International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

gef
GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

IIASA

UNIDO

science for global insight

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

Edward Byers, Matthew Gidden, David Leclère, Juraj Balkovic, Peter Burek, Kristie Ebi [2], David Grey [3], Peter Greve, Petr Havlik, Astrid Hillers[4], Nils Johnson, Taher Kahil, Volker Krey, Simon Langan, Nebjosa Nakicenovic, Robert Novak[5], Michael Obersteiner, Shonali Pachauri, Amanda Palazzo, Simon Parkinson, Narasimha Rao, Joeri Rogelj, Yusuke Satoh, Yoshihide Wada, Barbara Willaarts, Keywan Riahi

[1] International Institute for Applied Systems Analysis, Laxenburg, Austria

[2] University of Washington, Seattle, WA, US

[3] University of Oxford, Oxford, UK

[4] Global Environment Facility, Washington DC, US

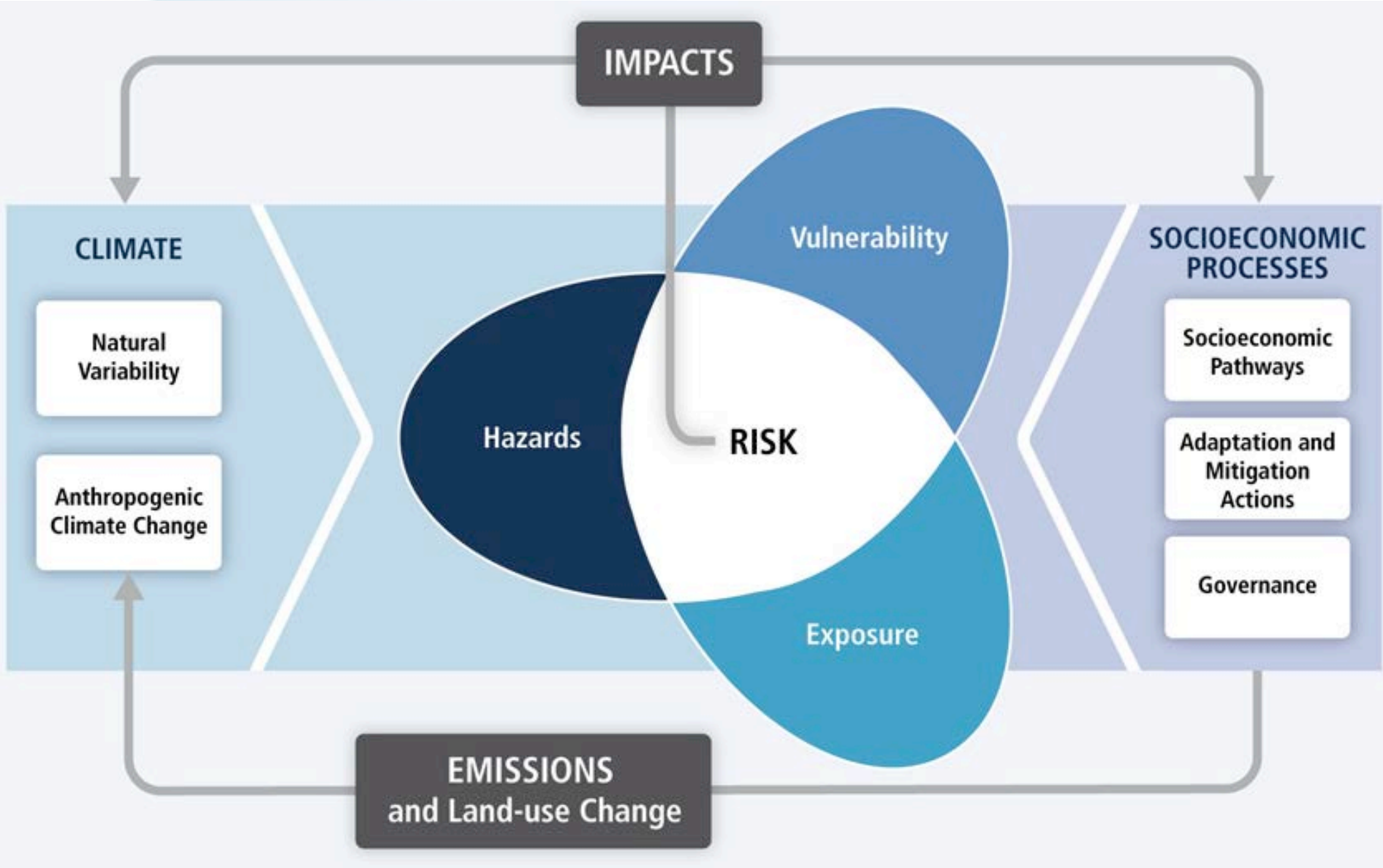[5] United Nations Industrial Development Organization, Vienna, Austria

Hazards   Exposure   Vulnerability

IPCC

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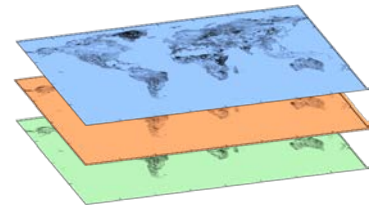
- Global coverage of 14 development and biophysical indicators at 0.5° resolution (~50km)
- 3 socioeconomic development scenarios – SSPs 1,2 &3
- 3 climate change scenarios – 1.5, 2.0 and 3.0°C

	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						

Sectoral analysis

Energy

e1: Lack of clean cooking access

e2: Heat events

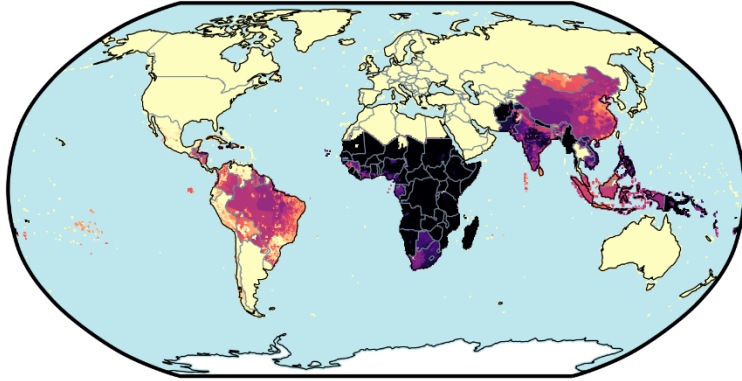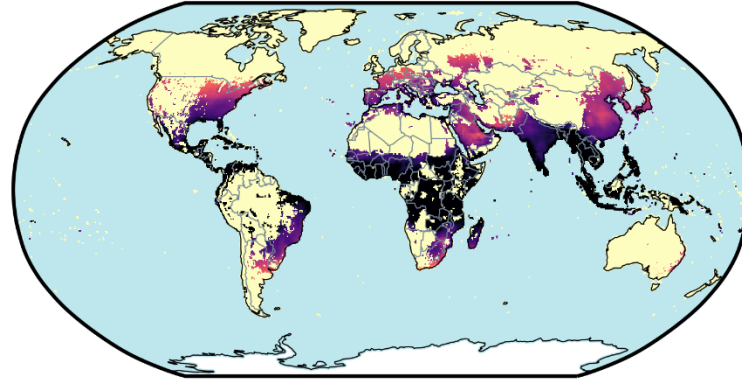**e3: Cooling degree days**
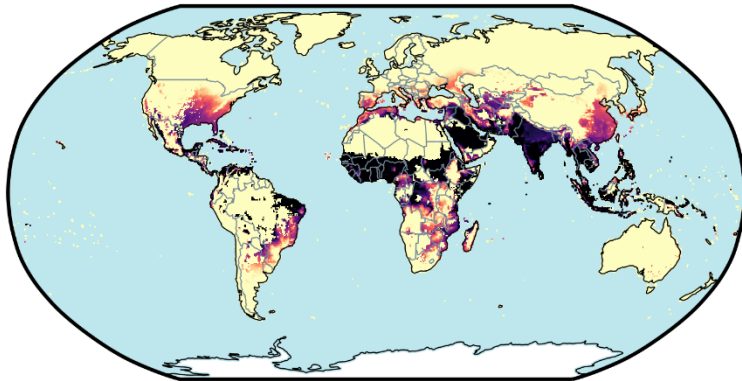
e4: Hydroclimate risk to power plants

Byers et al.
(2018, ERL)
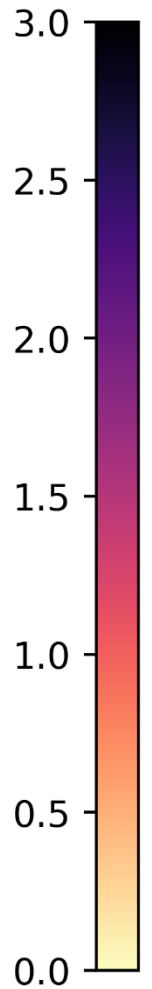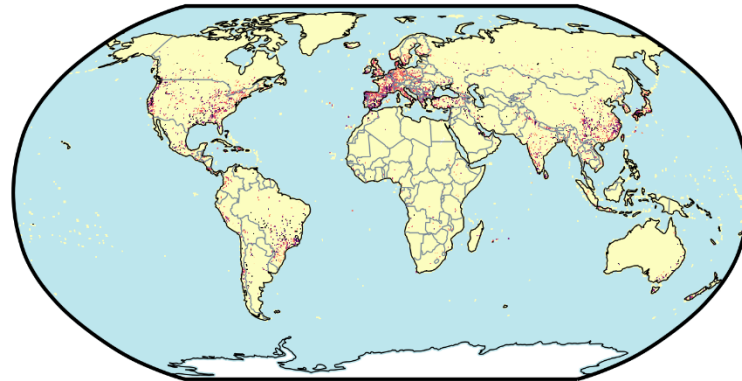
Energy impacts: 2.0° SSP2

Byers et al. (2018, ERL)

Water impacts: 2.0° SSP2

Byers et al. (2018, ERL)

Land impacts: 2.0° SSP2

0.0   0.5   1.0   1.5   2.0   2.5   3.0

Byers et al.
(2018, ERL)
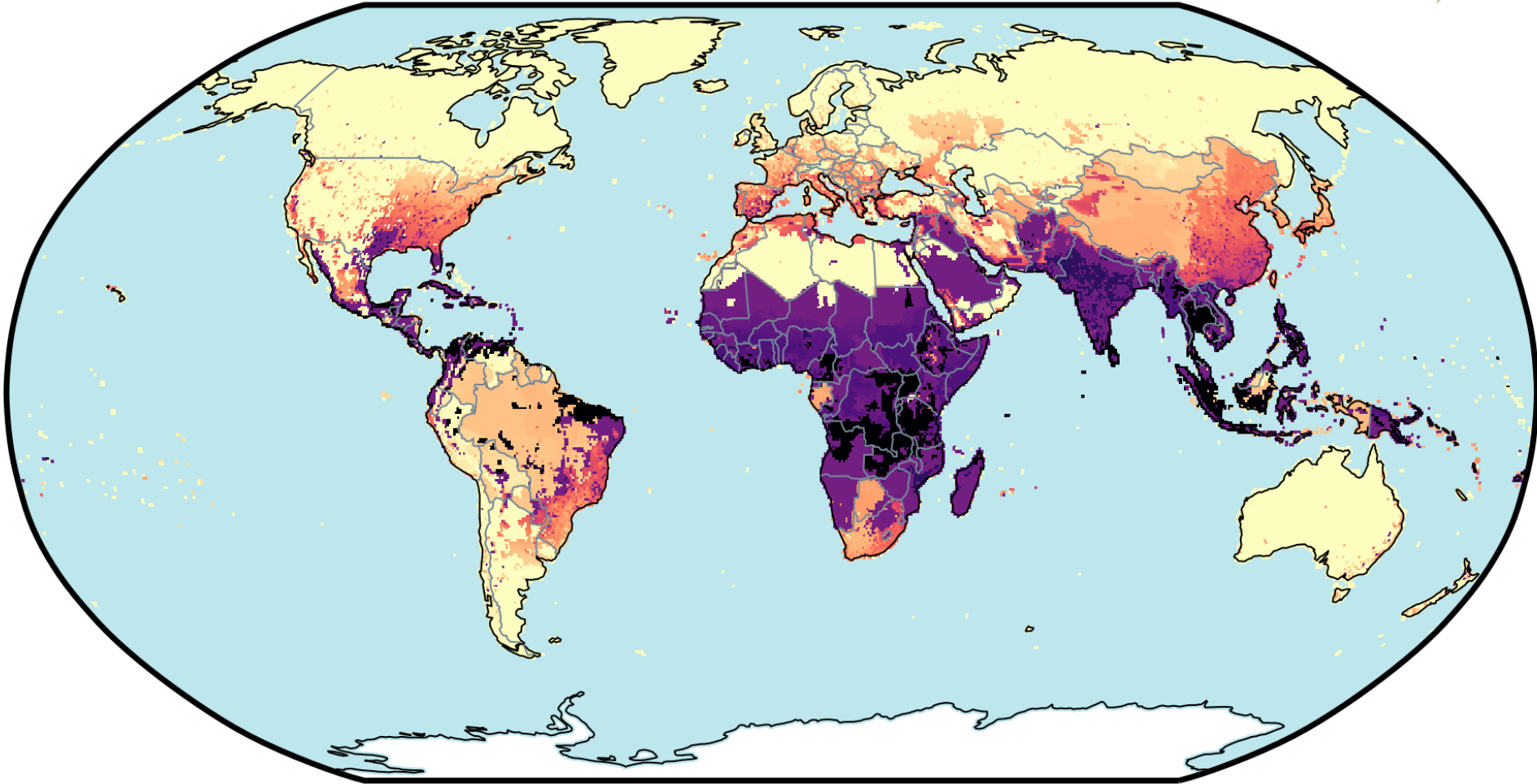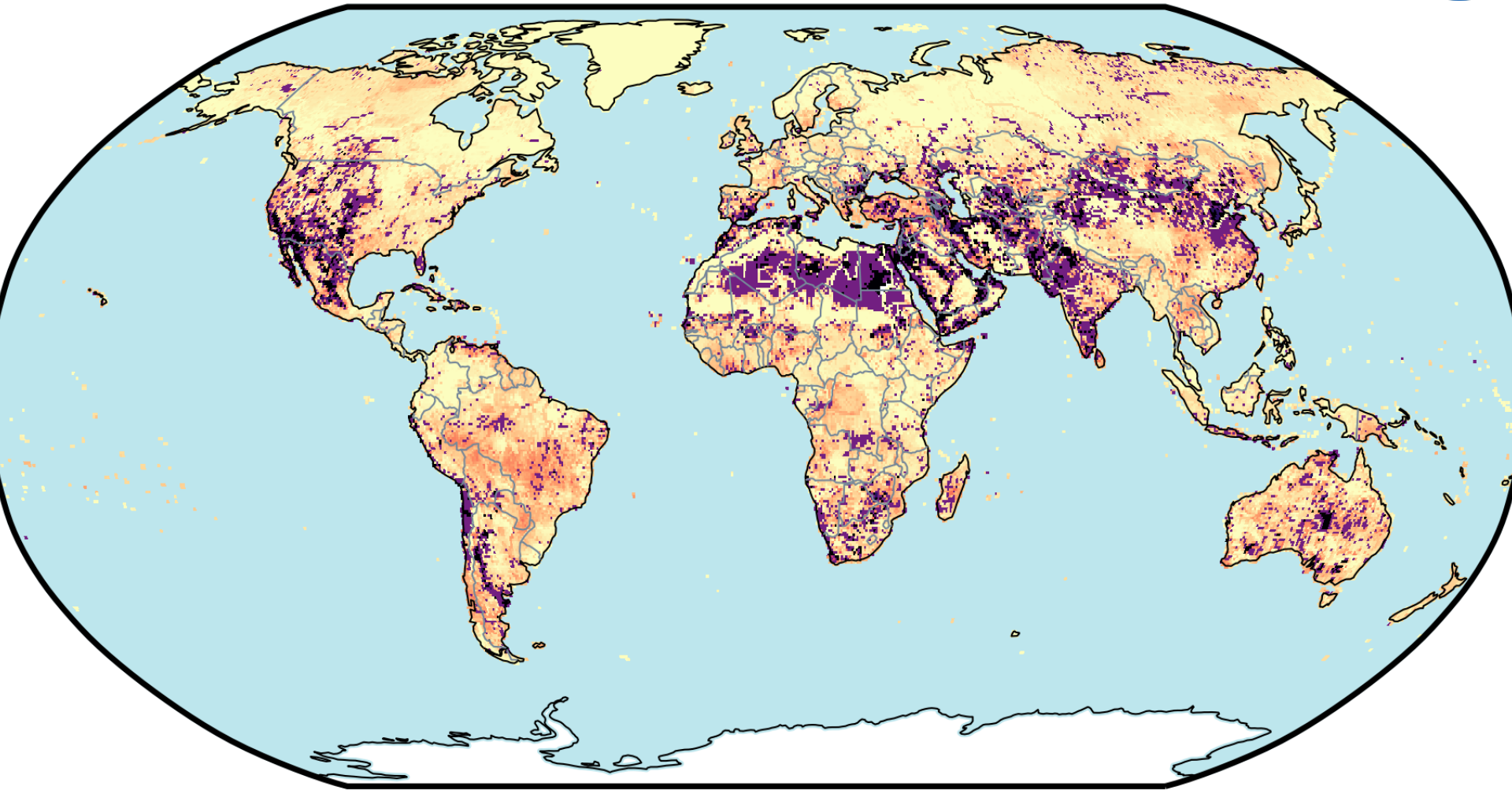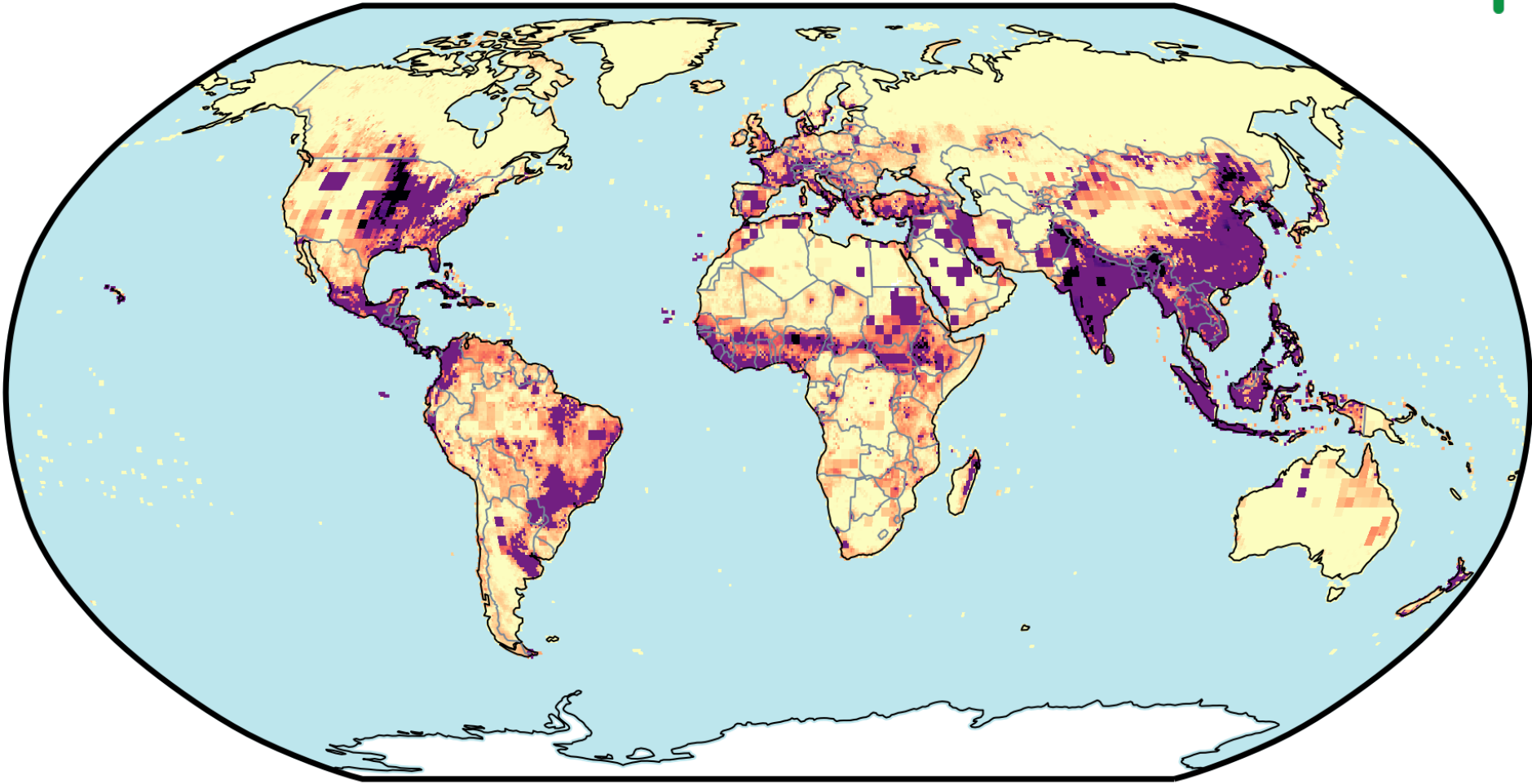
Multi-sector hotspots

Global hotspot exposure

3.0 °C

MSR

0 1 2 3 4 5 6 7 8 9

Byers et al.
(2018, ERL)
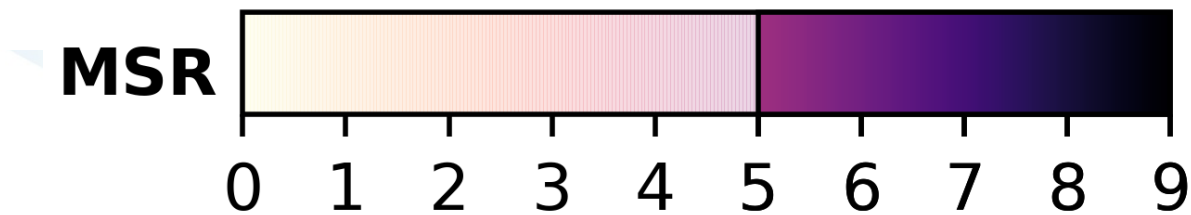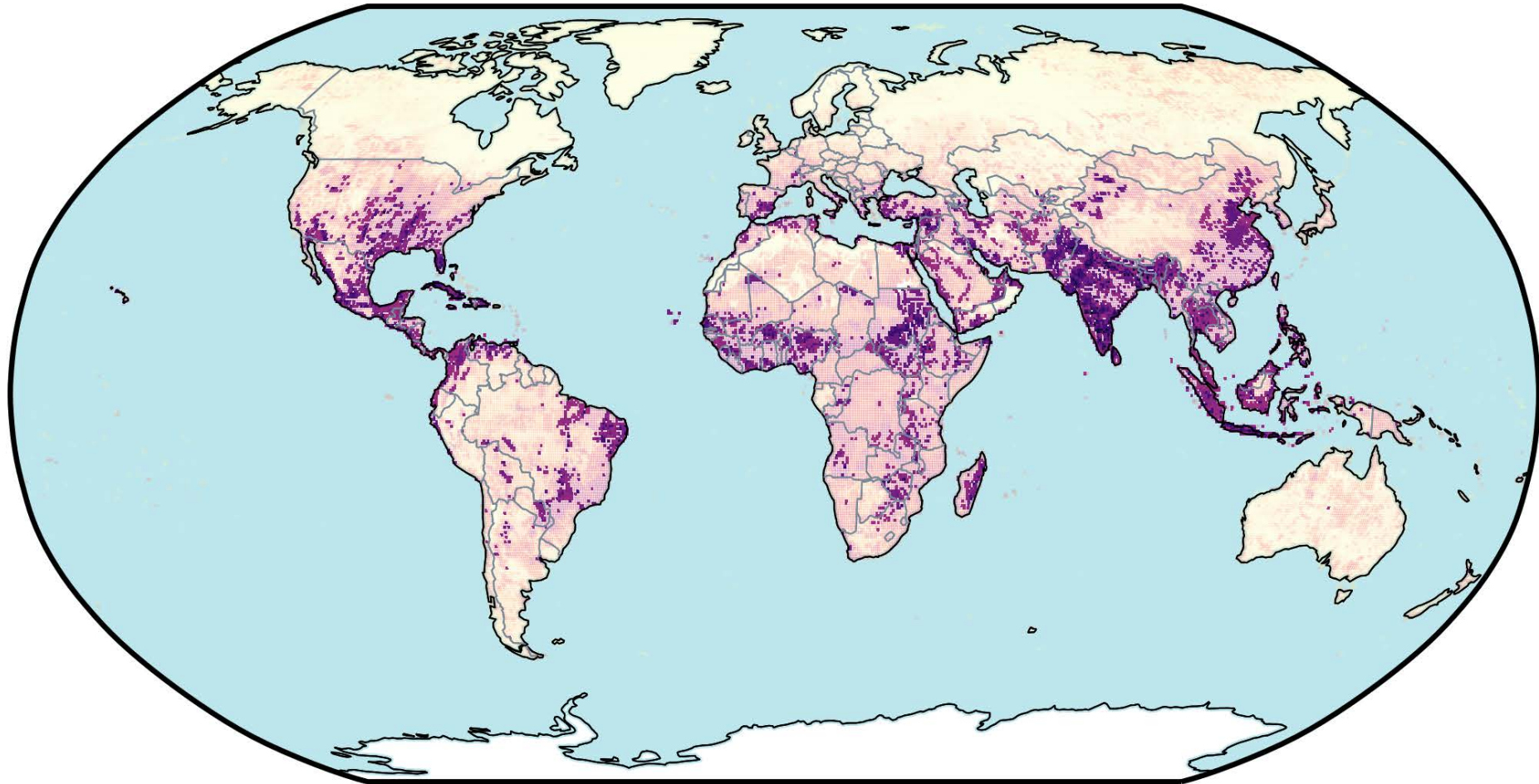
Incorporating vulnerability

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

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

Net annual poverty reduction 2% per annum

IIASA

Hot and vulnerable

3.0 °C
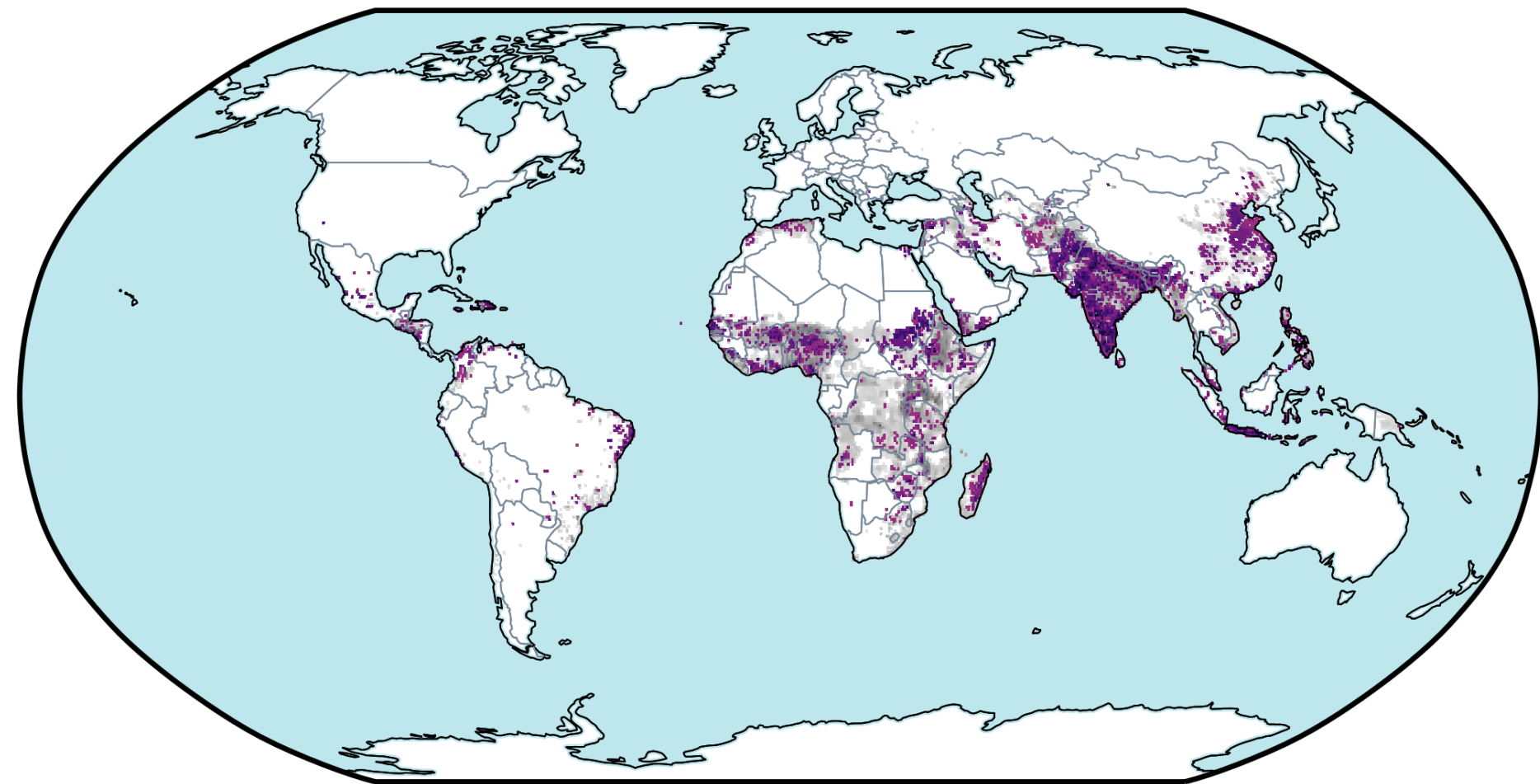
Vuln. pop. / km^2
income < $10 /day
MSR > 5.0

Byers et al.
(2018, ERL)
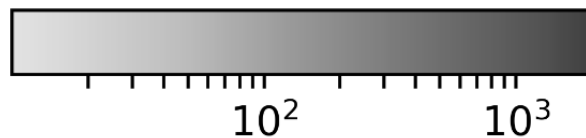
Regional impacts

3.0 °C
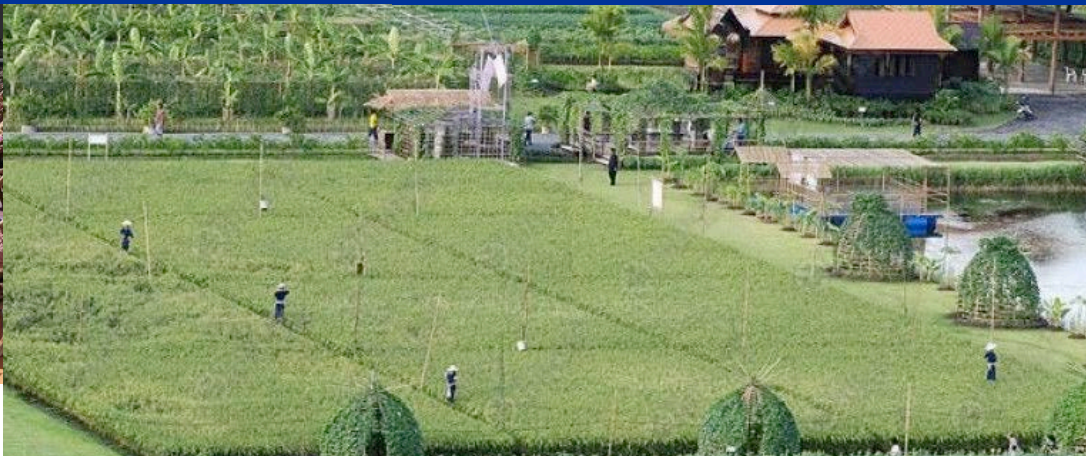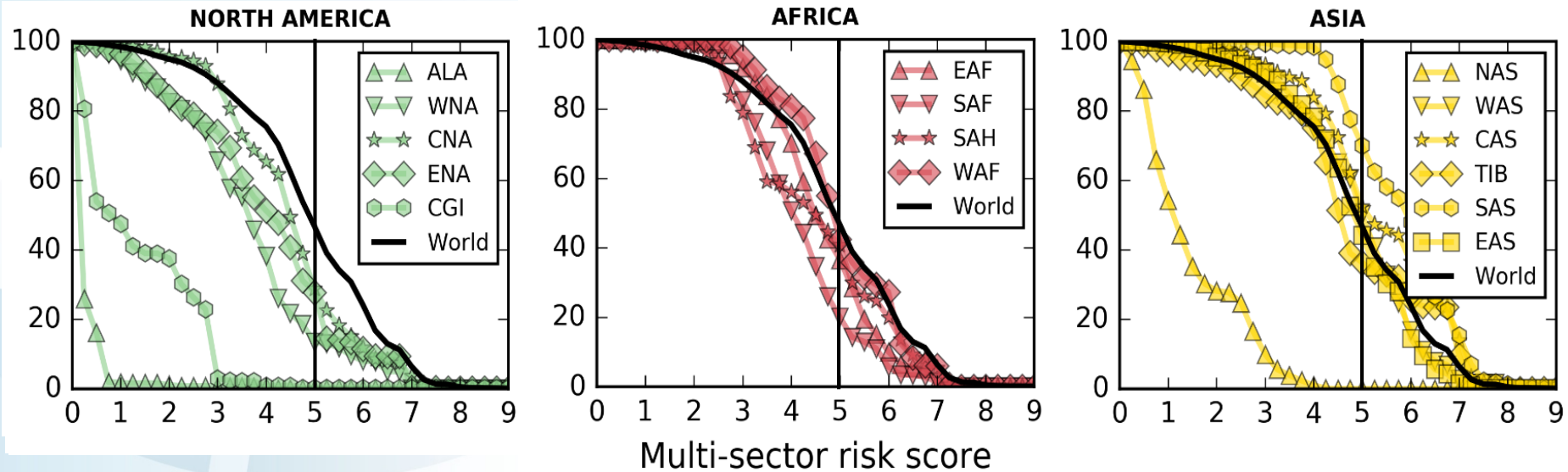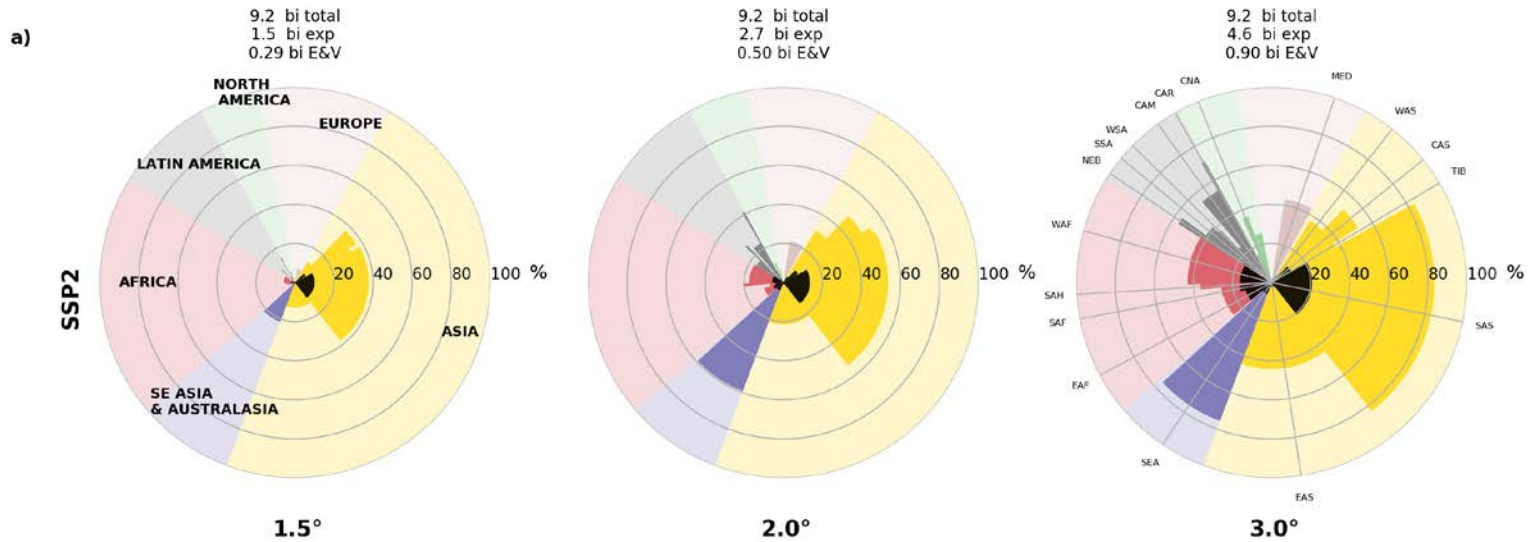

- **Northern hemisphere regions have better than average impacts**

- **Most Asian and southern regions are on/worse than average**

Exposure & vulnerability (27 regions)

2050 Exposed

a)

9.2 bi total
1.5 bi exp
0.29 bi E&V

9.2 bi total
2.7 bi exp
0.50 bi E&V

9.2 bi total
4.6 bi exp
0.90 bi E&V

1.5°   2.0°   3.0°

Exposed & Vul.

b)

2010: 1.29 bi
2050: 0.09 bi

No development
With SSP

2010: 1.29 bi
2050: 0.50 bi

2010: 1.29 bi
2050: 1.22 bi

SSP1   SSP2   SSP3
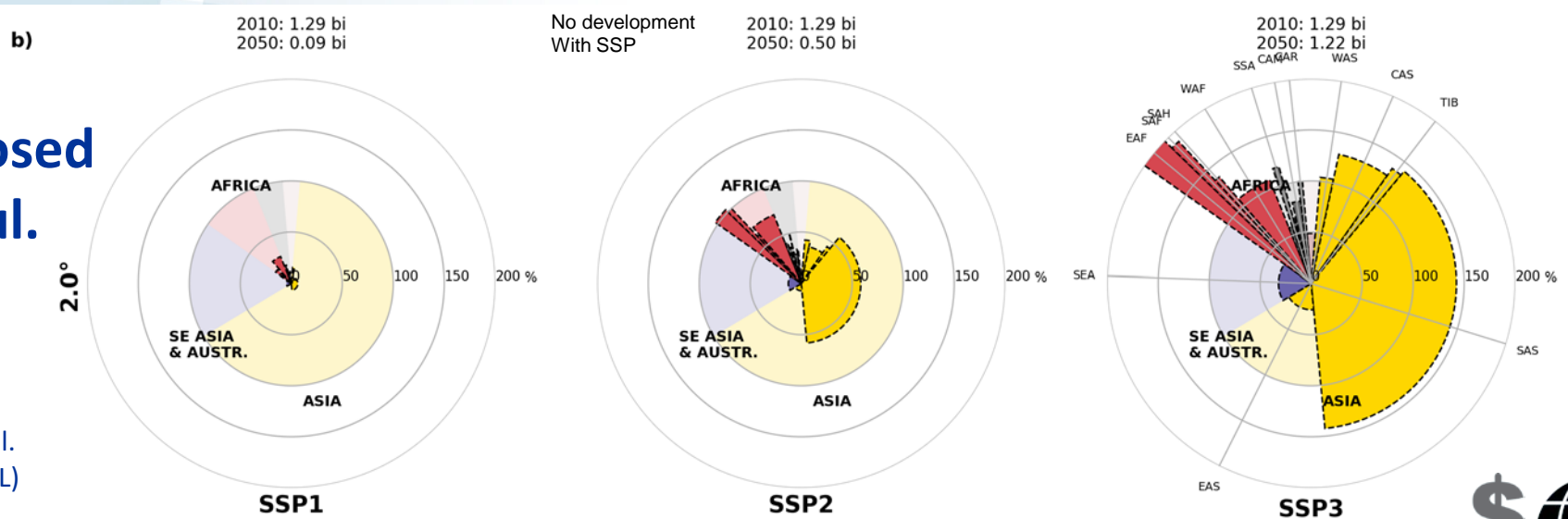
Sustainability   **Middle of the road**   **Rocky road**
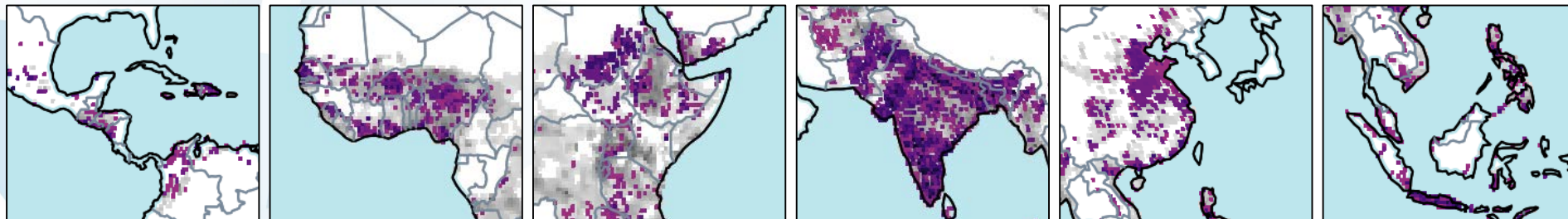
Byers et al.
(2018, ERL)

- 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,
… targeted in the most at-risk areas
to most effectively reduce vulnerabilities

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