



OptimESM

Optimal high resolution **Earth System Models**
for exploring future climate change



ISIMIP
Inter-Sectoral Impact Model
Intercomparison Project

Future projections of climate impacts accounting for changes in Direct Human Forcings

- Concept of ISIMIP3b group III
- Status of group III forcing datasets
- Outlook on which simulations may be completed and when
- Further data needs and open questions
- Research ideas based on group III simulations

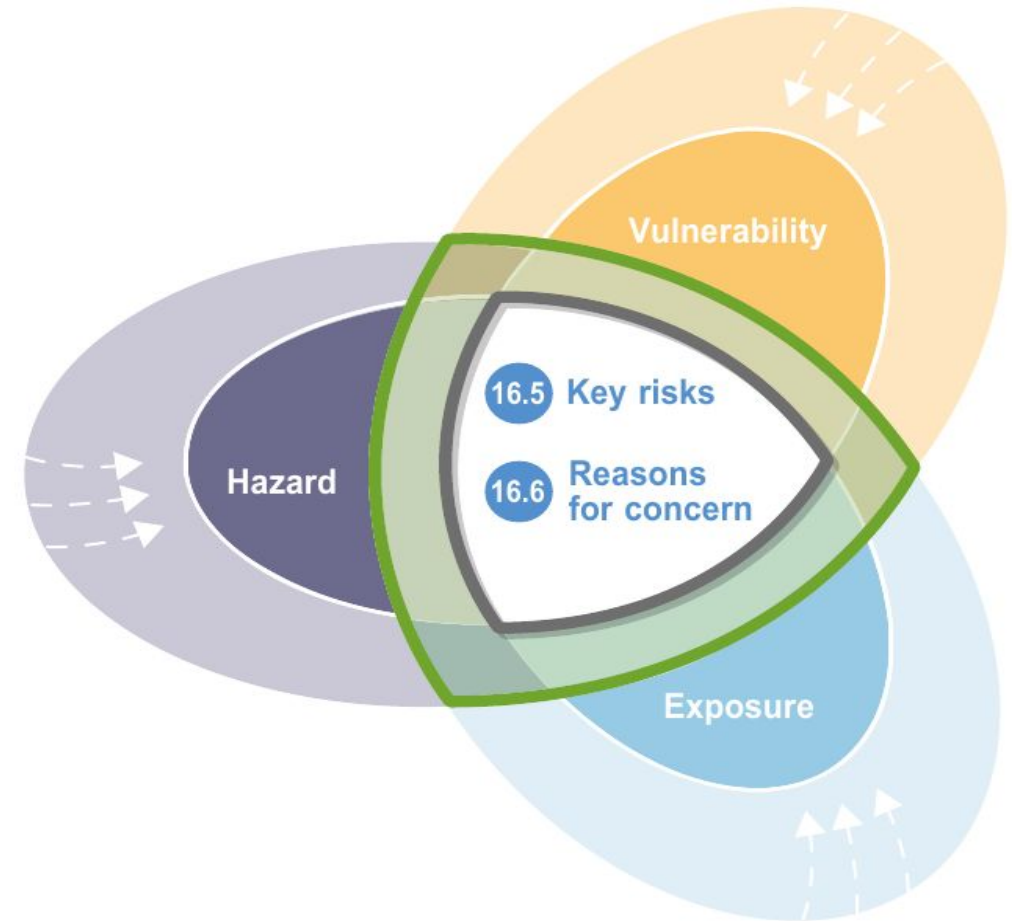
presentation

discussions

Why another set of ISIMIP future simulations?

Severity of Key Risk Depends on Direct Human Forcing and Adaptation

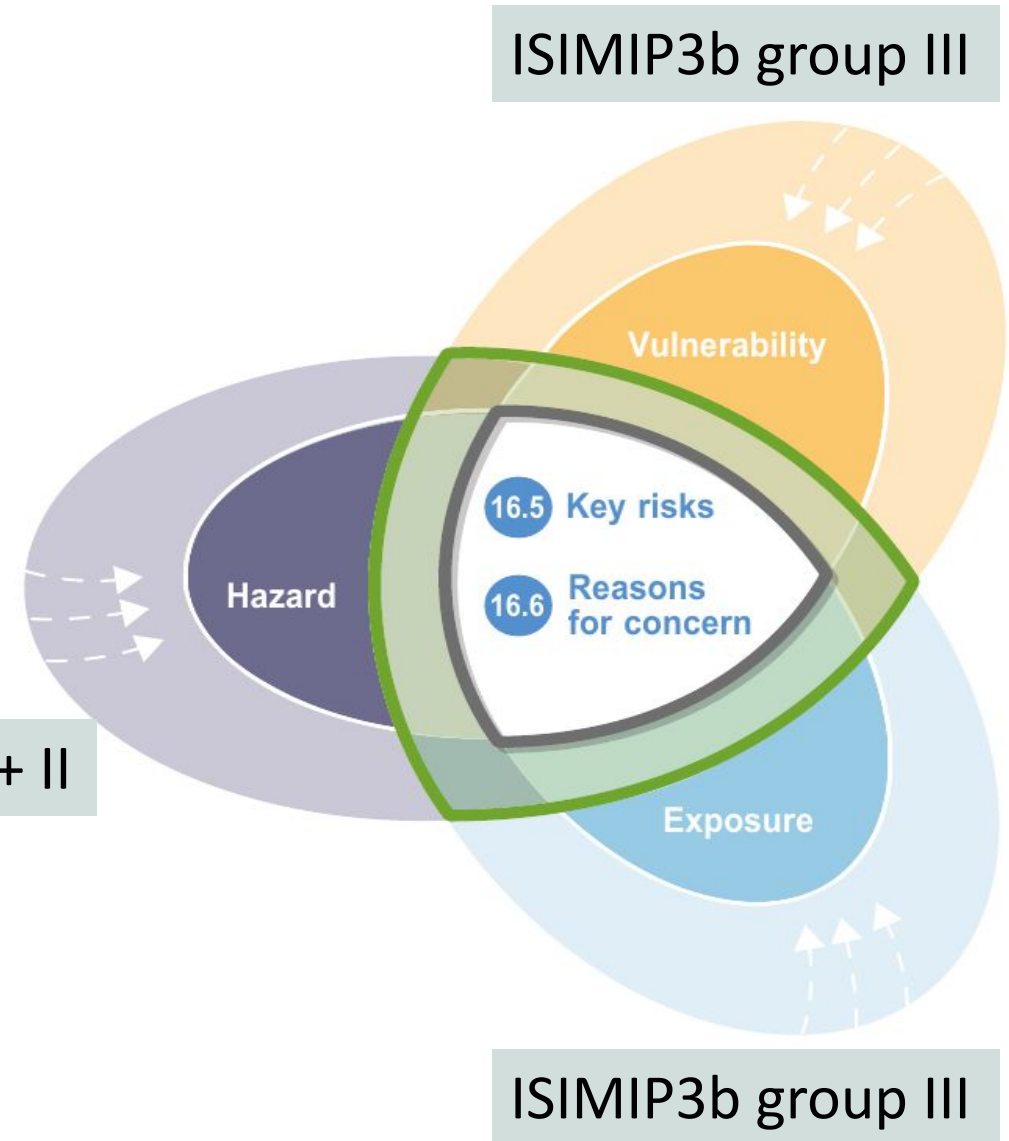
- › *“Representative key risks are expected to increase in the coming decades and will depend strongly **not only on how much climate change occurs, but also on how the exposure and vulnerability of society changes, as well as on the extent to which adaptation efforts will be effective enough to substantially reduce the magnitude of severe risks.**”*
- › key risks are by definition cross-sectoral (e.g. risk to peace and human mobility, food security, human health, living standards, critical infrastructures, networks and services) and depend on the changing direct human forcing



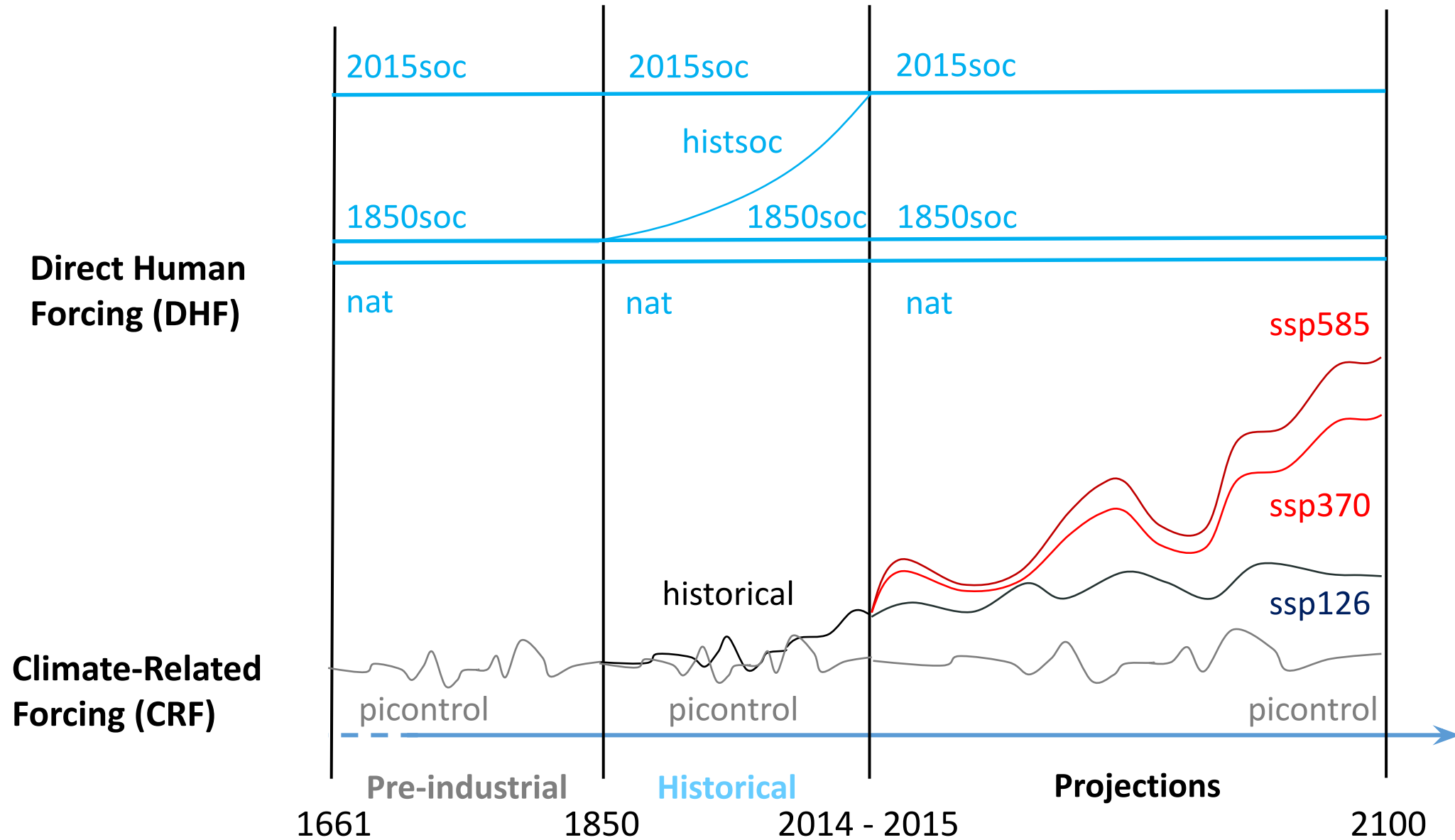
Why another set of ISIMIP future simulations?

- Integration of mitigation measures and remaining impacts (e.g. bioenergy crops, hydropower dams...)
- Development of adaptation scenario
- Evaluation of various adaptation measures (AC deployment, seawater desalination...)

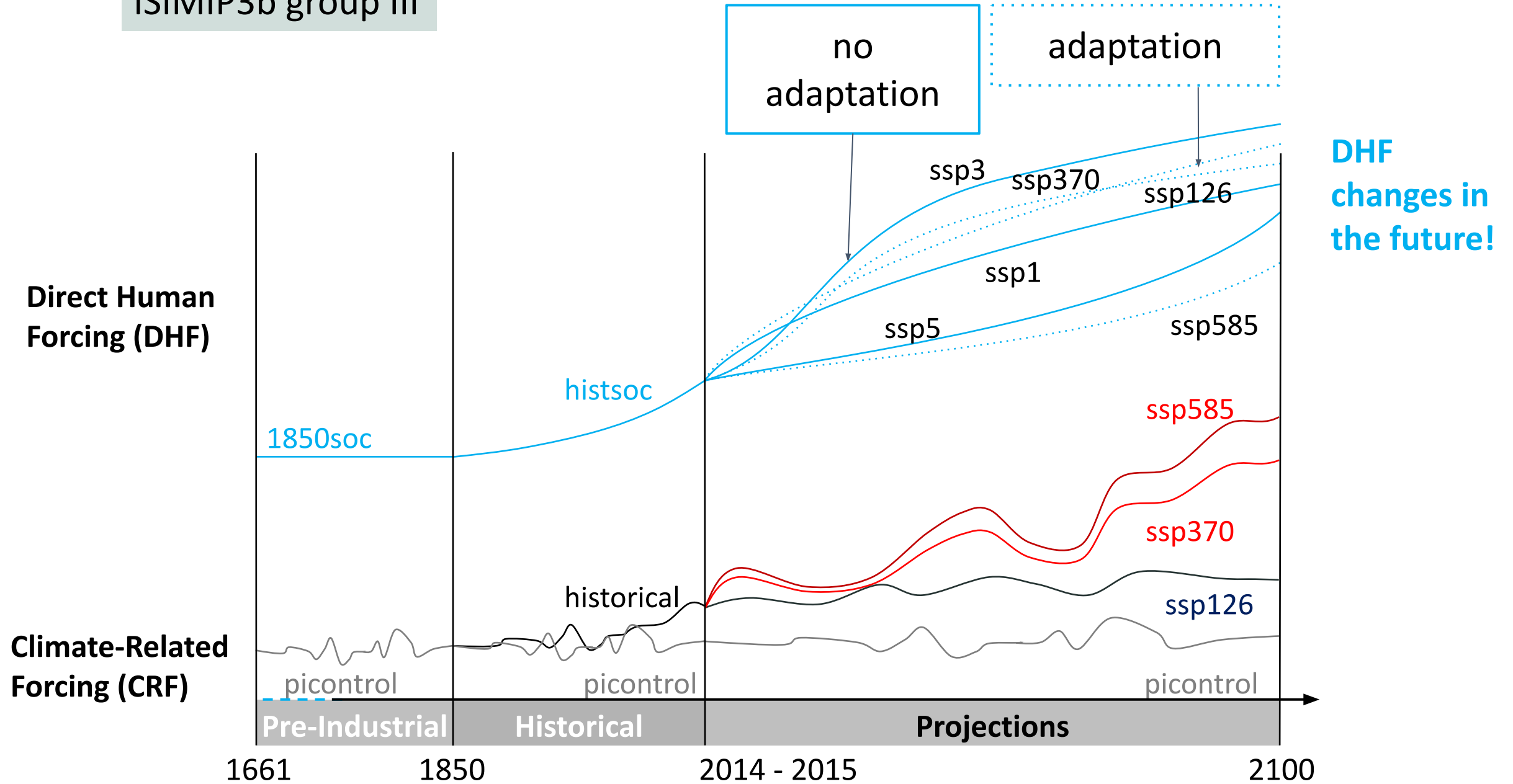
ISIMIP3b group I + II



ISIMIP3b group I + II

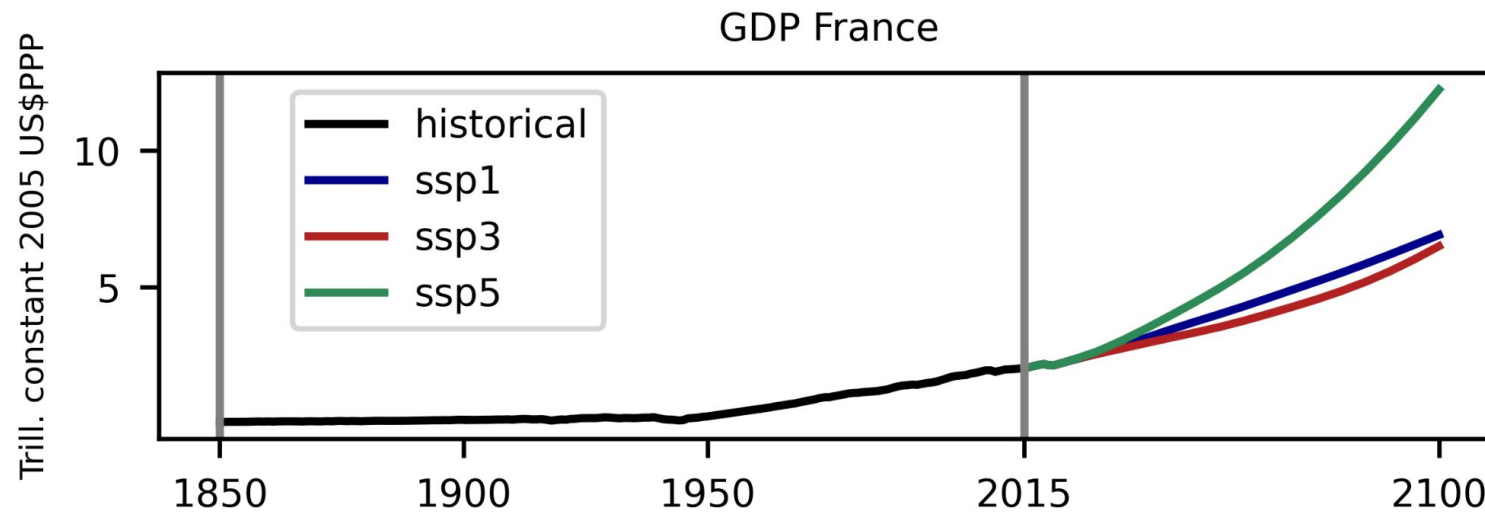
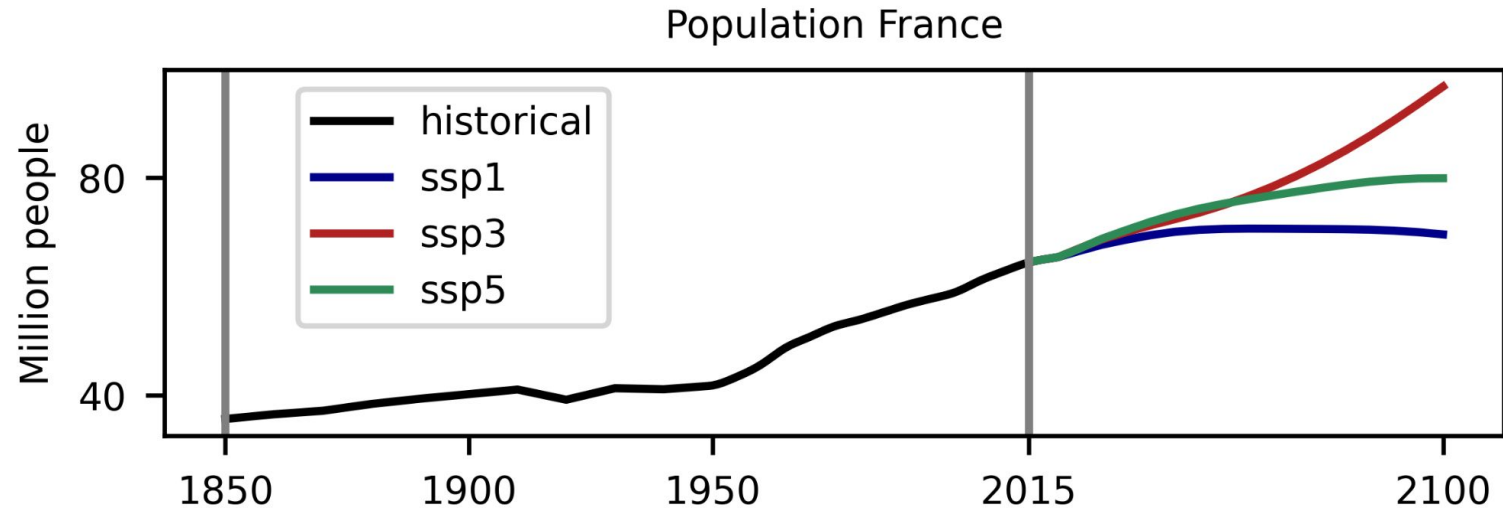


ISIMIP3b group III

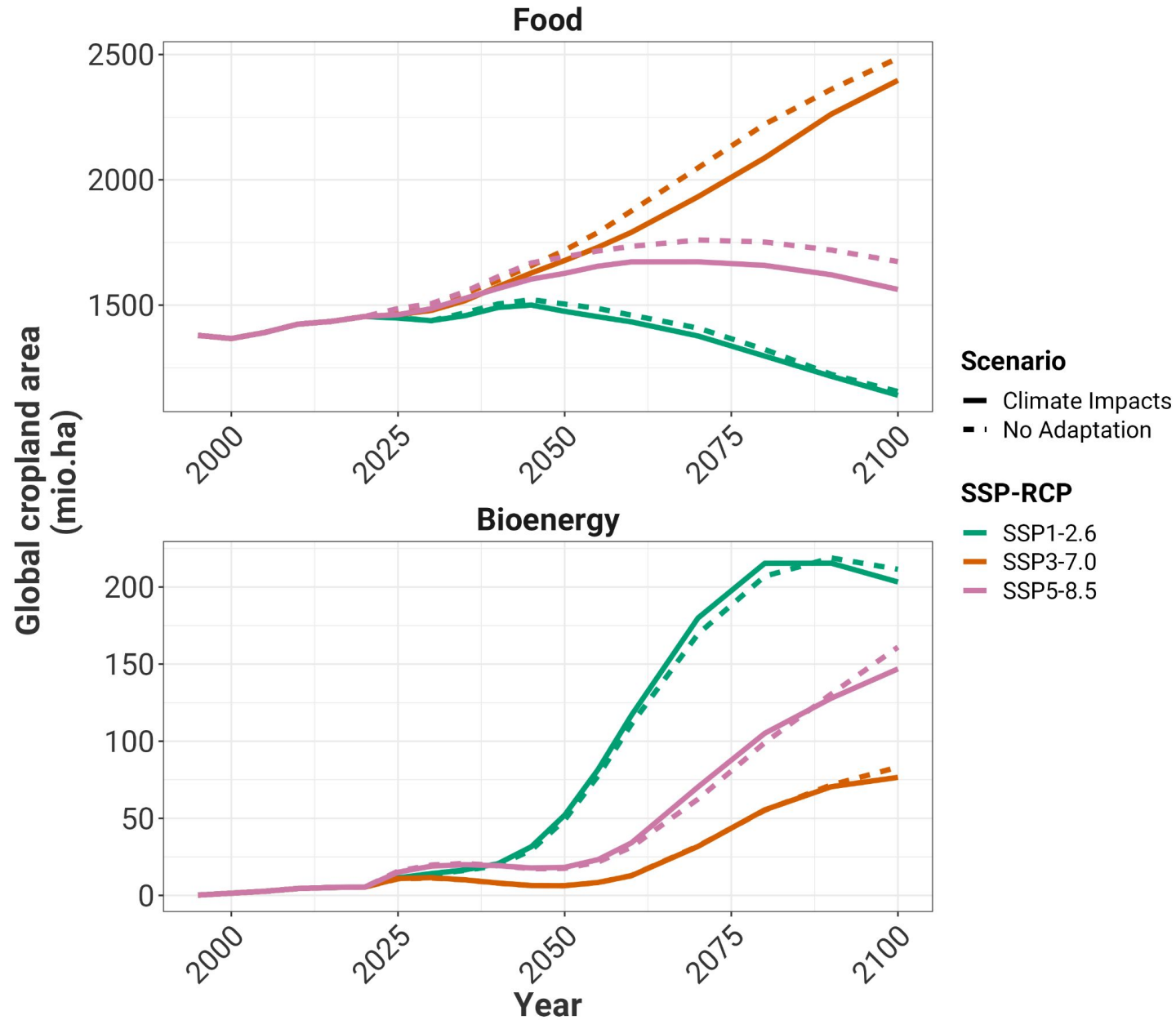


Direct human forcing for ISIMIP3b group III: examples

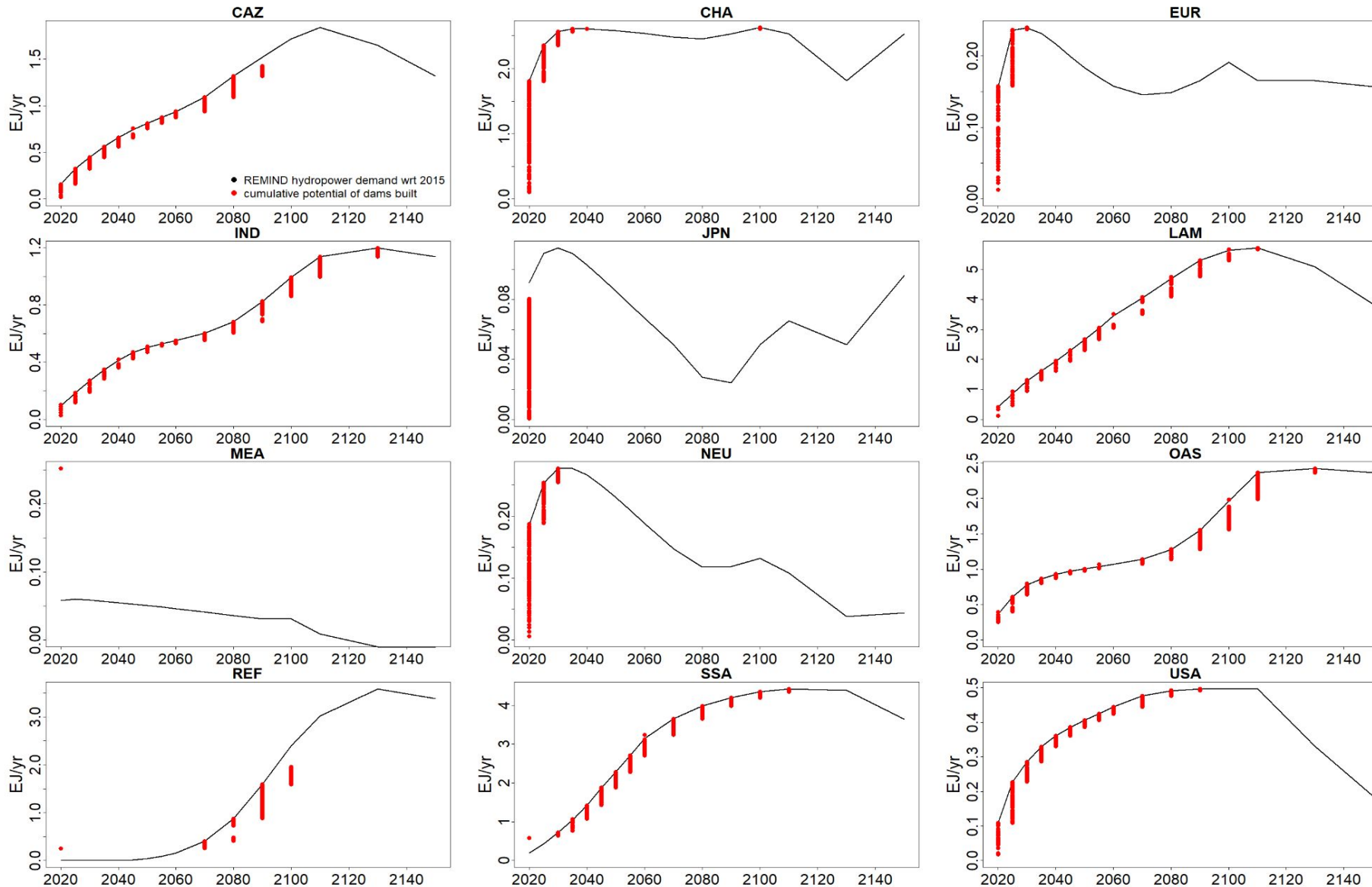
Changes in Direct Human Forcings - Population and GDP



Changes in Direct Human Forcings - Land use



Changes in Direct Human Forcings - Hydropower dams



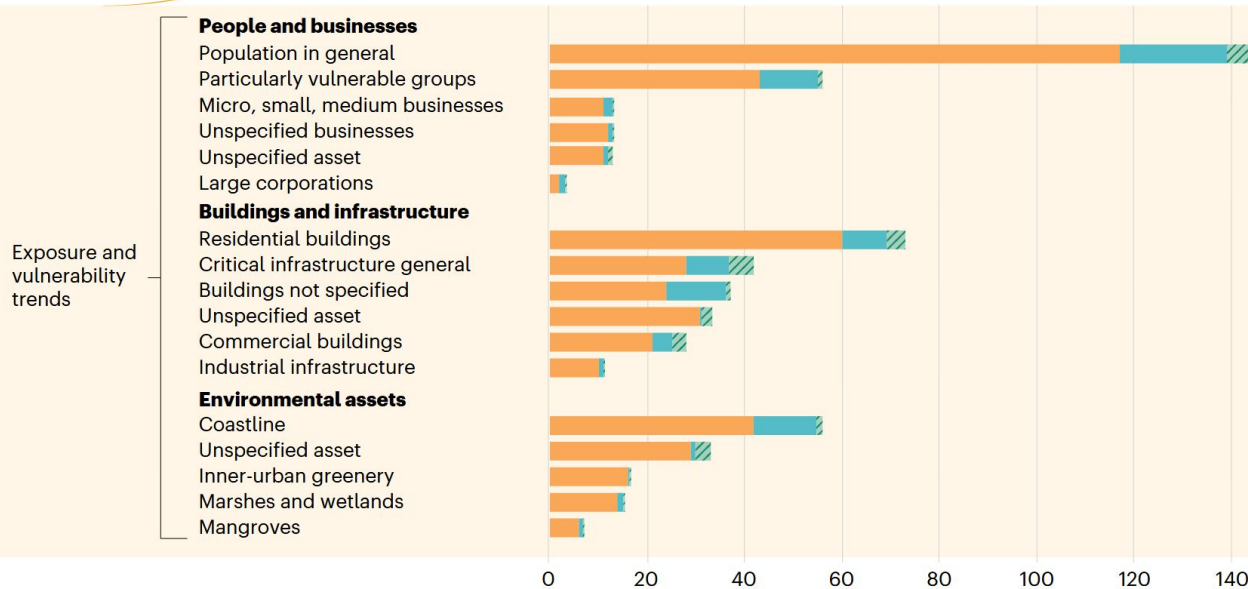
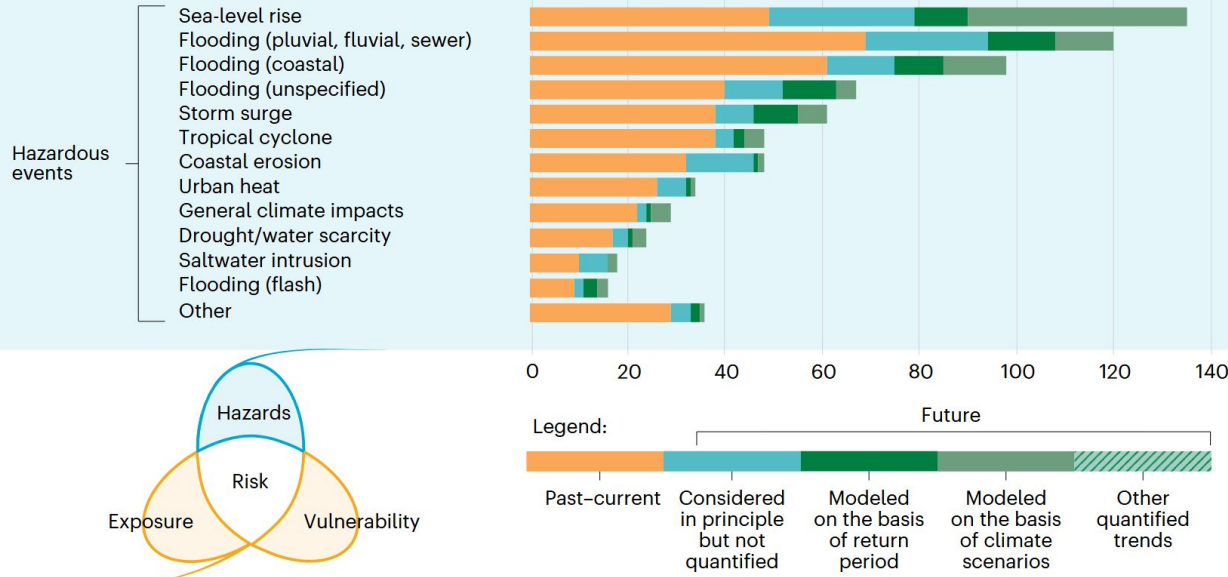
Changes in
hydropower
demand
(SSP585)

Cumulative
potential of new
dams

Information gap in adaptation action

“In the vast majority of coastal cities, reported adaptation considers **only past and current patterns** [of exposure and vulnerability of people and assets]... In scenarios in which future trends in exposed and vulnerable assets are considered, they are accounted for in a general or conceptual way, but **not in terms of quantified scenarios.**”
(Wannewitz et al., 2024, Nature Cities)

Number of cities considering different risk factors and their temporal dynamics in reported adaptation processes



Group III forcing datasets

Land use (fraction of grid cell)
Irrigation (fraction of grid cell)
Land transformation
Synthetic fertilizers N (disaggregated)
Total N deposition
Crop calendar

Gridded Population: total, urban, rural (people/yr)
National Population: total, urban, rural (people/yr)
Gridded Gross domestic product Int\$ PPP 2005
National Gross domestic product Int\$ PPP 2005 and GDP in MER 2005

Wood harvest
Dams and reservoirs
Non-irrigation water use (withdrawal and consumption)
Seawater desalination
Inter-basin water transfer
Irrigation techniques share

Sectors ready to start Group III:

- Water (global)
- Energy (demand)
- Fire
- Permafrost
- Biomes (*almost*)
- Agriculture (*almost*)

Sectors with no Group III plan yet:

- Food Security and Nutrition
- Groundwater
- Labour
- Lakes
- Water regional
- ...plus sectors with no ISIMIP3b protocol

Under construction:

Animal manure N
Animal manure P
Livestock numbers
Synthetic fertilizers (P) on cropland
Synthetic fertilizers (P) on grassland
Marine fishing effort
Forest management

Sectors where Group III input data is under construction:

- Water quality
- Marine Ecosystems & Fisheries
- Forests (regional)
- Peatland

Now ready!

Almost ready!

Anything missing? Let us know!



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Show protocol for:

☐ ISIMIP3a

☒ ISIMIP3b

☐ only Group III

Filter for sectors:

☒ Agriculture

☐ Biomes

☐ Energy (demand)

☐ Fire

☐ Food Security and Nutrition

☐ Groundwater

☐ Labour

☐ Lakes (global)

☐ Lakes (local)

☐ Fisheries and Marine Ecosystems
(global)

☐ Fisheries and Marine Ecosystems
(regional)

☐ Peatland

☐ Permafrost

☐ Water (global)

☐ Water (regional)



ISIMIP3b

Group III

data updates

Provision of
gridded GDP and
disaggregated
fertilizer inputs

Show protocol for:

☐ ISIMIP3a

☒ ISIMIP3b

☐ only Group III

Filter for sectors:

☒ Agriculture

☐ Biomes

☐ Energy (demand)

☐ Fire

☐ Food Security and Nutrition

☐ Groundwater

☐ Labour

☐ Lakes (global)

☐ Lakes (local)

☐ Fisheries and Marine Ecosystems
(global)

☐ Fisheries and Marine Ecosystems
(regional)

☐ Peatland

☐ Permafrost

☐ Water (global)

☐ Water (regional)



Models getting ready to run Group III

4 models are already running Group III simulations!

~13 more models are getting ready!

~15 more models are planning simulations. → Number may rise during this workshop :)

sector	Water Quality	Peat	Water-global	Biomes	Agriculture	Energy	Forests regional	Fire
running/ completed				1		1	2	
preparing	2		3	4	?		4	
planning		1		2-3	?		4	6-8

Group III simulations: Progress by sector

Lakes: not started yet and currently no capacities to implement into the models

Agriculture: ready to start as soon as fertilizer inputs are ready.

Water Quality:

- Group III protocol in development; input data under construction
- future timeline will depend on input data from other sectors
- challenge: diversity of water quality models, respective data needs

Group III simulations: Progress by sector

Peat:

- Needs additional inputs (peat type areas, drainage depth and density)
- LPX-Bern could run simulations early 2026; LPJ-GUESS and JULES-Peat are interested

Water global:

- 3 models ready to start, outputs expected after ca. 3 months after additional DHF is available, i.e. late summer/autumn 2025;
- Questions around implementation of some of the new forcings (e.g. irrigation techniques) -> **sectoral session**
- Some resource constraints to complete the simulations. -> **see priorities in the protocol**

2.3 Group III experiment priorities

ISIMIP3b

Table 2.5 lists the priorities for the different **group III** experiments in ISIMIP3b. We kindly ask you to run the experiments marked as **Tier 1: Core set** in any case and the other experiments with the priority given.

Table 2.5: Experiment priorities for ISIMIP3b group III.

Priority	Climate forcing	LU model	Direct human forcing	Show all tiers
Tier 1: Core set				Hide tier ^
1	GFDL-ESM4	IMAGE	ssp585-noadapt	
2	GFDL-ESM4	MAGPIE	ssp585-noadapt	
3	GFDL-ESM4	GLOBIOM	ssp585-noadapt	
4	GFDL-ESM4	IMAGE	ssp585-adapt	
5	UKESM1-0-LL	IMAGE	ssp585-noadapt	
6	MPI-ESM1-2-HR	IMAGE	ssp585-noadapt	
7	IPSL-CM6A-LR	IMAGE	ssp585-noadapt	
8	MRI-ESM2-0	IMAGE	ssp585-noadapt	
9	GFDL-ESM4	IMAGE	ssp126-noadapt	
10	GFDL-ESM4	IMAGE	ssp126-adapt	
11	GFDL-ESM4	IMAGE	ssp370-noadapt	
12	GFDL-ESM4	IMAGE	ssp370-adapt	
Tier 2: Complete ssp585 adapt runs for IMAGE and GFDL-ESM4				Show tier v
Tier 3: Complete land use models for GFDL-ESM4 (ssp126)				Show tier v
Tier 4: Complete land use models for UKESM1-0-LL (ssp585, ssp126)				Show tier v



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Group III simulations: Progress by sector

Labour: Group III protocol under development

Biomes:

- Running: VISIT
- Runs planned: CLM, LPJmL, ORCHIDEE,...
- LPJmL waiting for inputs (fertilizer, water use, maybe irrigation technique scenarios, dams, manure) -> now all available except fertilizer (almost ready) and manure
- issue: histsoc crop calendars only go back to 1991, not full historical period -> thanks, will be corrected
- would be good to be transparent about what models include and exclude in group III forcings. → **model documentation**

Break-out group discussions

Please discuss:

1. What additional data or information would you need in order to run Group III simulations? Please be as concrete as possible.
If you are ready to run Group III, what is your timeline?
2. What papers should or could be written based on Group III simulations (on adaptation or other topics)?

- Please form groups of 3-4 people
- Online people will be grouped automatically
- please write your ideas on paper cards & put on boards
(online: Miro board)
→ include your name

<https://tinyurl.com/paperIdeasAR7>



Some starting points for paper ideas:

- What are realistic future impacts, taking into account both climate change and socioeconomic change? (*can be addressed with no-adapt runs*)
- What are the impacts/risks that need adapting? (*can be addressed with no-adapt runs*)
- How effective is adaptation? What are the residual risks after adaptation? How are they distributed?
- Where are (hard) limits of adaptation?
- Where are risks of maladaptation?
- Side-effects (positive and negative) of adaptation measures
- Tradeoffs and synergies between adaptation and mitigation, or between different adaptation measures