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ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

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Multi-sector climate impacts assessment for water, energy and land

Edward Byers, Matthew Gidden, Peter Burek, David LeClere, Amanda Palazzo, Simon Parkinson, Joeri Rogelj, Yusuke Satoh, Yoshi Wada, Petr Havlik, Volker Krey, Simon Langan, Barbara Willaarts, Keywan Riahi

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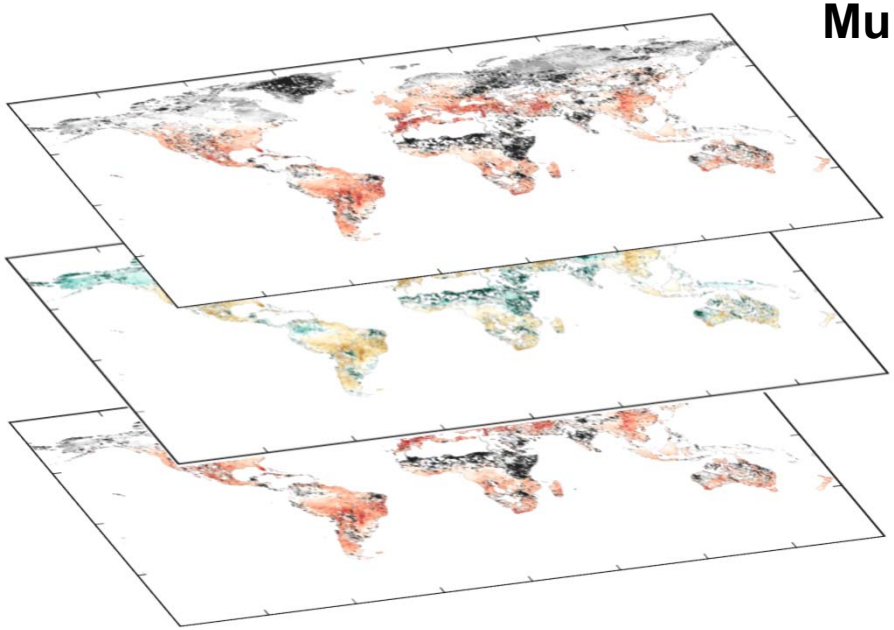
ISIMIP workshop 2017

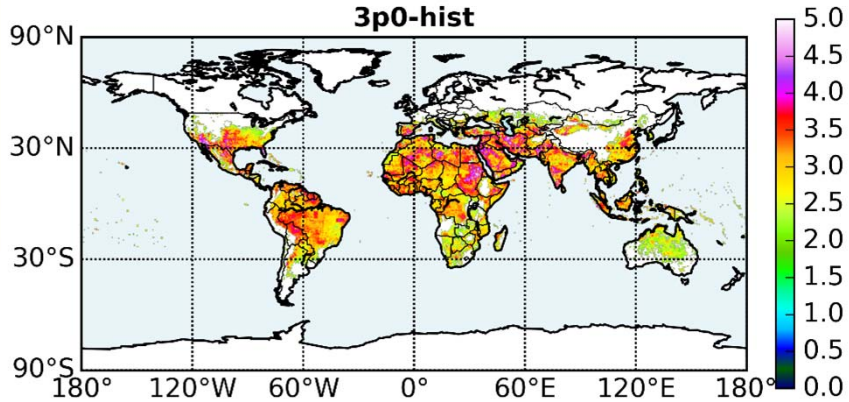
9th October 2017

Global mapping of multi-sector climate and vulnerability hotspots

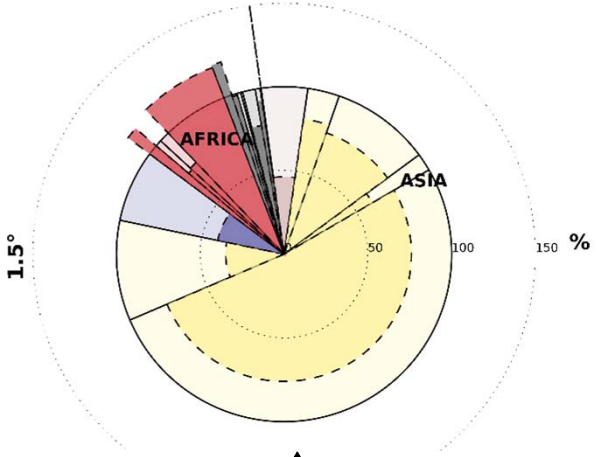
Multiple Indicators (~12) across 3 sectors



combined indicators



Regions with multi-sector climate hotspots and vulnerable populations



Downscaling future scenarios of socioeconomic change

- **Shared Socioeconomic Pathways (SSPs)**

O'Neill et al. (2014)

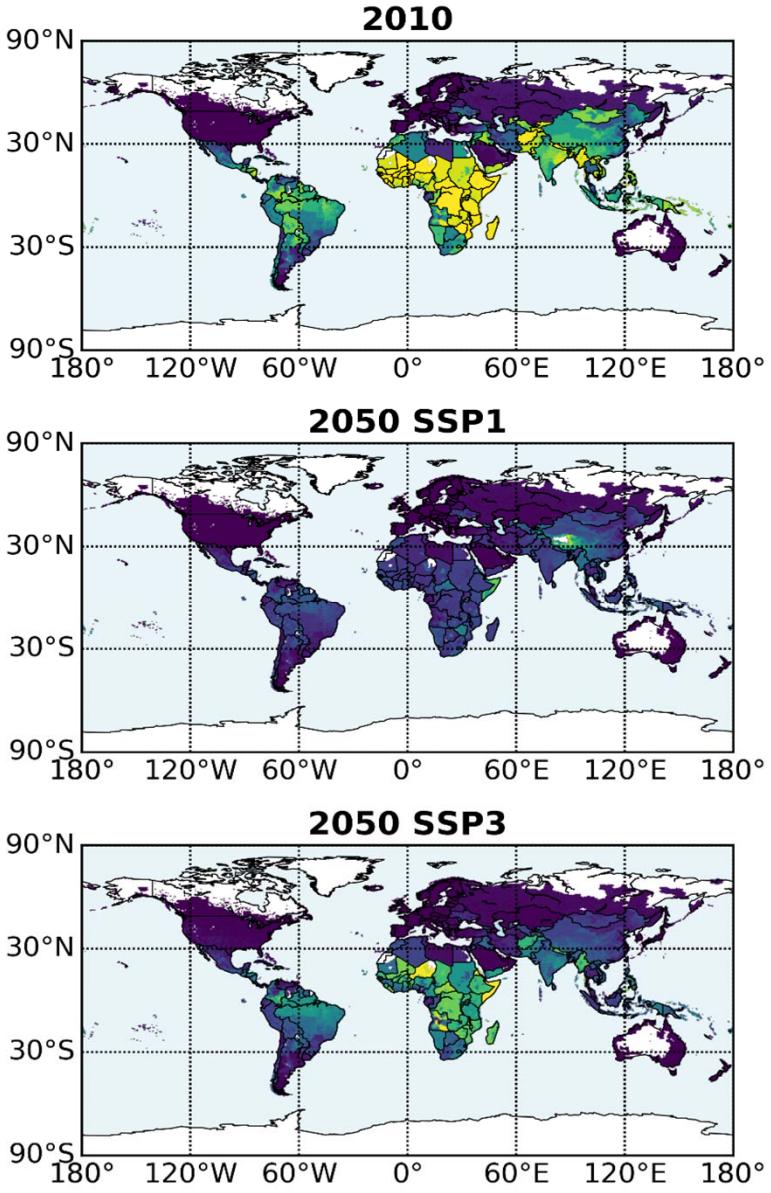
- **Population**
- **Urbanization**
- **GDP**
- **GINI (inequality)**
- **Income**

Jones & O'Neill (2016)
Jiang & O'Neill (2017)
Dellink et al. (2017)

Gridded to 0.125° (1/8th °)

Gidden et al. (…)

Who is vulnerable to poverty (<$10/day)?



Indicators

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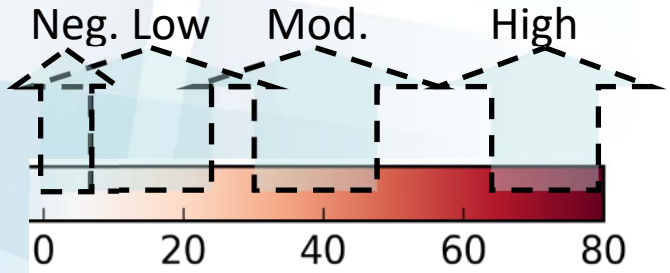
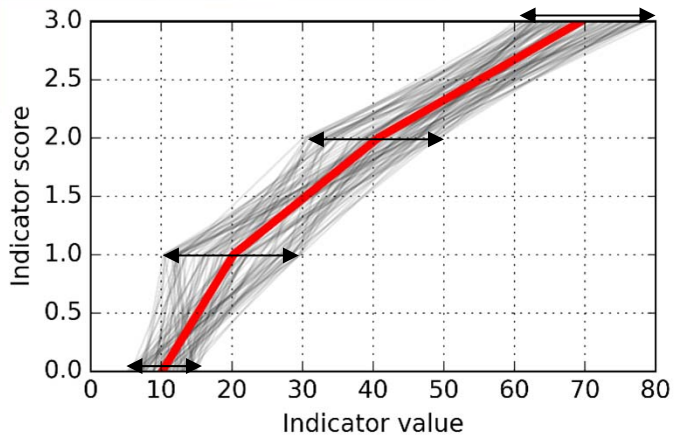
Indicator	Description	Models & data
Water		
Water stress index	Water stress index: as a proportion of human demands divided by renewable surface water resources	5 GCMs, 3 GHMs
Non-renewable GW abstraction index	Fraction of groundwater abstraction that is non-renewable	HadGEM2-ES + PCR-GLOBWB
Drought intensity	% change in drought intensity (deficit / duration)	5 GCMs, 4 GHMs
Peak flows risk	High fraction of ensemble agreement where substantial change in flood risk (doubling) is expected	5 GCMs, 4 GHMs
Seasonality	% change for the index of mean seasonality	5 GCMs, 4 GHMs
Inter-annual variability	% change for the index of mean inter-annual variability	5 GCMs, 4 GHMs
Energy		
Access to clean cooking	*Fraction of population with access to clean cooking*	MESSAGE + SSPs
Heatwave event exposure	Total days experienced as 5-day events above hist. p99 for locations where Tmean p99>26°C.	5 GCMs
Cooling demand growth	Measure absolute change in CDD>26°C.	5 GCMs
Hydroclimate risk to power production	Combined thermal and hydropower capacity impacted by changes in low flows, peak flows, drought intensity and variability	5 GCMs, 4 GHMs, Platts, Raptis
Land		
Crop yield	Mean change in crop yield as basket of staple crops	GLOBIOM
Water exploitation index	Identify major changes of agriculturally driven water exploitation	GLOBIOM + LPJmL
Habitat degradation	Change from non-ag to agricultural land use	GLOBIOM
Nitrogen leaching	*Measurement of excess nitrogen leaching due to intensive agriculture*	GLOBIOM

Climate change index scoring under uncertainty

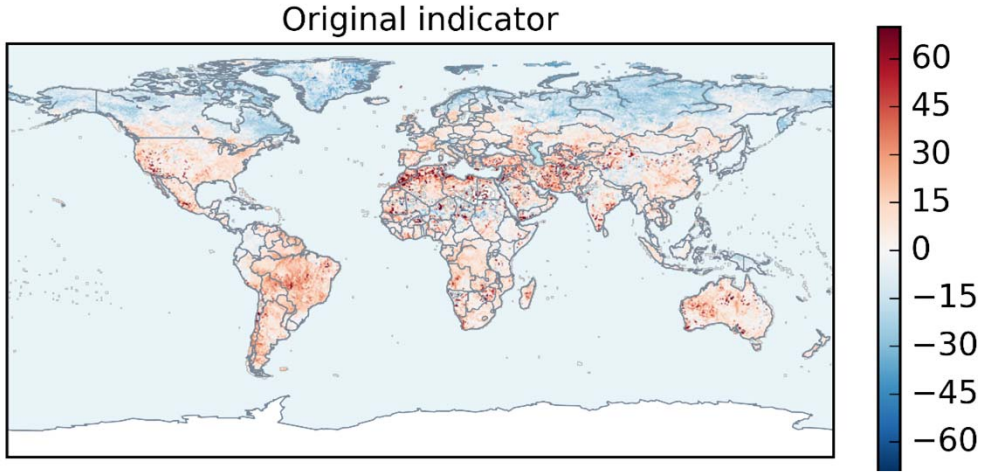
Continuous scale (0 to 3) with intermediate ranges determined

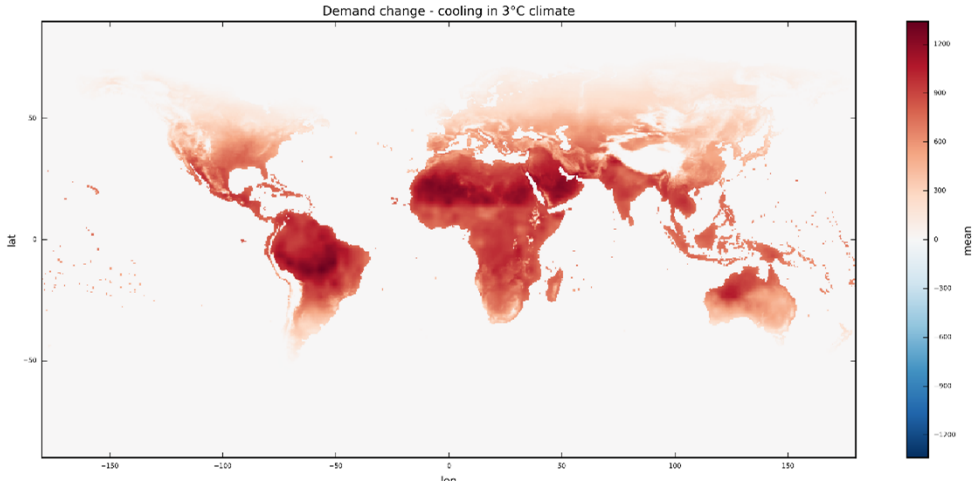
0. Negligible risk
1. Low risk
2. Moderate risk
3. High risk

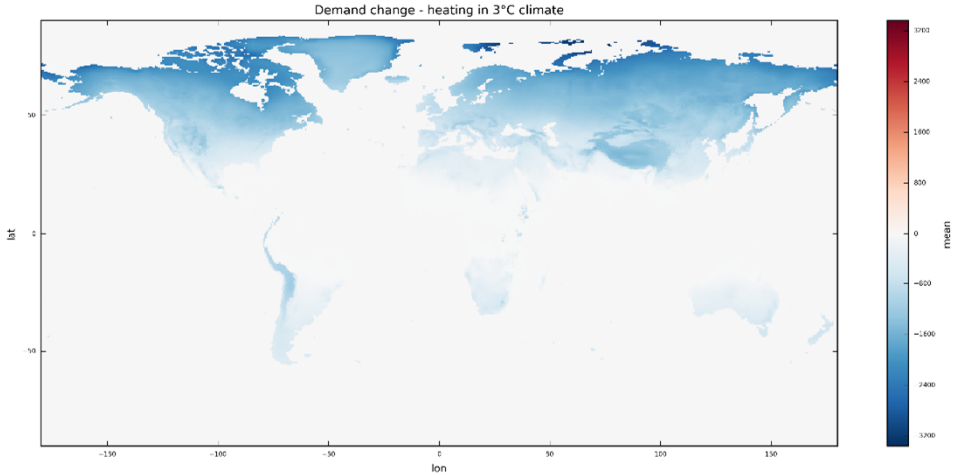


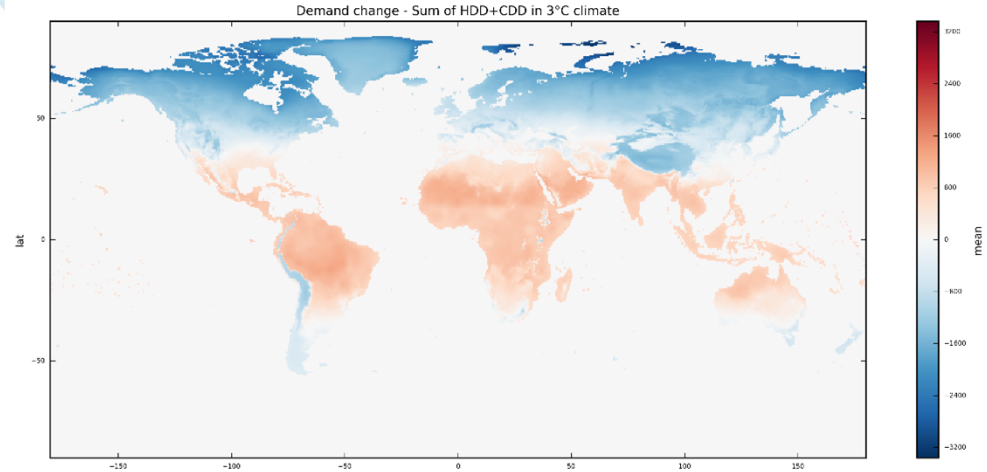


2.0°C climate example: Drought intensity change









Heating & cooling

COOLING ENERGY DEMANDS

- Poorer tropics see **increase** in cooling demands

HEATING ENERGY DEMANDS

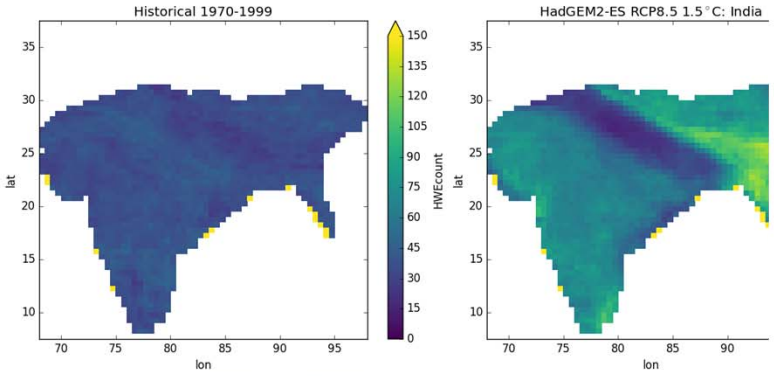
- Rich sees **reduction** in heating demands

OVERALL

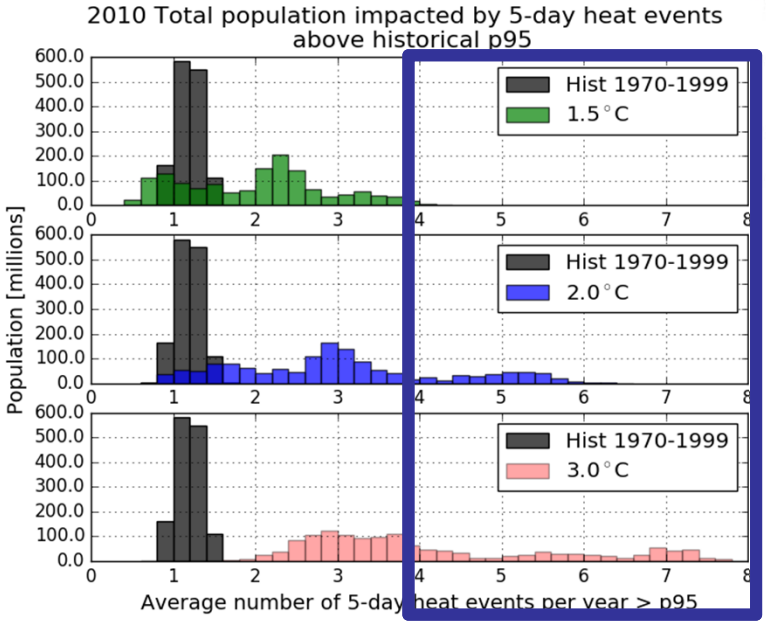
- **Energy savings for the "Rich North"**
- **Energy increases for the "Poor South"**

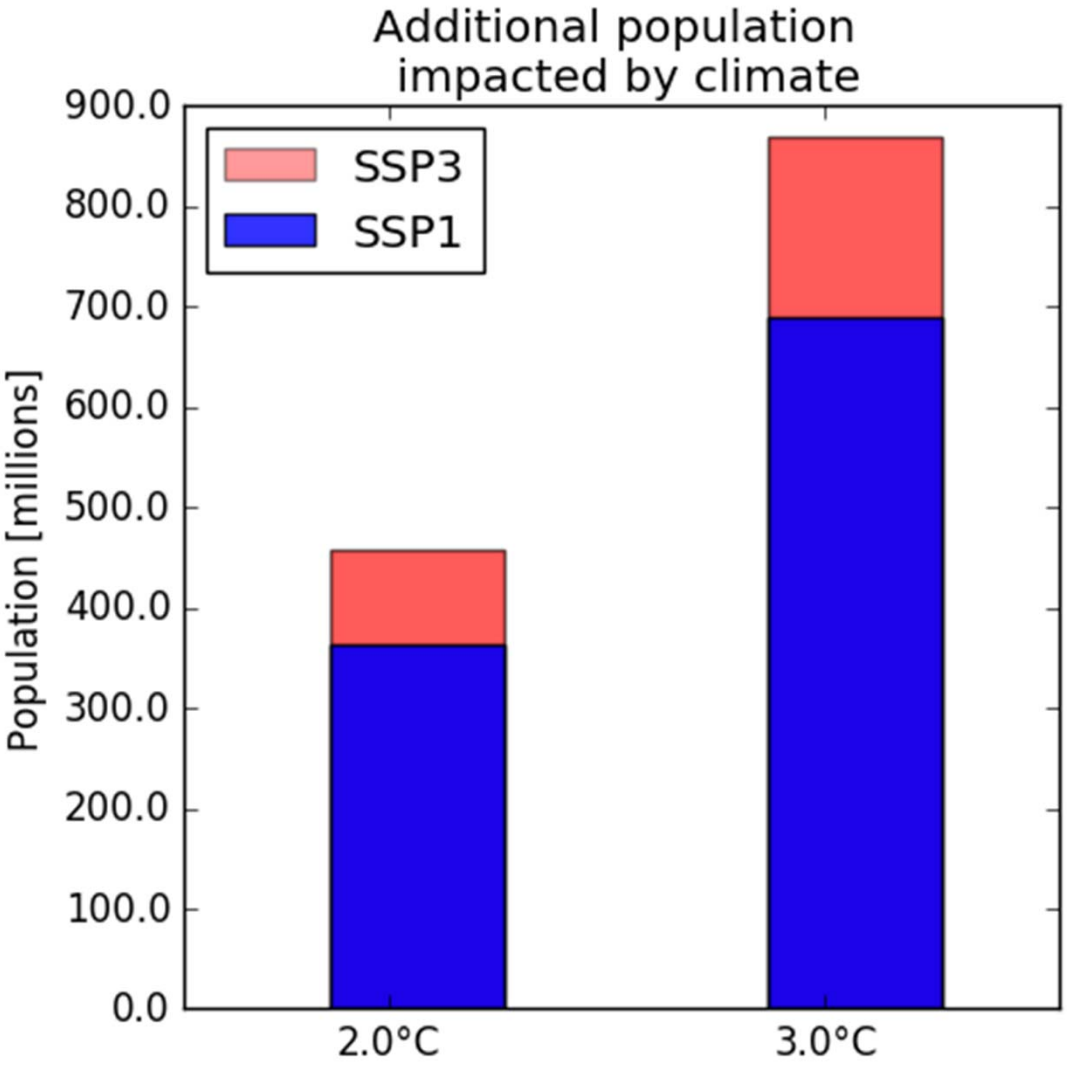
Example: South Asia heatwave events on population

In a 30-year period, how many "very hot" (>p95) 5-day events can be expected?



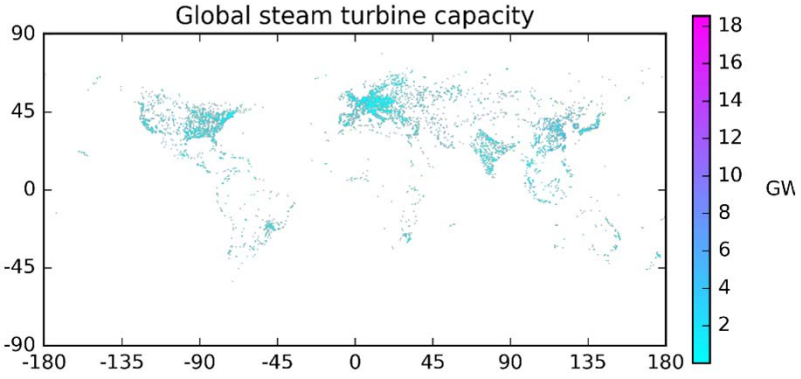
Hist	1.5°C



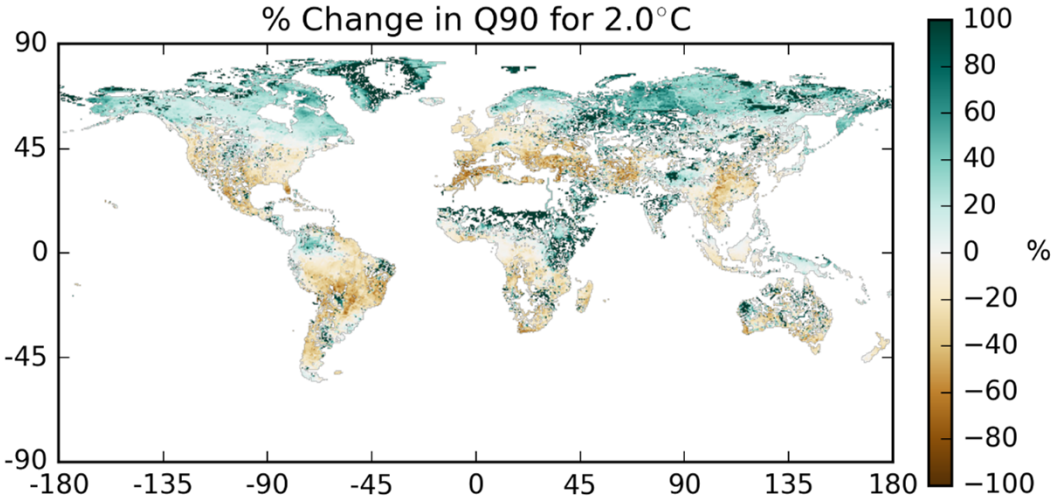


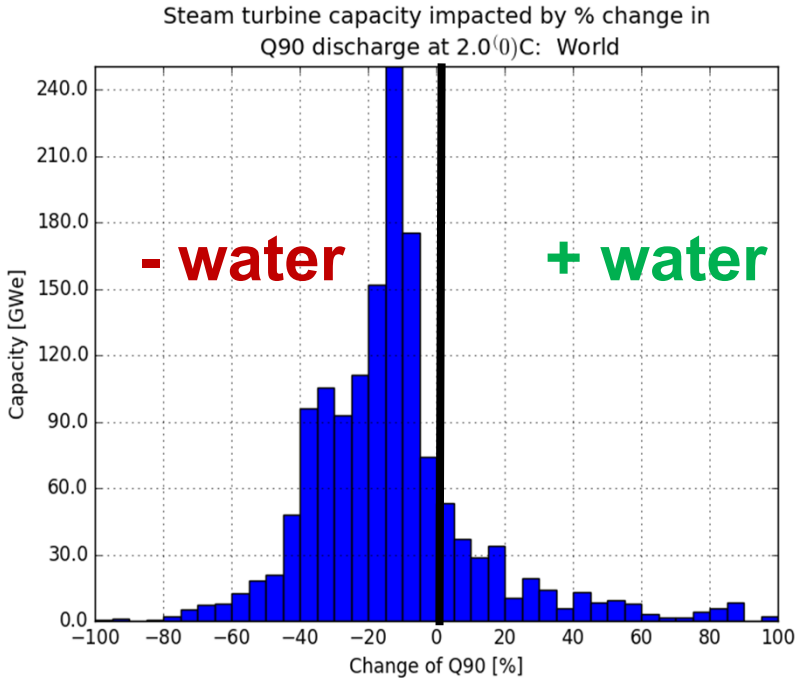
Example: hydroclimate impacts on steam turbine and hydro power plants

Powerplant database	
Fuel types	[coal, bio, gas, hydro,..., sun]
Unit types	[CCGT, ST, CT,...IC, HY]
Cooling systems	[ot_fresh, cl_fresh,... air]
Status	[Operational, Planned, Retired]



EXAMPLE Impact datasets

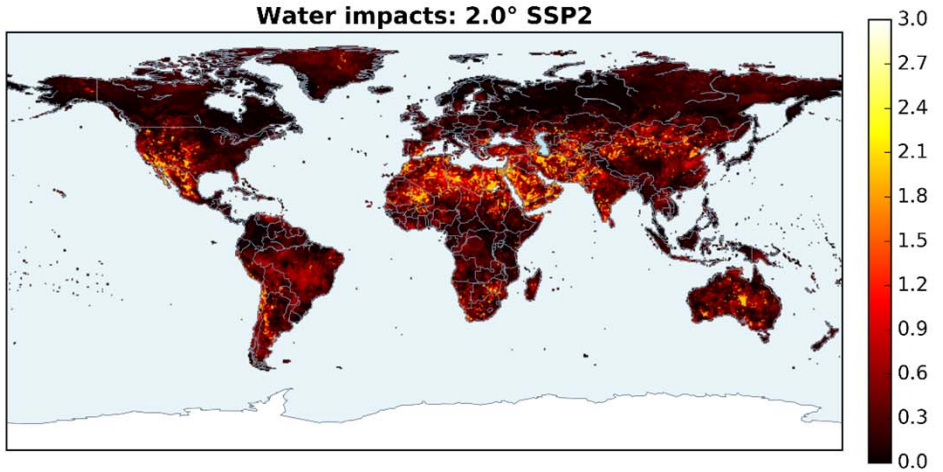


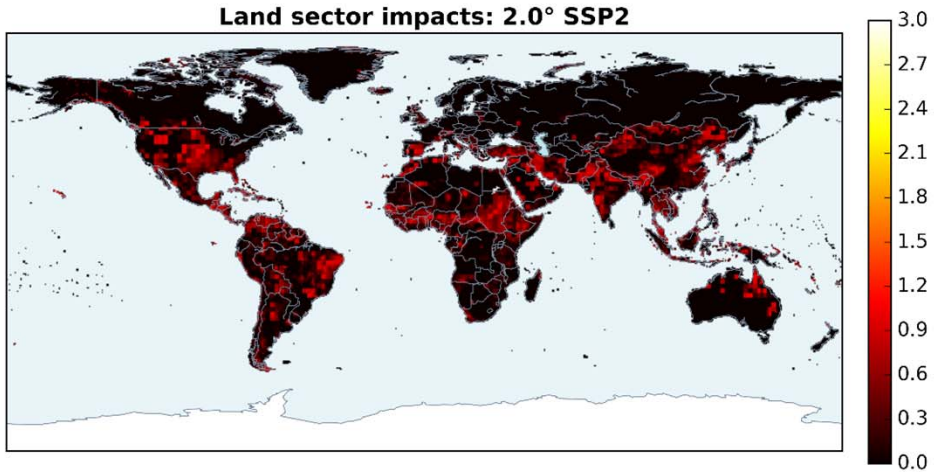


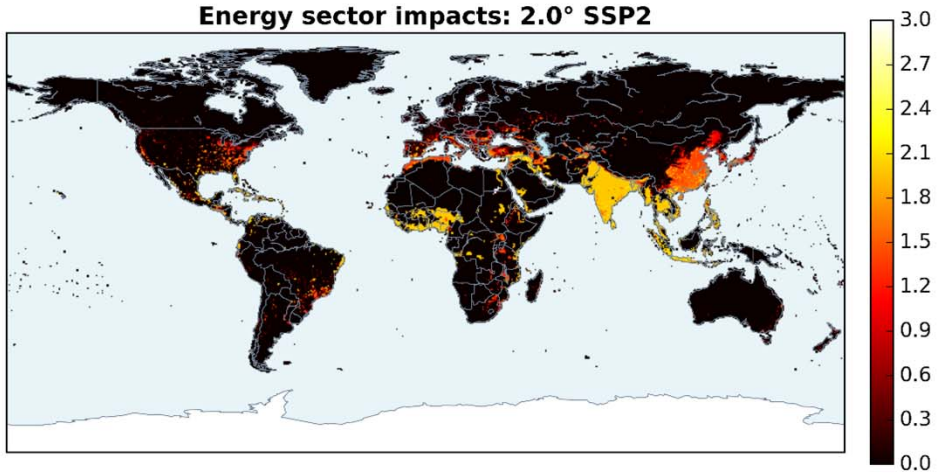
Sectoral aggregation

Combine average scores with ‘hotspot points’

- Scores are averaged within sectors and indicators can be weighted
- Hotspots:
  - Min. score 2 if 2 sectors > 2.5
  - Min. score 2 in 1 sector == 3.0



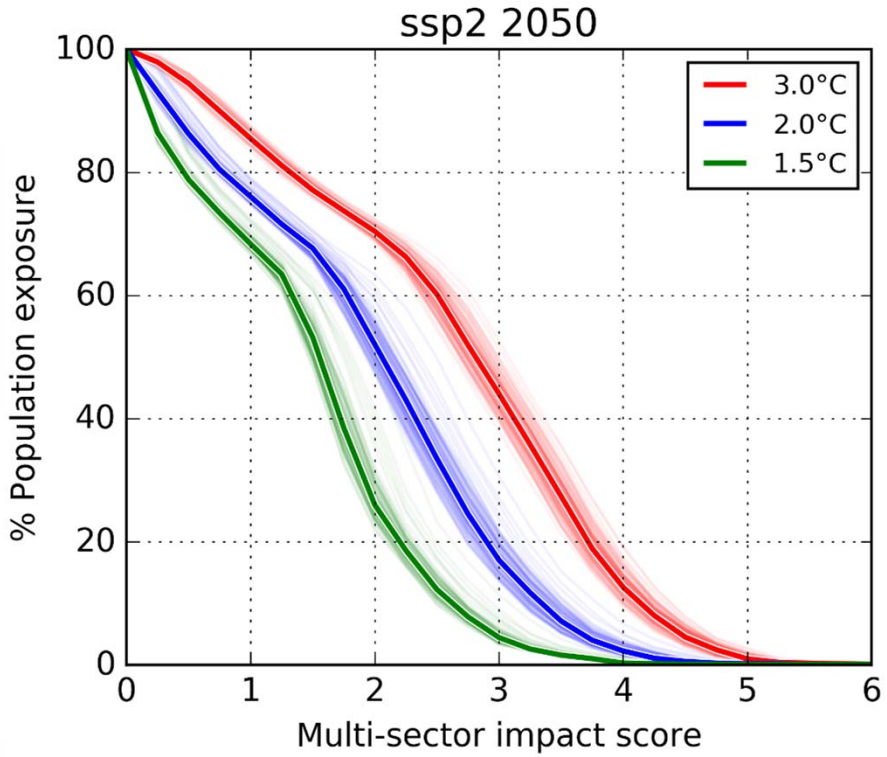


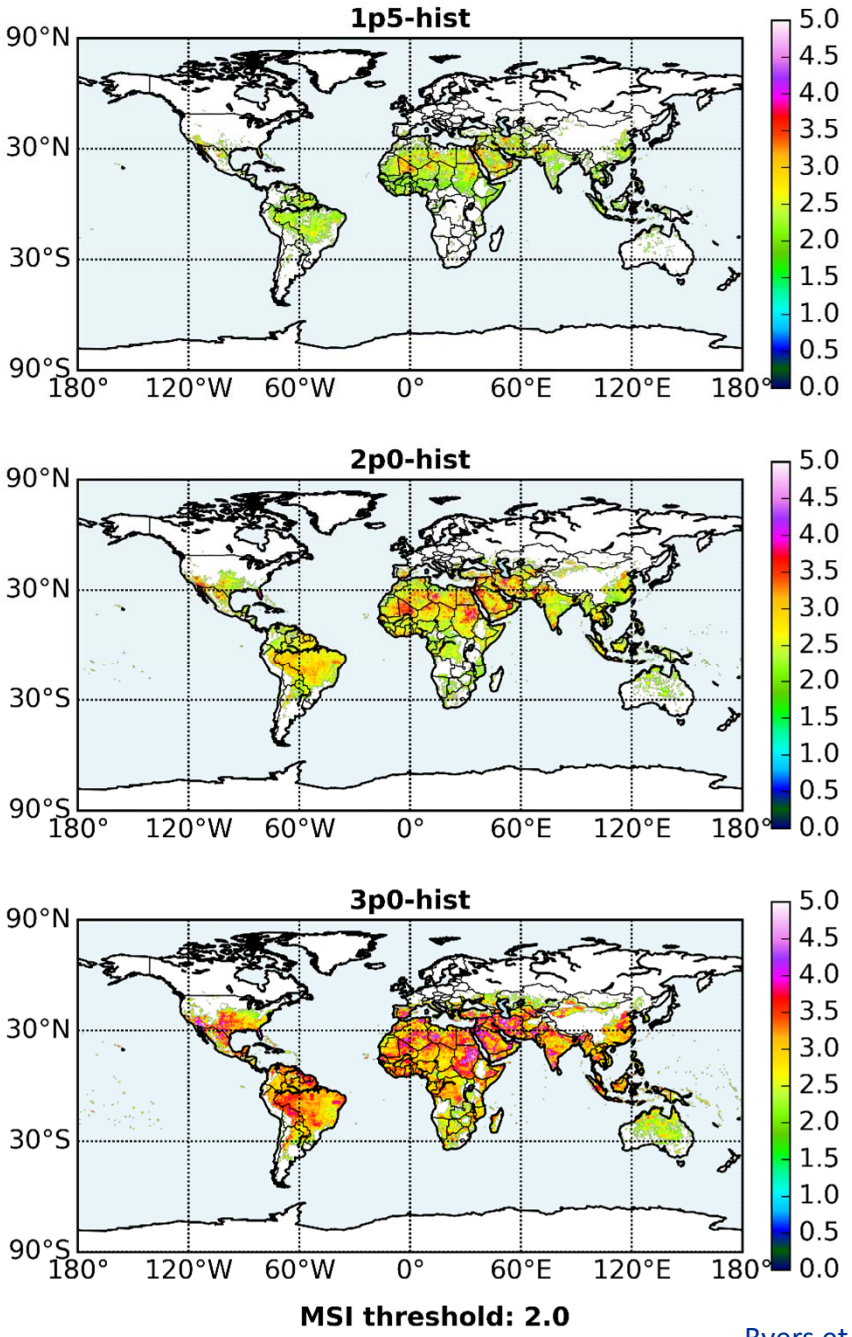


Byers et al. (…)

Hotspot areas

- **Growing in area**
- **Growing in intensity**

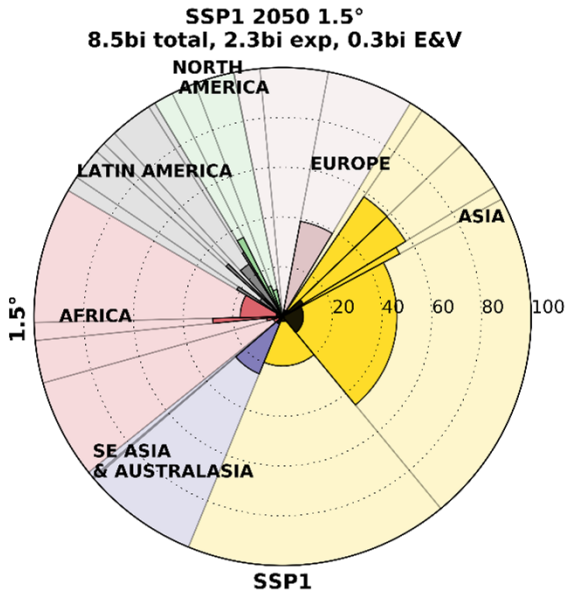


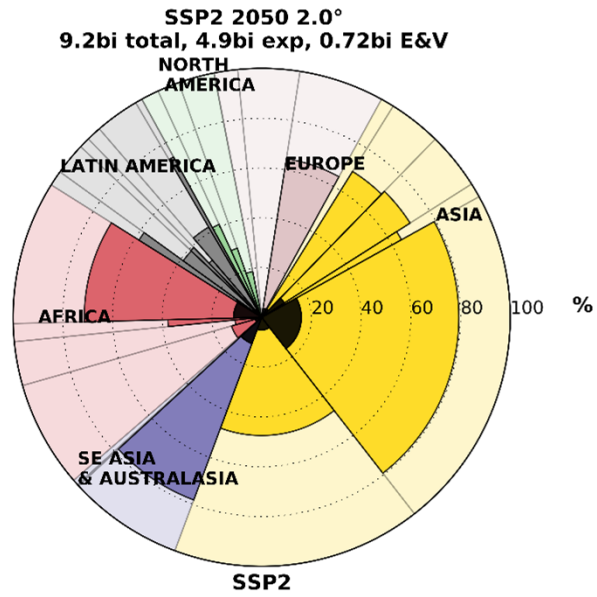


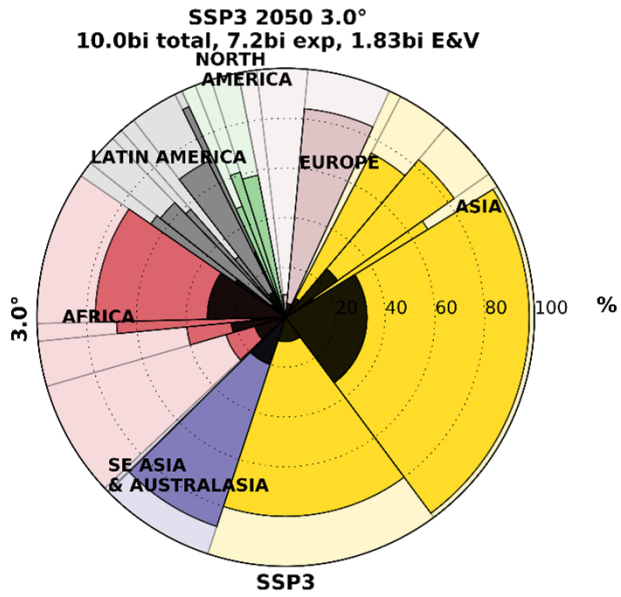
Byers et al. (...)

Exposure & vulnerability

2050	1.5°C / SSP1
T	8.5 bi
E	2.3 bi x2
V	1.1 bi
E&V	0.3 bi x2







Byers et al. (…)

Conclusions

Energy

- Energy sector is challenging because it spans from clean cooking access to high-tech infrastructure
- Projections of future capacity are still needed
- Temperature-related impacts are substantial for both H&C and heat-related stress

Overall

- Overall exposure depends most on GMT
- Reducing inequality and poverty is key to reducing the Exposed & Vulnerable population, regardless of GMT

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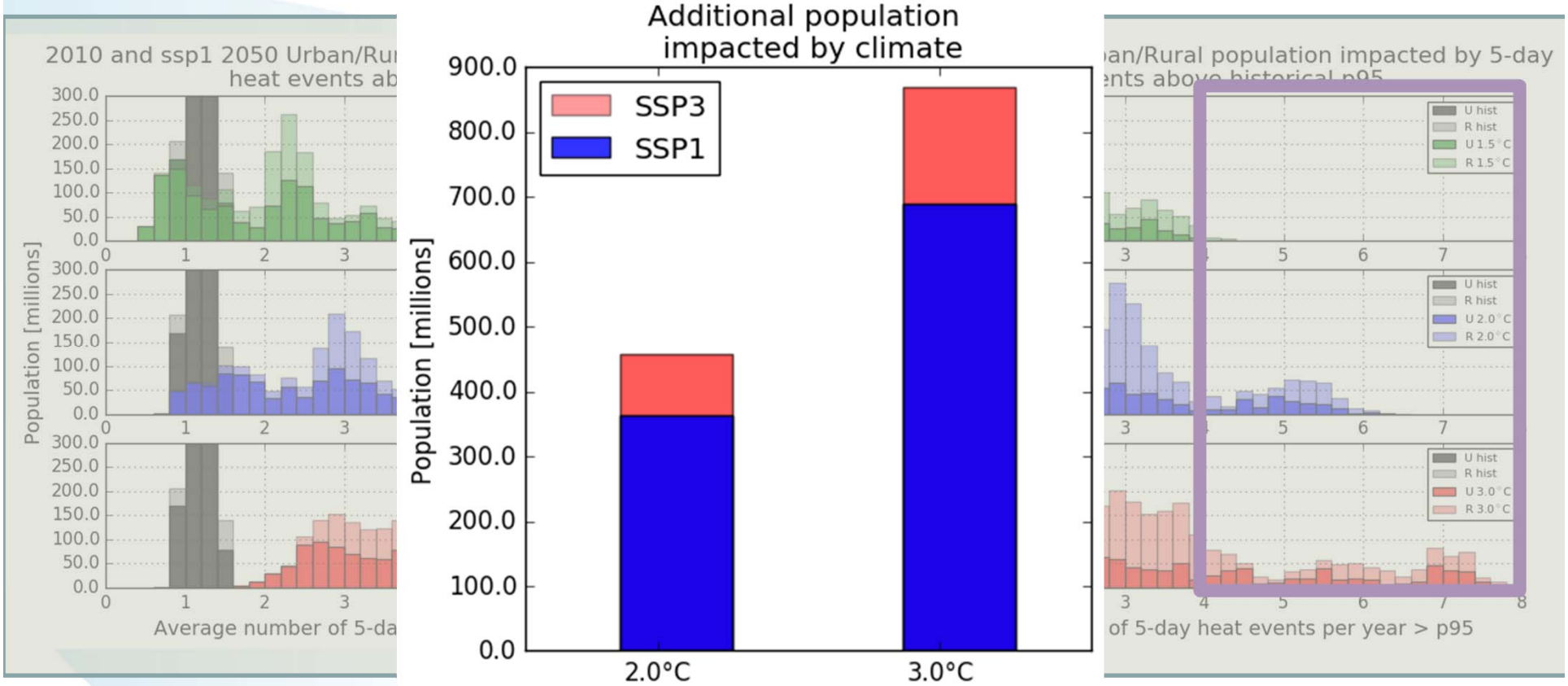
Additional slides

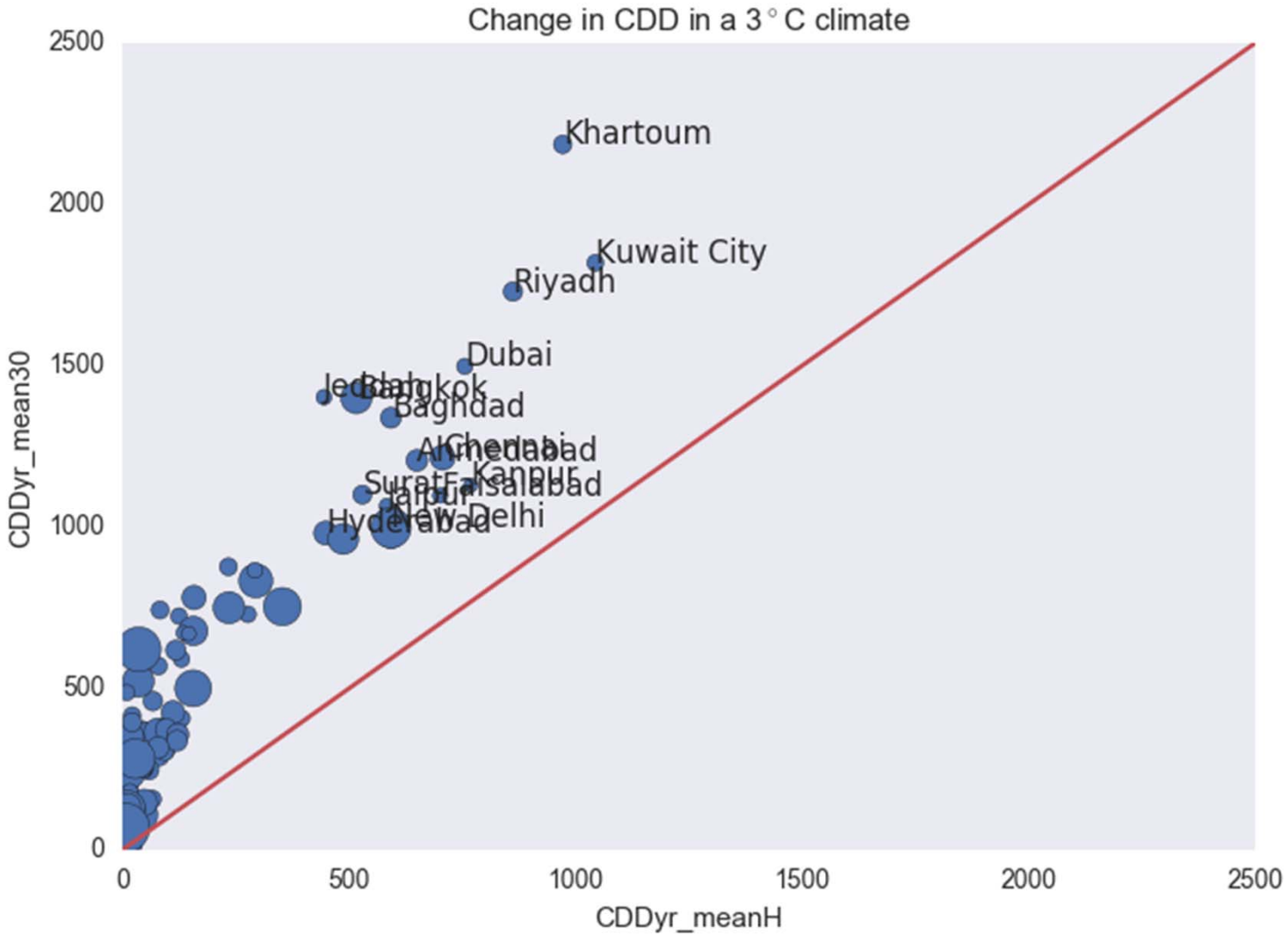
SSP1 & SSP3 compared in 2050



High urban population
More wealthy
Access to cooling

High rural population
Low cooling access and vulnerable

Cooling Demand in Top 150 Cities



Future 3°C

Historical