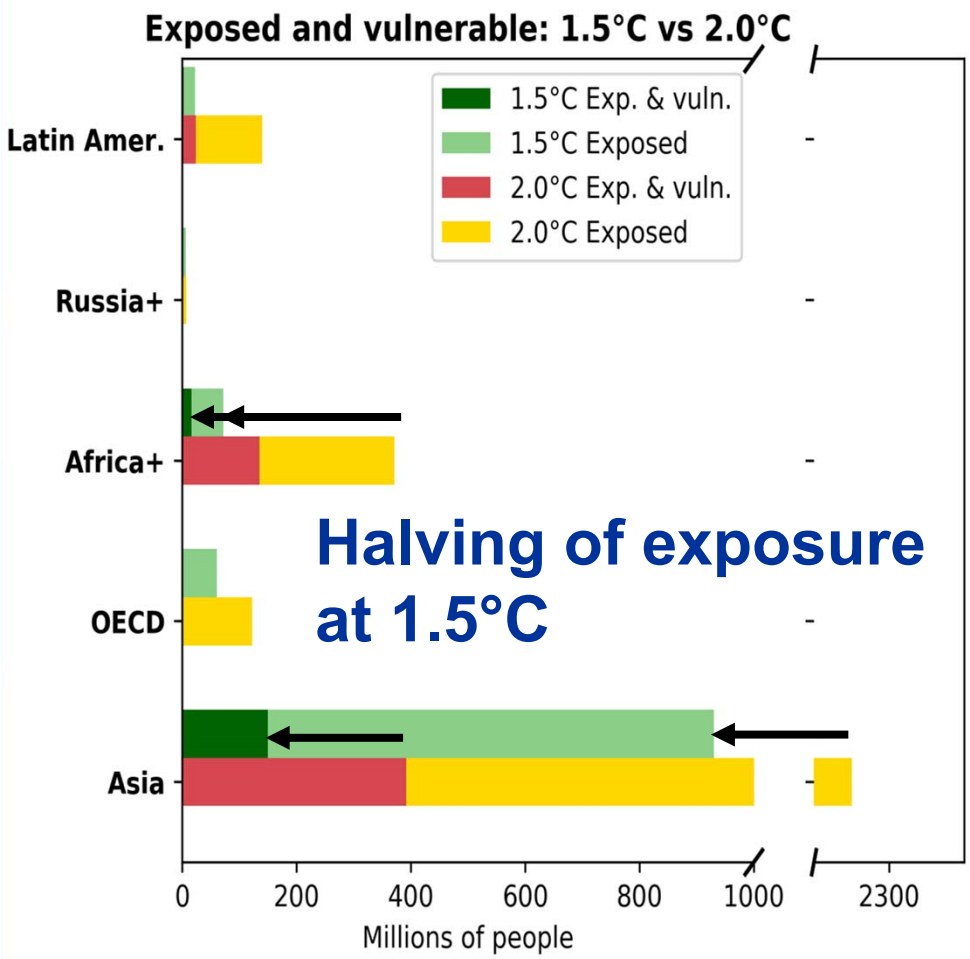
China & Turkey: Water-Land

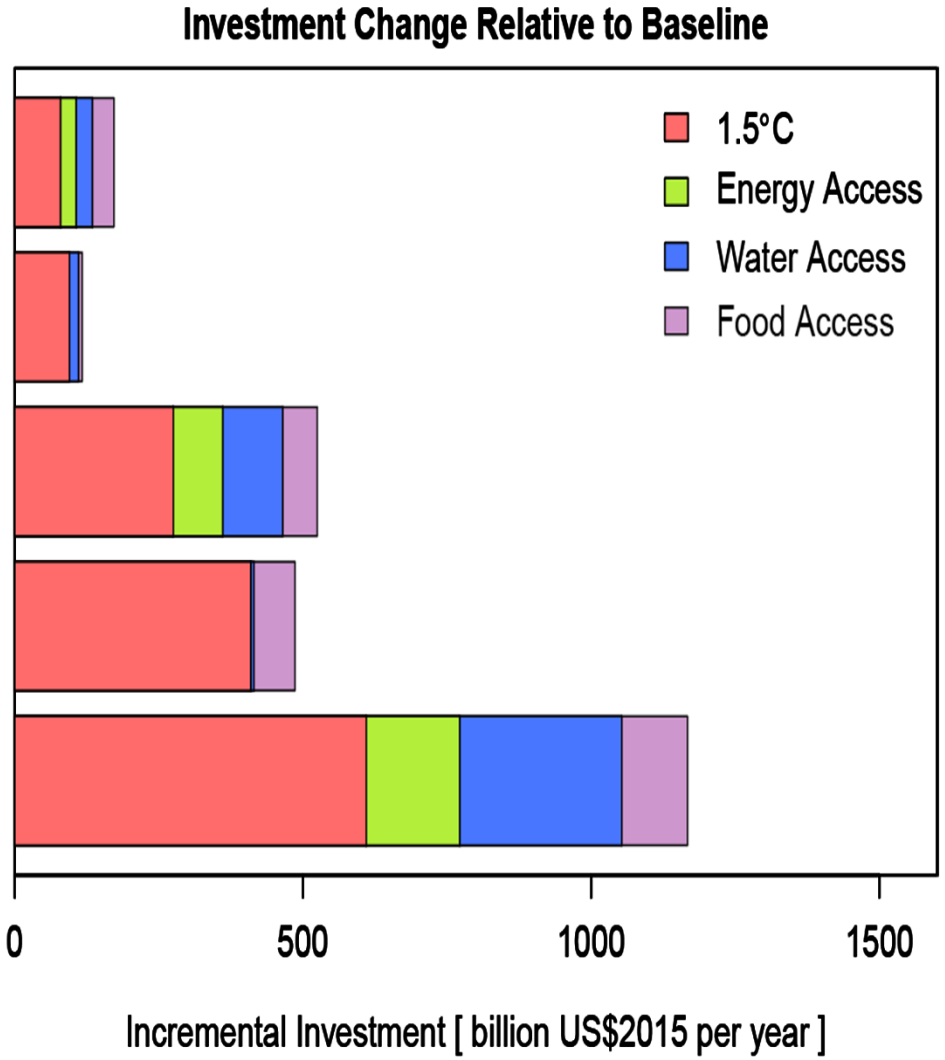
Water challenges in stronger in Middle East



Climate exposure

Investment needs



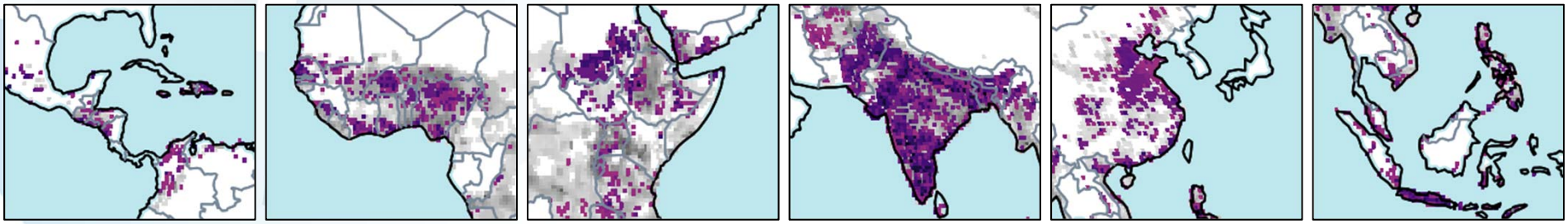


- Substantial differences between 1.5° and 2.0°C
- South and SE Asia highly exposed even at 1.5°C

3.0 °C

Keep global mean temperatures as low as possible
… to reduce exposure of the global population and limit economic impacts

- Large vulnerable populations in low-latitude multi-sector hotspots



Pursue ambitious socioeconomic development, …
investments targeted in the most at-risk areas to most effectively reduce vulnerabilities

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science for global insight

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

Global exposure and vulnerability to multi-sector development and climate change hotspots

Environmental Research Letters 2018, 13 055012
https://doi.org/10.1088/1748-9326/aabf45

IIASA, International Institute for Applied Systems Analysis