Targeting Mental Models of Climate Change Risk to facilitate Climate Action

Climate change perceptions, expectations, observations, and projections

Lake Victoria Basin

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Overview

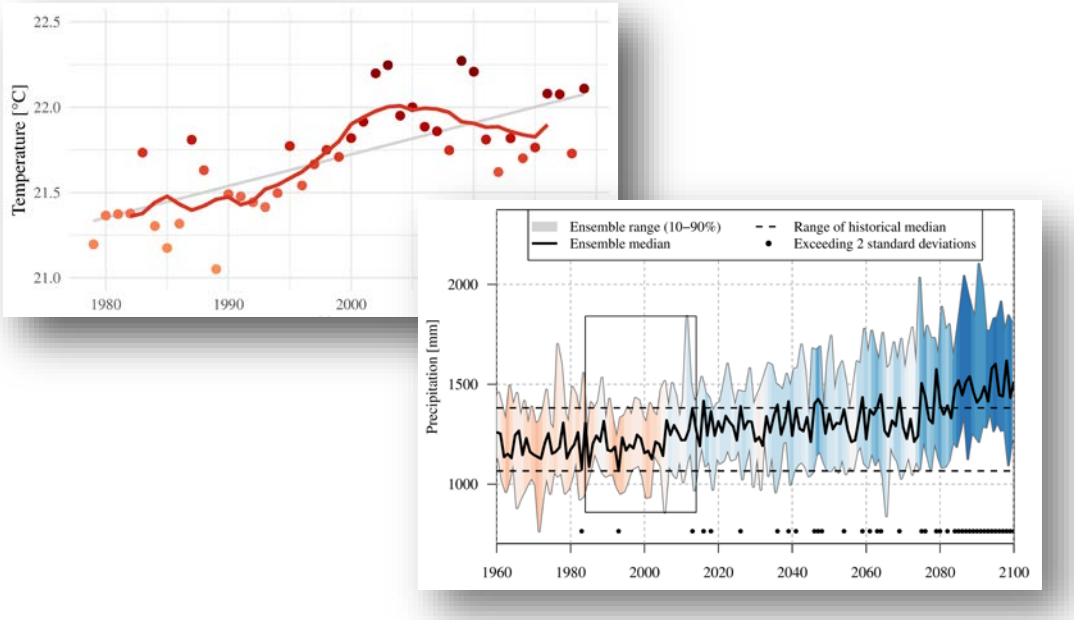
Study at Lake Victoria (East Africa)

Surveys

- About **climate change perceptions**
- Experts (*n* ~20, online)
- Community members (*n* ~140)

Comparison of climate change consequences

- Perceptions with observations (past climate)
- Expectations with model projections (future climate)

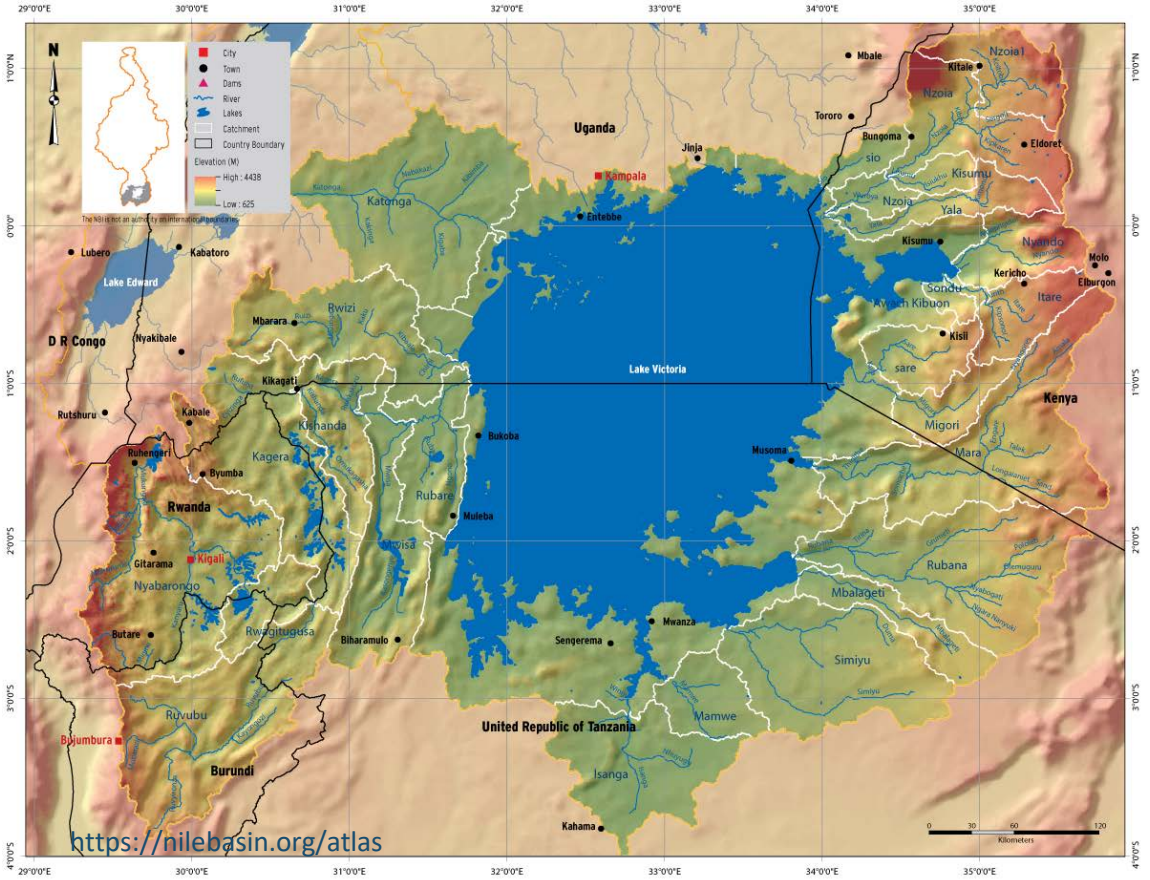


Lake Victoria

East African Rift Valey

Largest of the Great East African Lakes

- 68,000 km^2
- Basin area: 260,000 km^2
- At the equator



The survey

At Lake Victoria

Five questions about climate change

Experts and communities

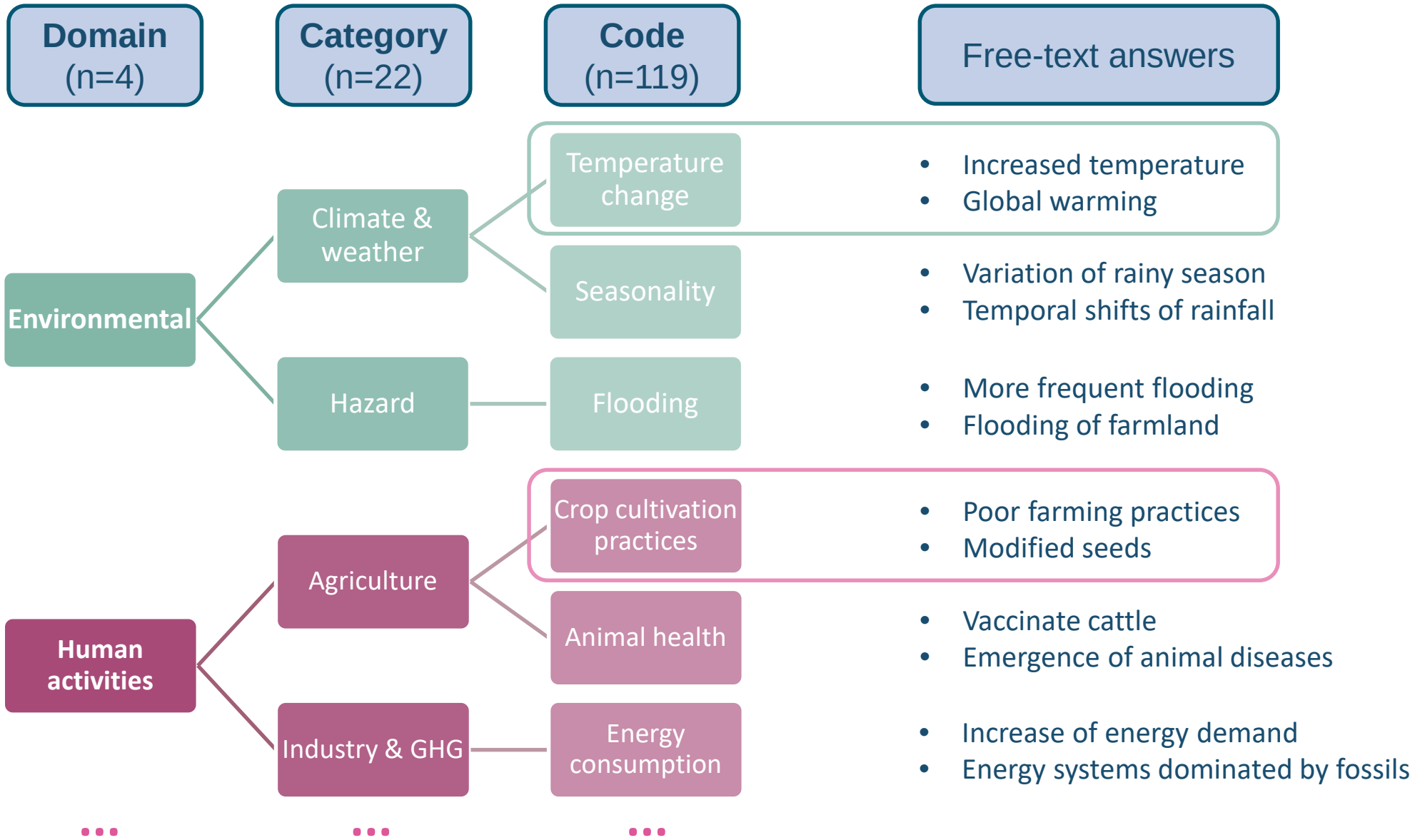
Causes

Consequences

…experienced already today?
…expected in the future?

Adaptation Mitigation

Coding of answers



Domains

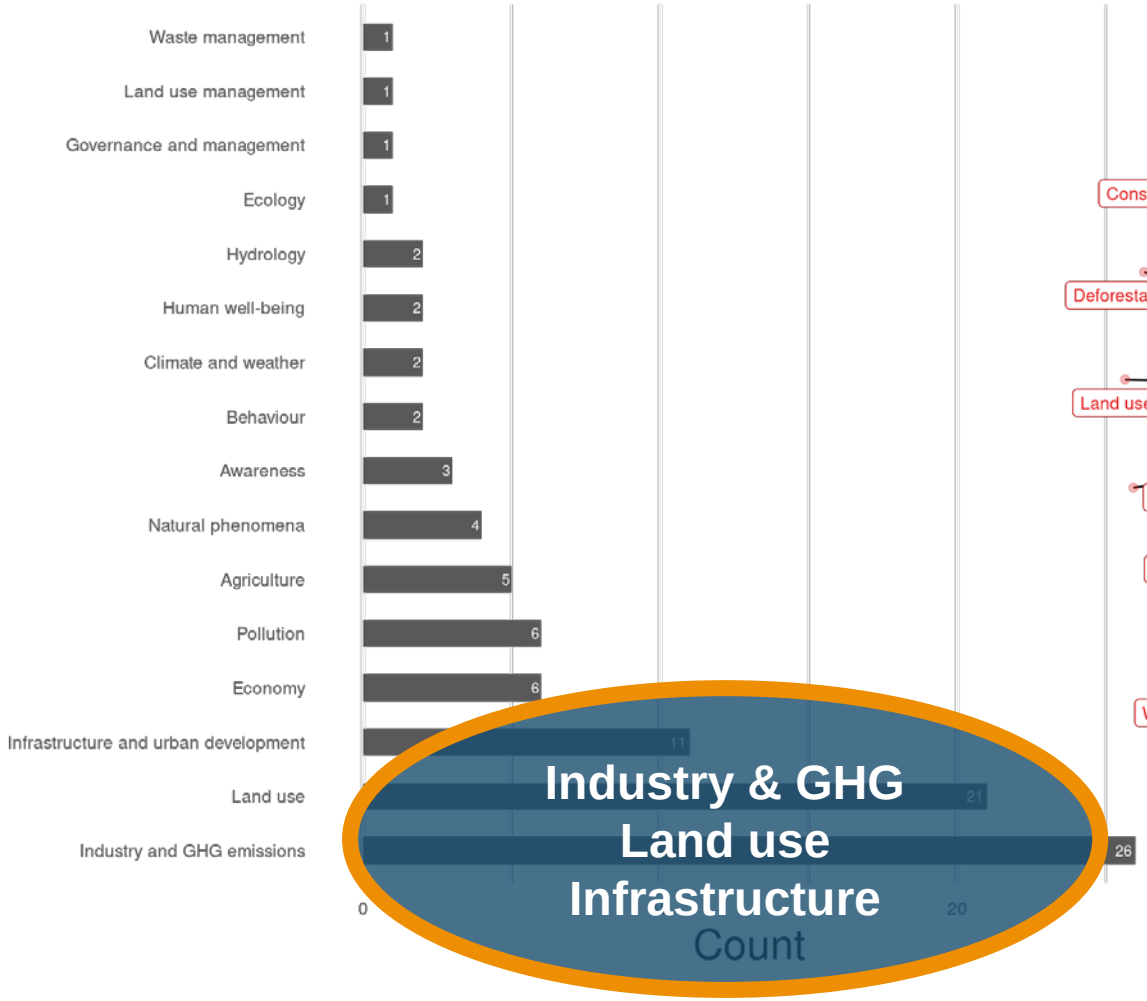
Superordinate entities

	Environmental	Human activities	Governance & Policy	Societal
Categories	Climate & weather Ecology Hazards Hydrology Natural phenomena	Industry & GHG Land use Agriculture Fishery Pollution Behaviour	Governance & mgt. Economy Infrastructure Urban development Land use management Awareness Technology Waste management	Beliefs Supernatural powers Human well-being

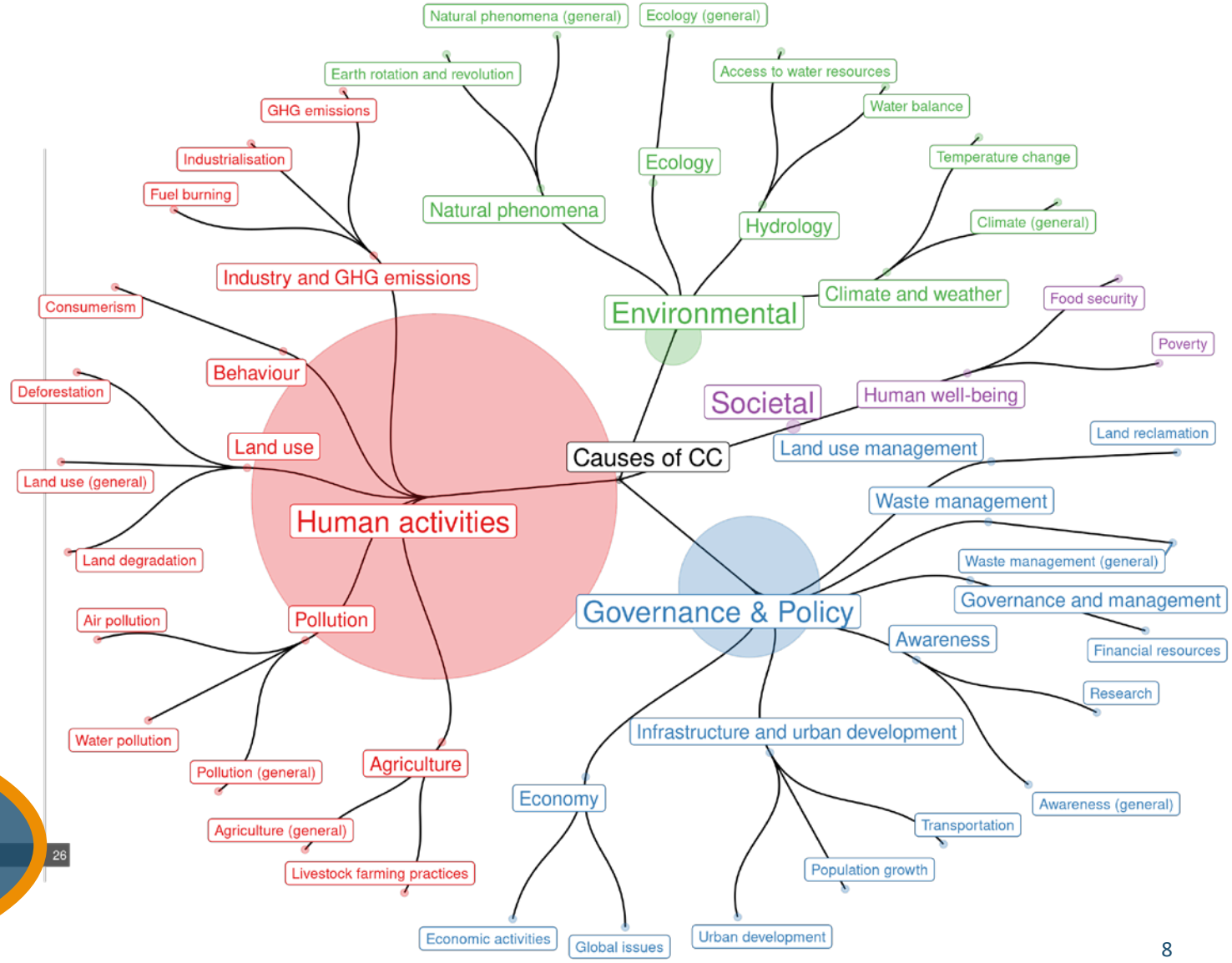
Each of us plays a part everywhere...

Causes of climate change

Expert survey

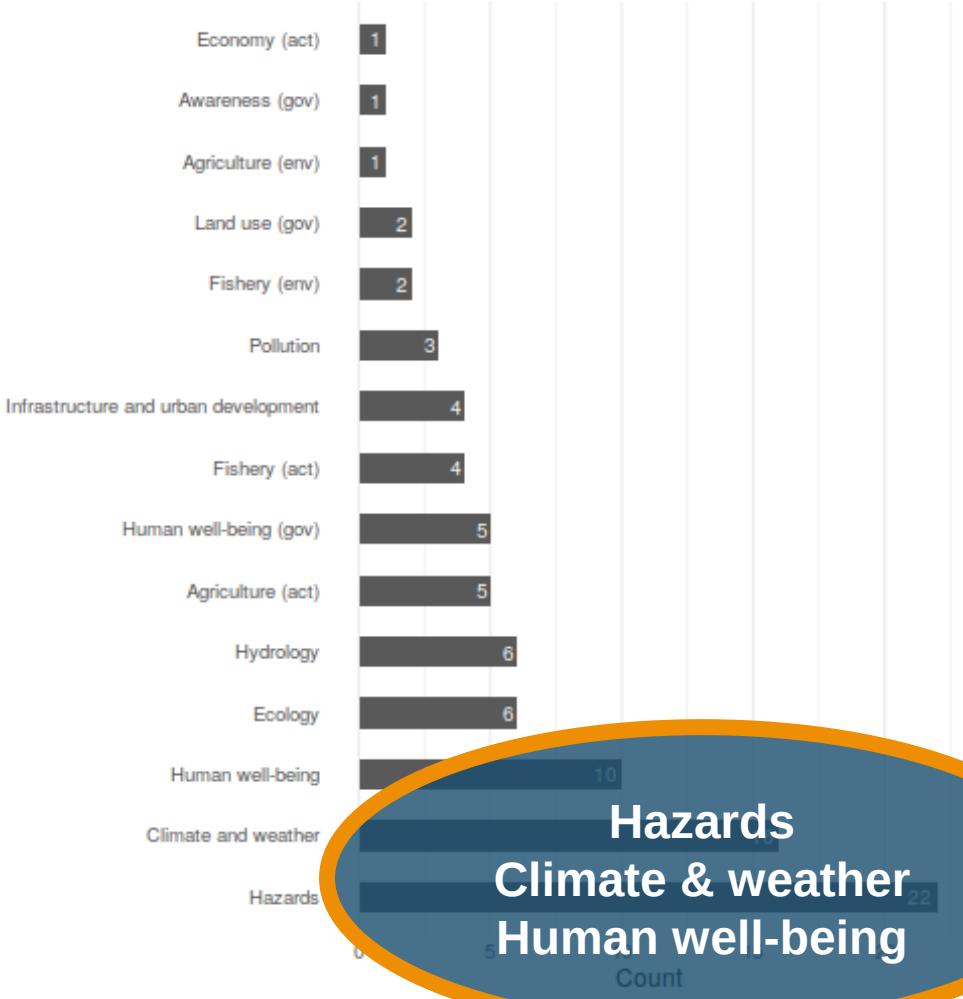


Industry & GHG
Land use
Infrastructure

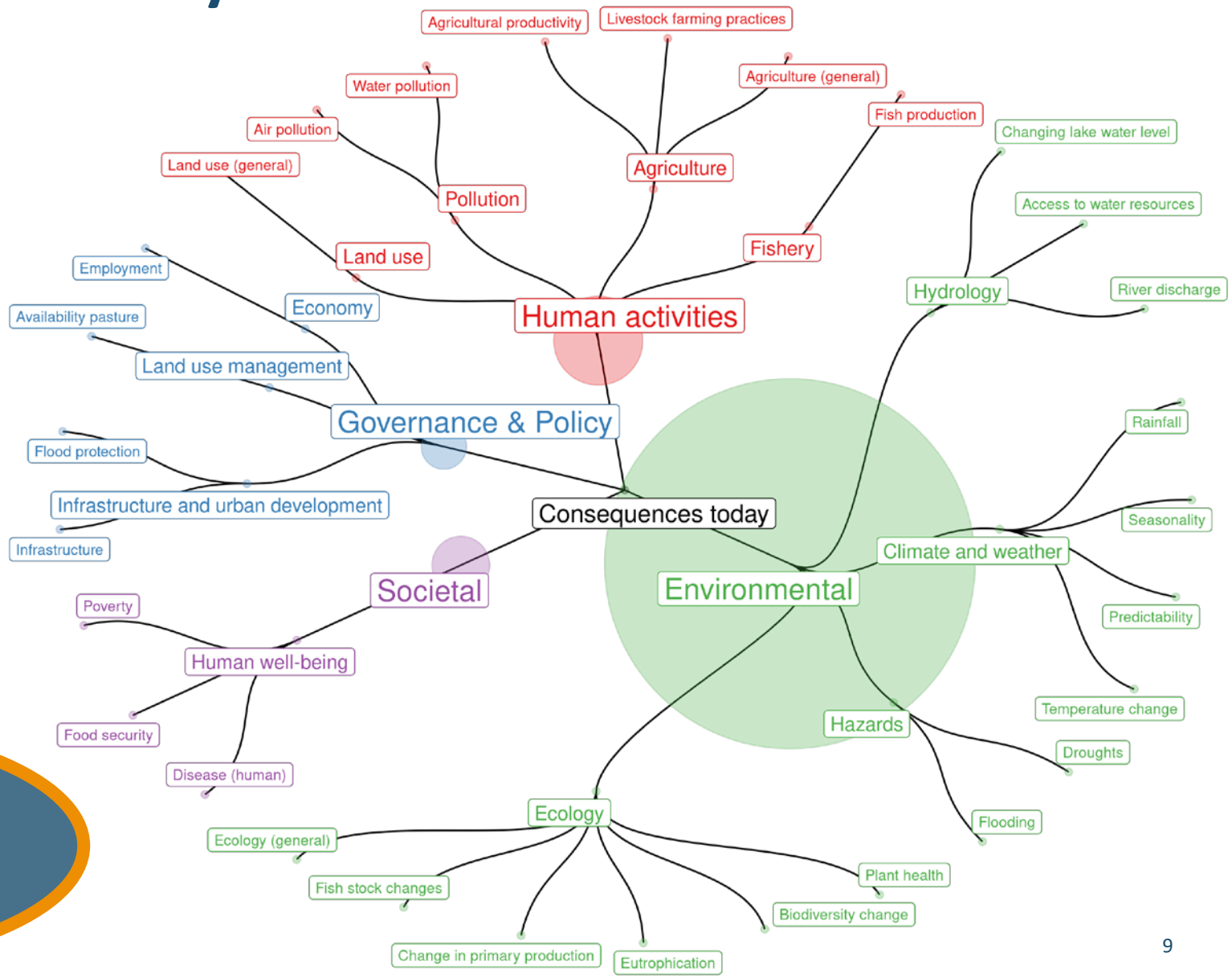


Consequences already felt today

Expert survey

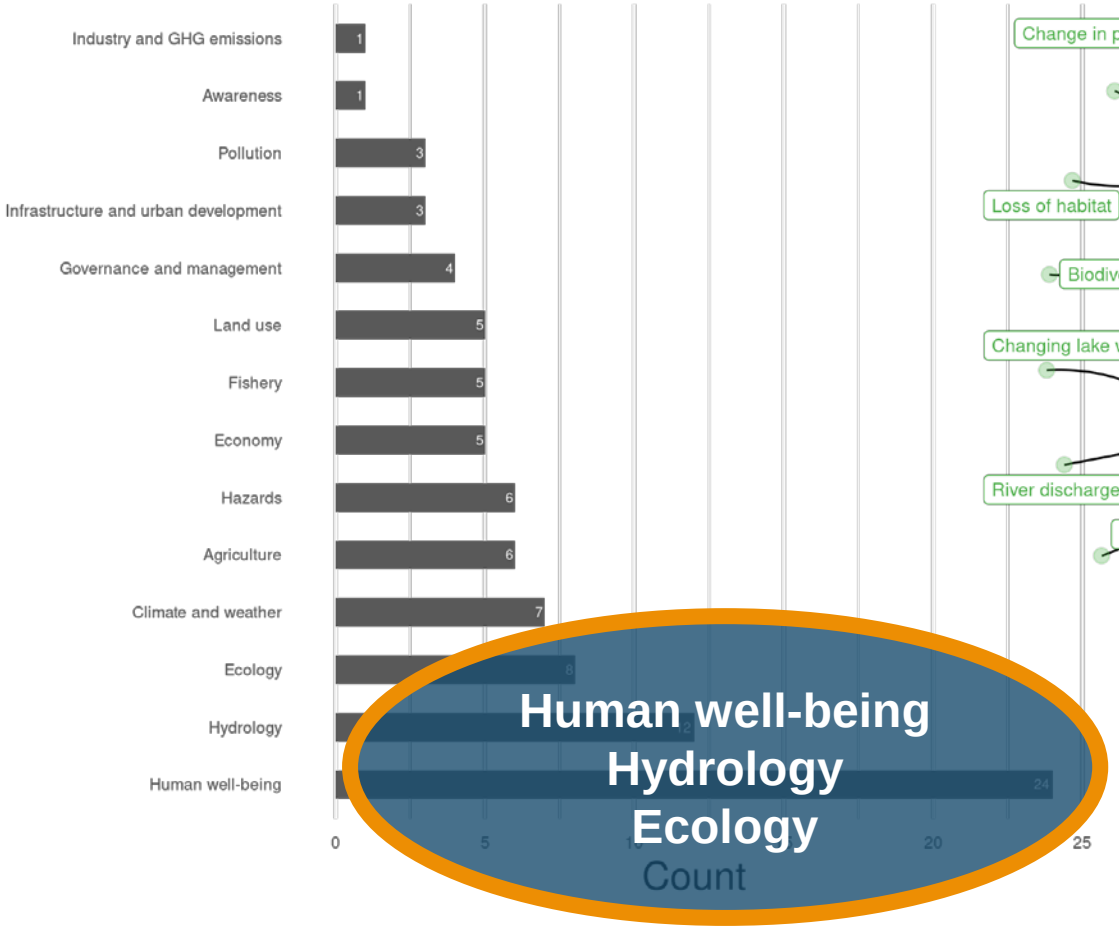


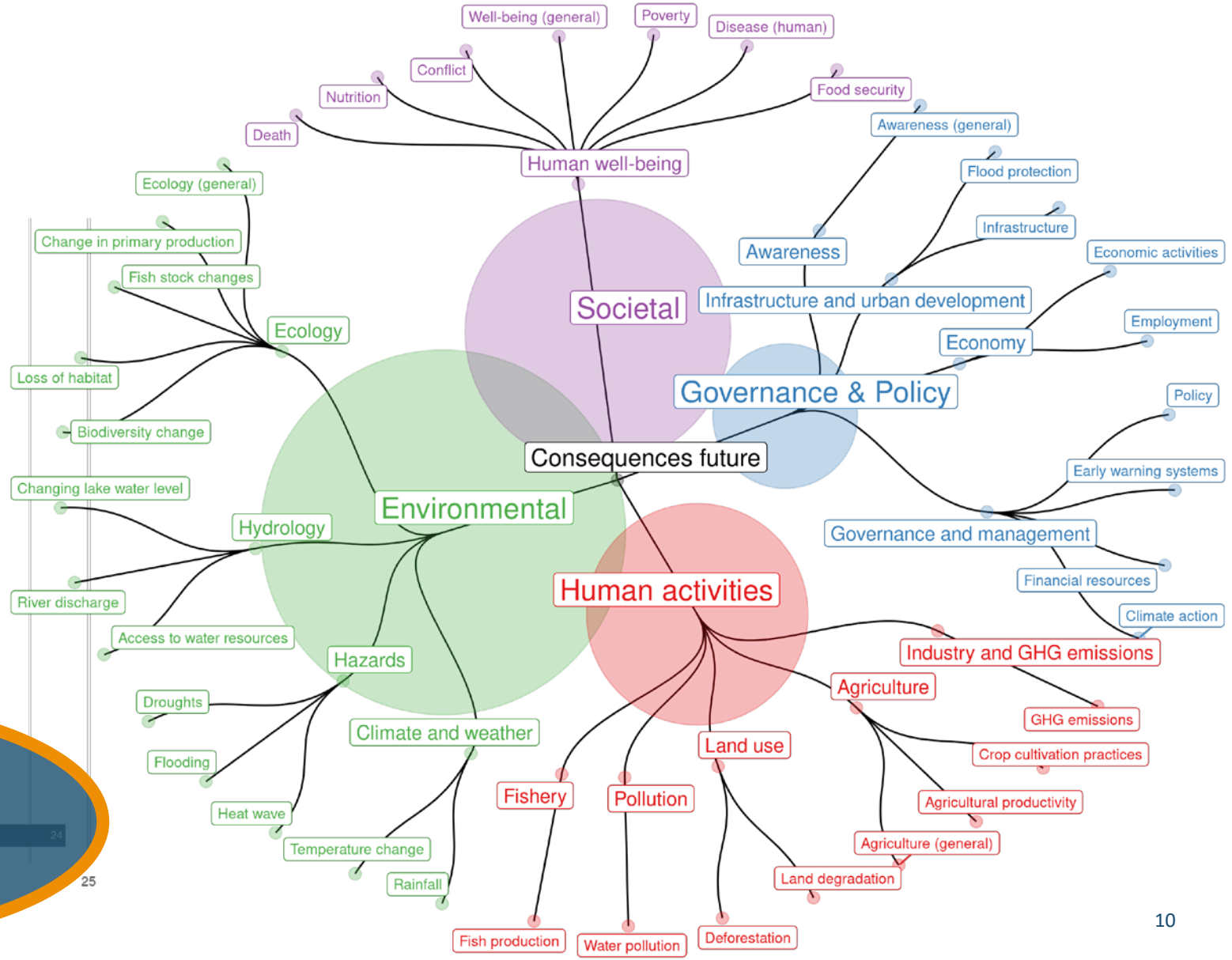
Hazards
Climate & weather
Human well-being



Future consequences of climate change

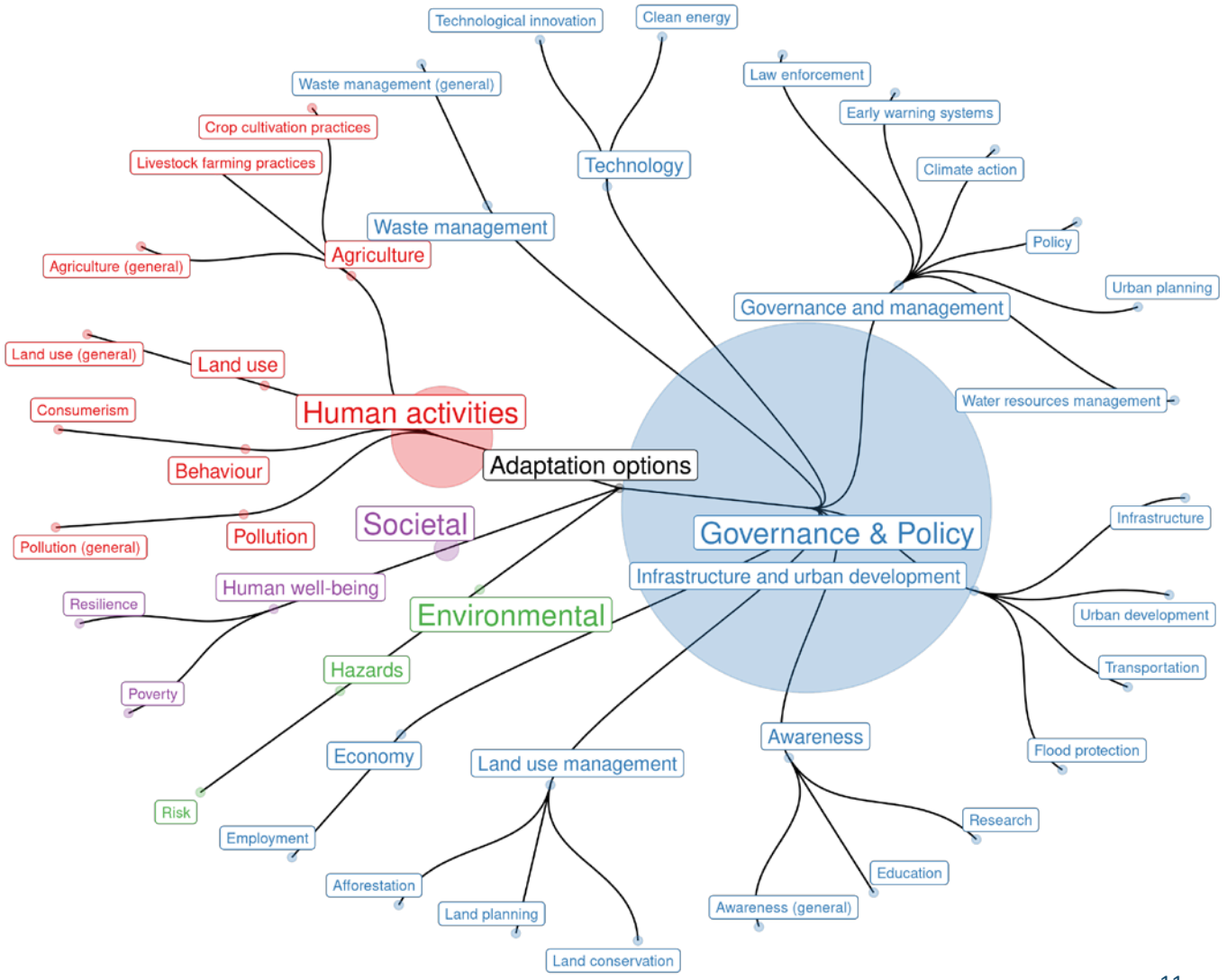
Expert survey





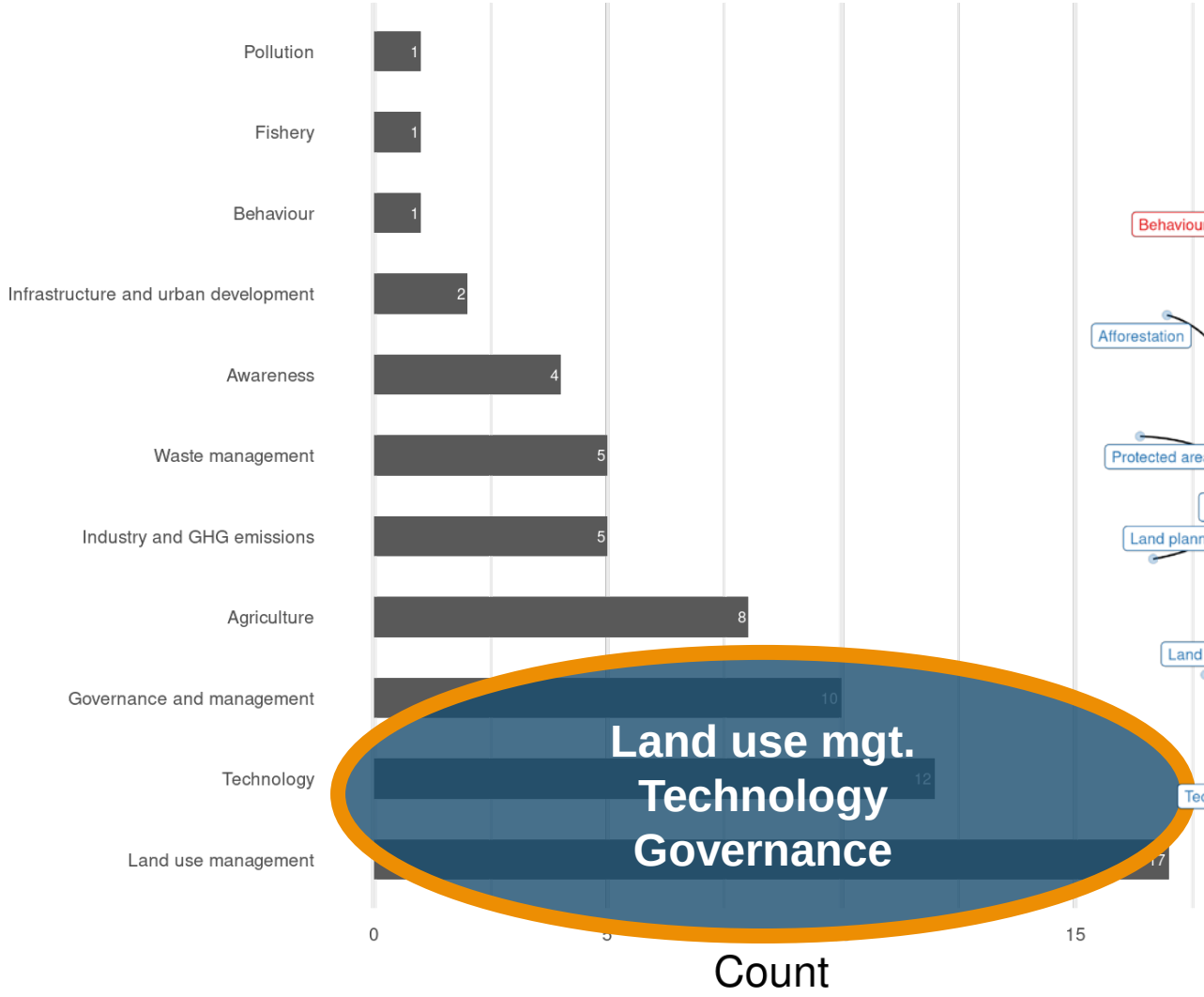
Adaptation options

Expert survey

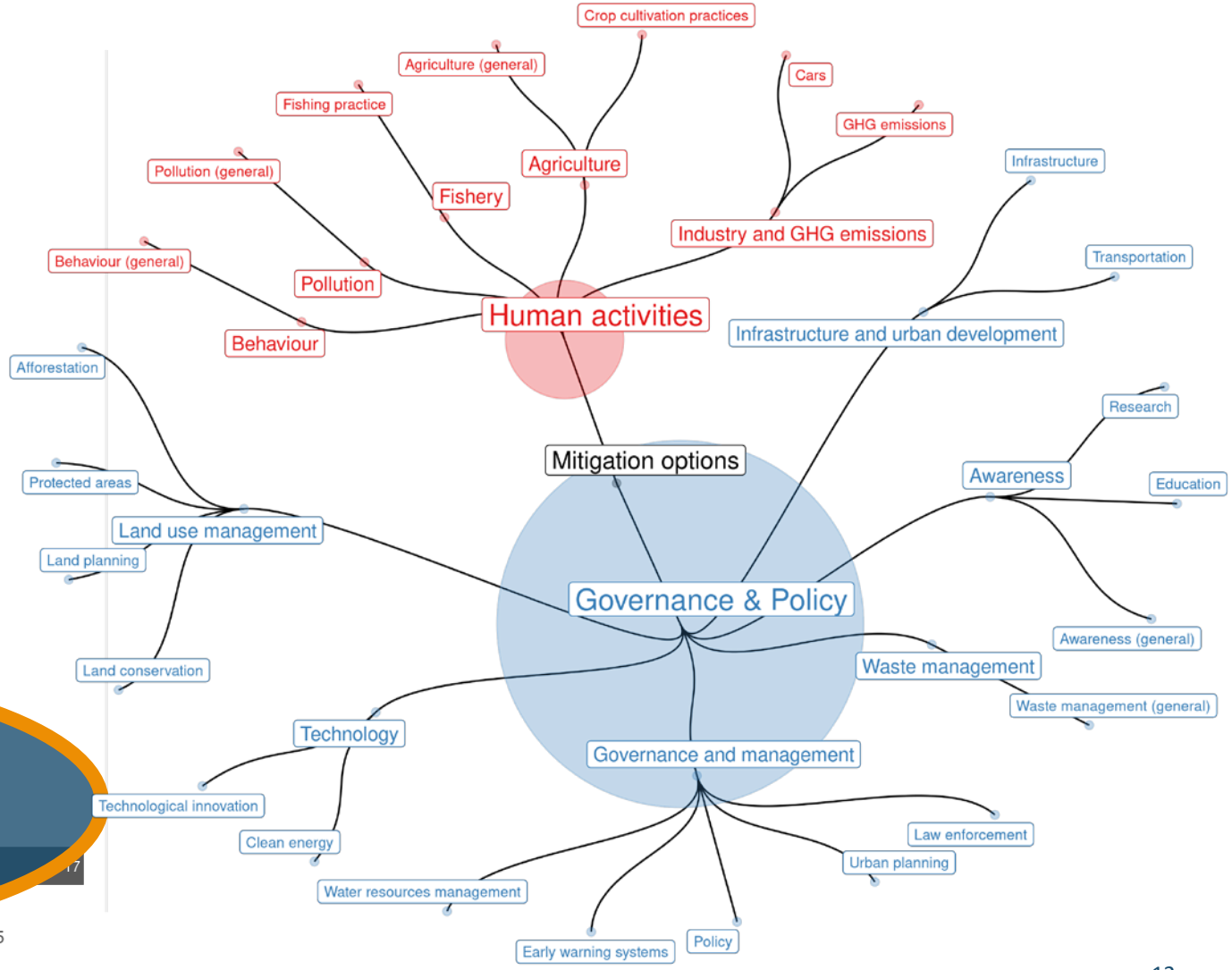


Mitigation options

Expert survey



Land use mgt.
Technology
Governance



Comparison between experts and communities

Importance of domains, measured by the *number of code mentions*

Causes

- High agreement
- Human activities

Consequences (today)

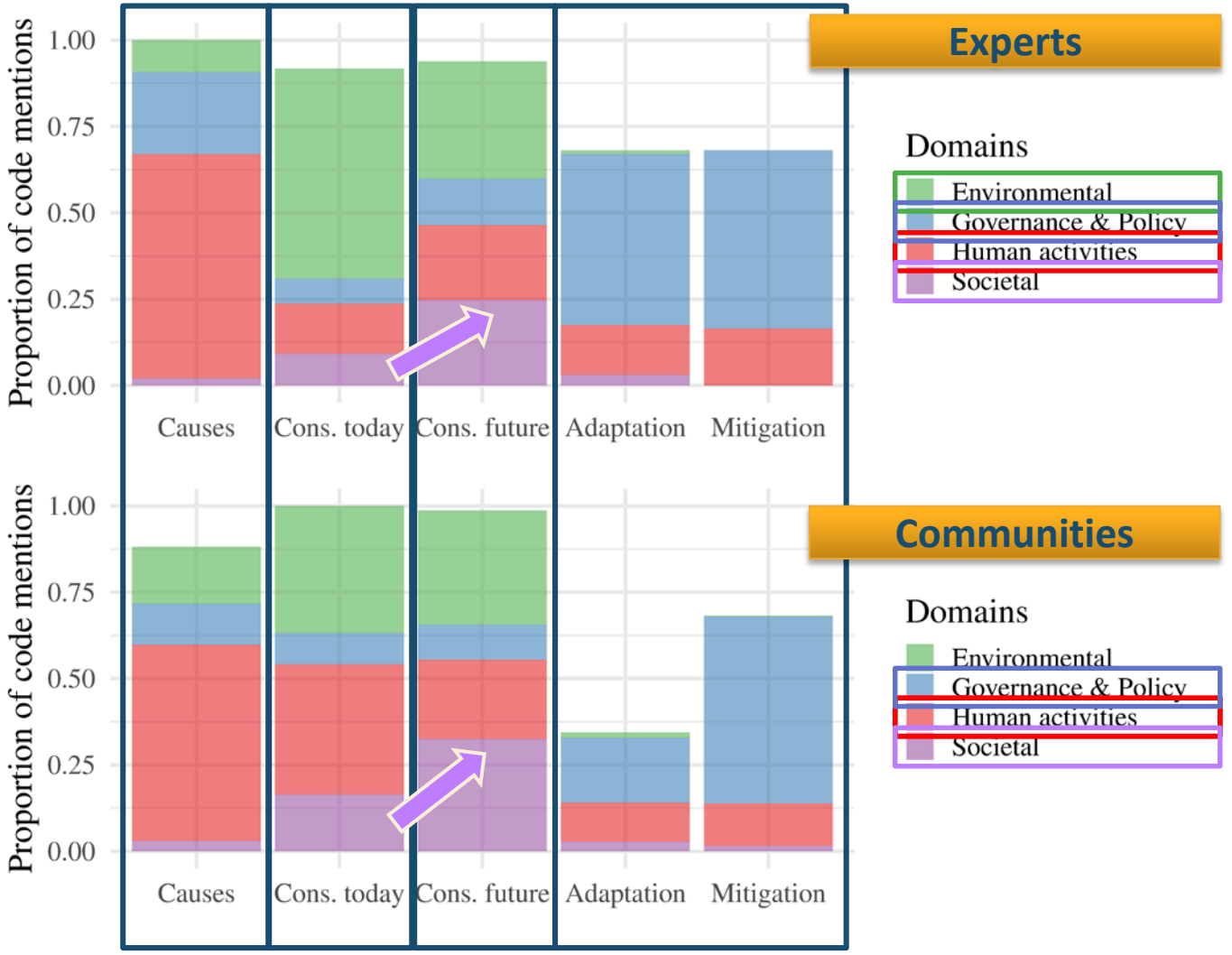
- Lower agreement
- **Impact on human activities more important for communities**

Consequences (future)

- High agreement
- **Concern about the future, concern about human well-being**

Adaptation / mitigation

- High agreement
- Governance & policy

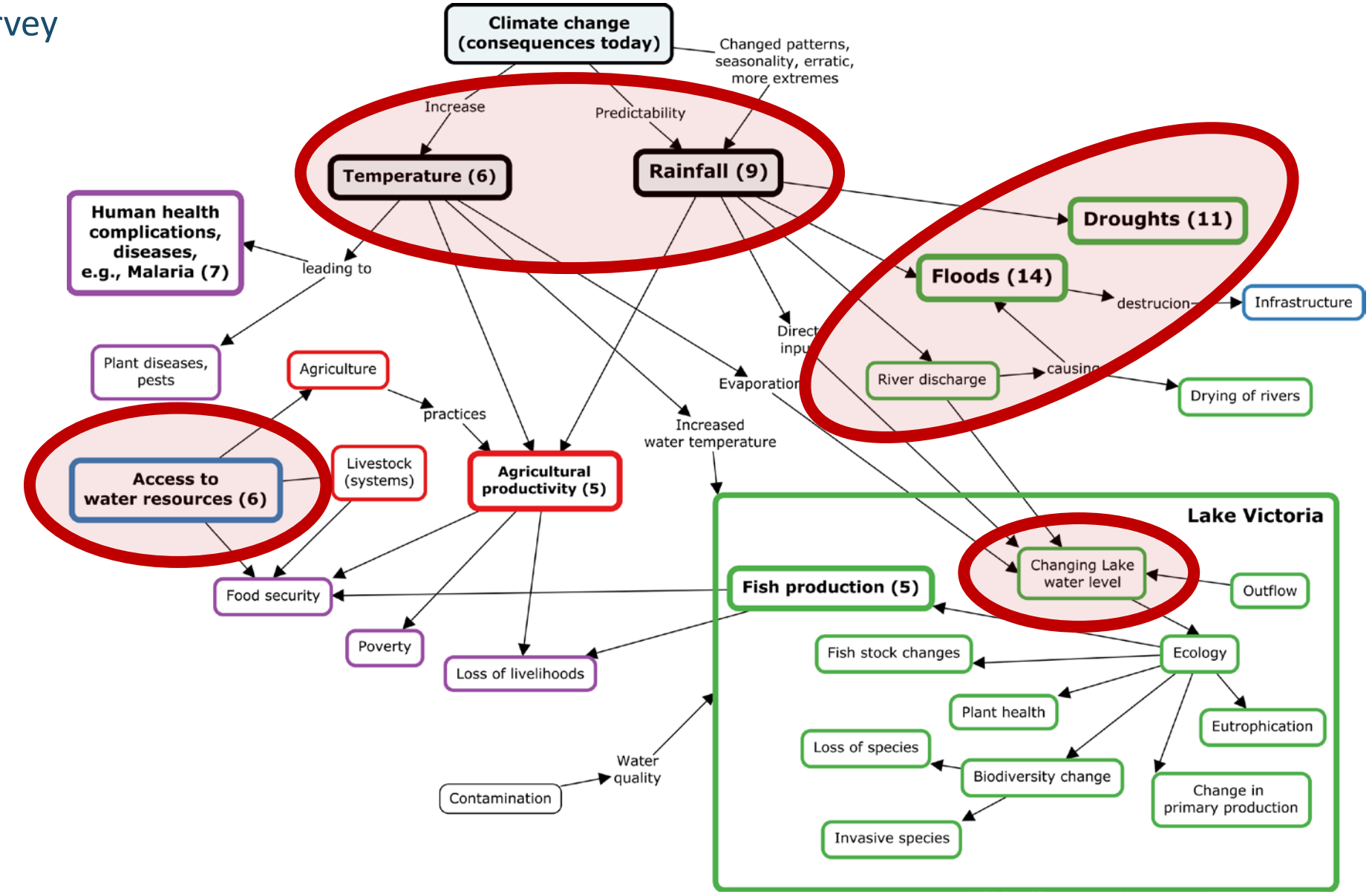


What was the past like?

Perceptions versus observations...

Narrative (consequences today)

Expert survey



SWIM: Eco-hydrological model

Natural processes, land and water management

Input: Weather / climate

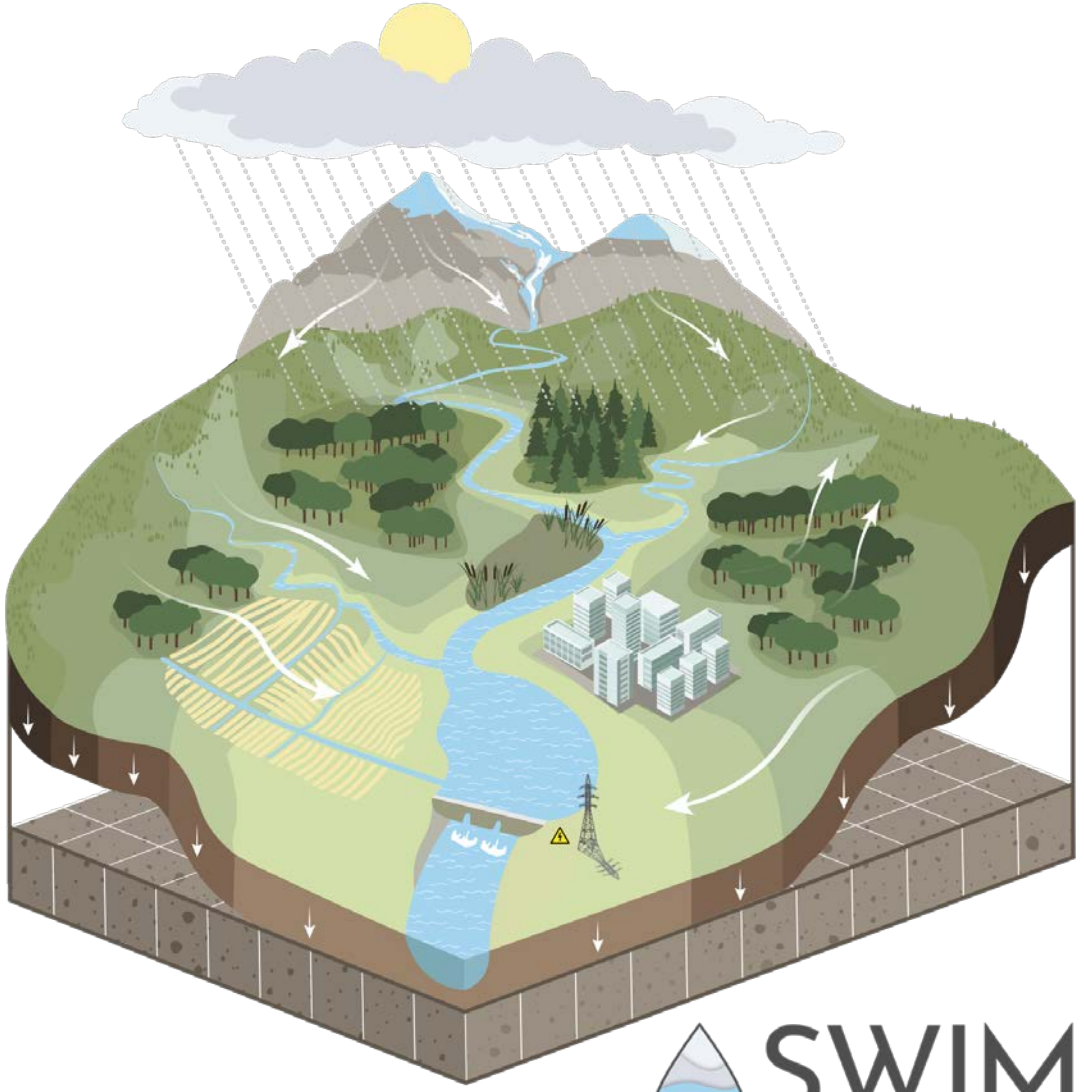
- Precipitation (rain & snow)
- Temperature, solar radiation, rel. humidity

Hydrology, vegetation

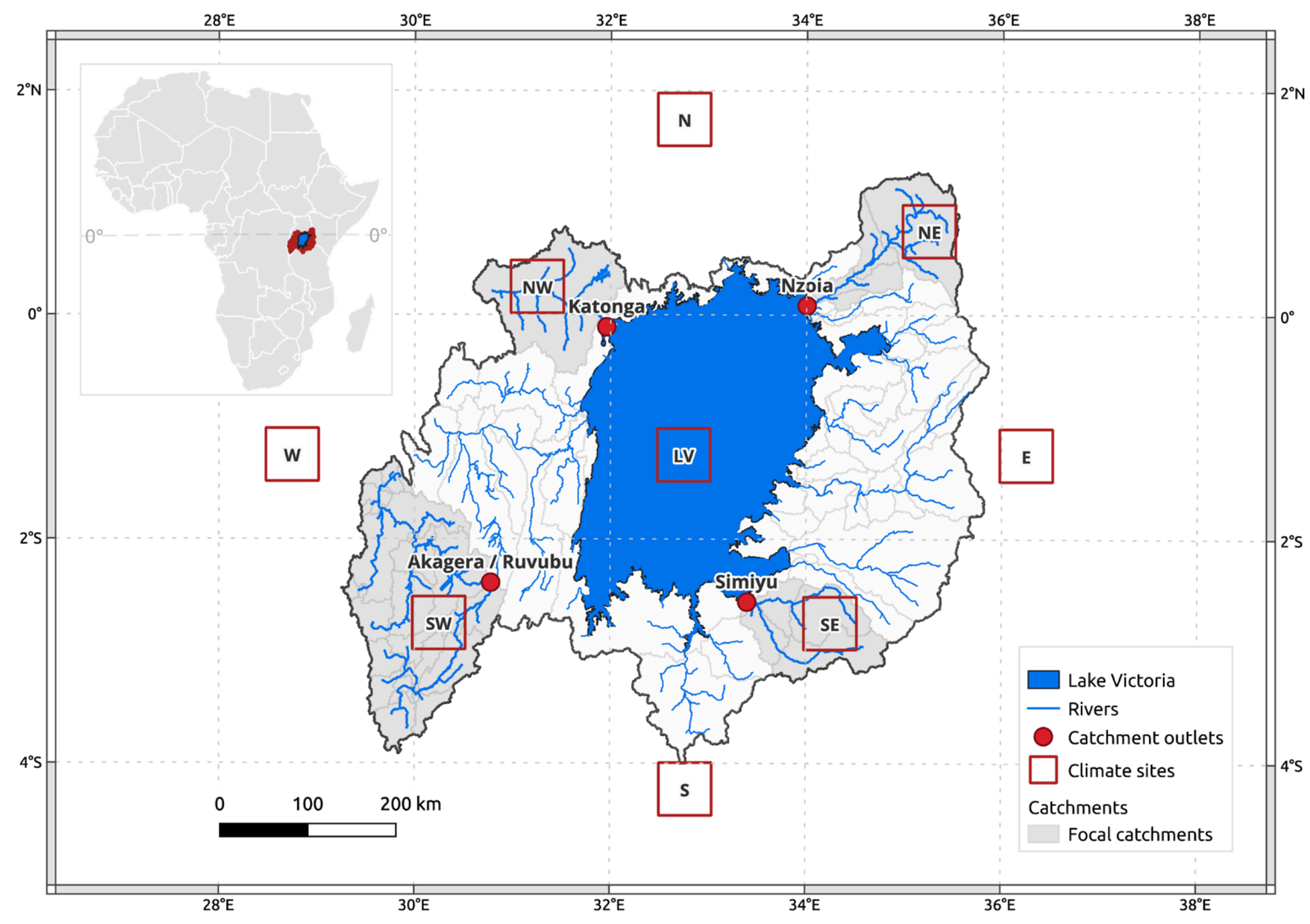
- Runoff: surface, sub-surface, groundwater
- Evapotranspiration
- Natural and managed vegetation

Reservoirs

- **Simulation of natural**
  - **Lakes and wetlands**
- Flood protection, hydropower
- Water storage / supply



SWIM
Soil and Water Integrated Model



Meteorology
WFDE5 (1979-2019)

Resolution: 0.5°
18 x 15 = 270 grid cells
- *9 selected*
- *4 focal catchments*

Area
Lake: 68,000 km2
~ Ireland
Total: 260,000 km2
> UK

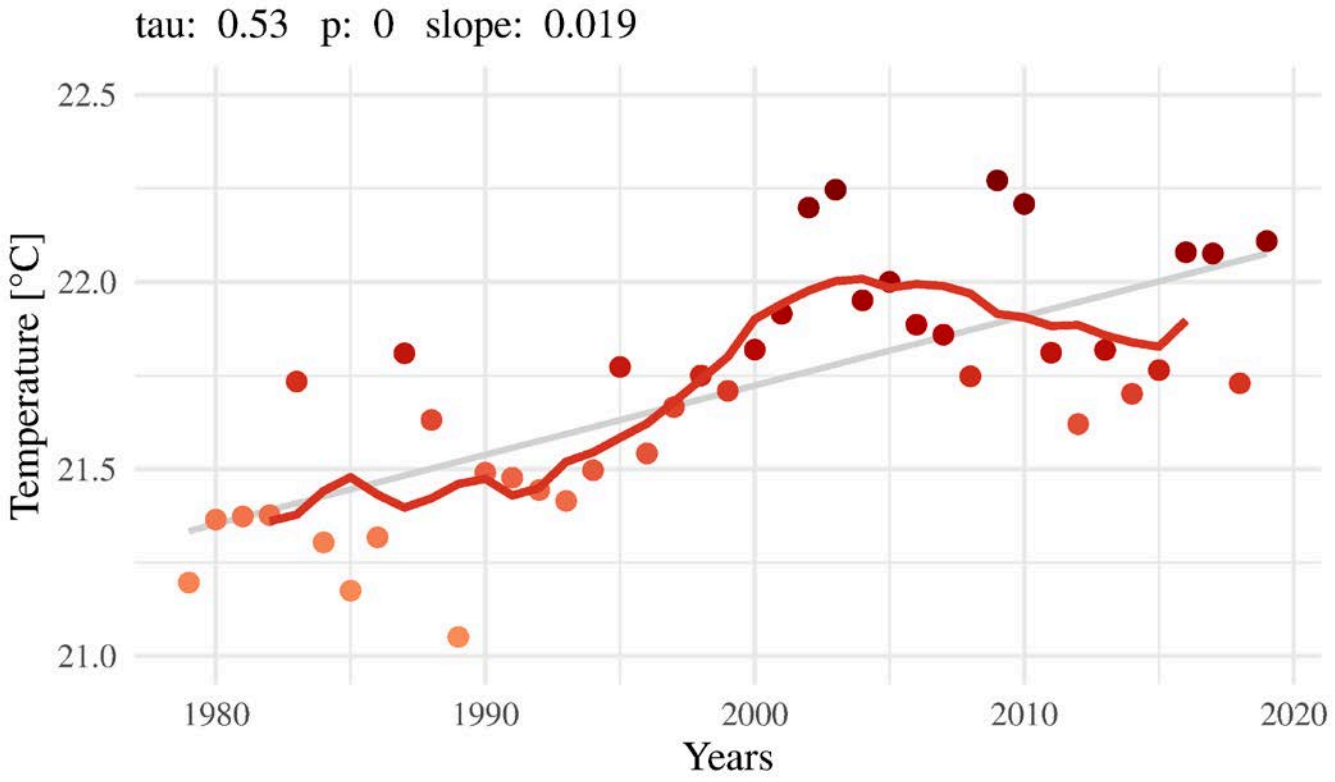
Codes associated to “temperature“

Topic: Consequences today

“Increase”

“High”

“Hot”



Increase by 0.8 °C
WFDE5: 1979 – 2019
~0.2°C per decade

Codes associated to “rainfall“

Topic: Consequences today

Intensity

“Increase”

“Intense”

“Heavy rains”

Patterns, seasonality

“Unreliable”

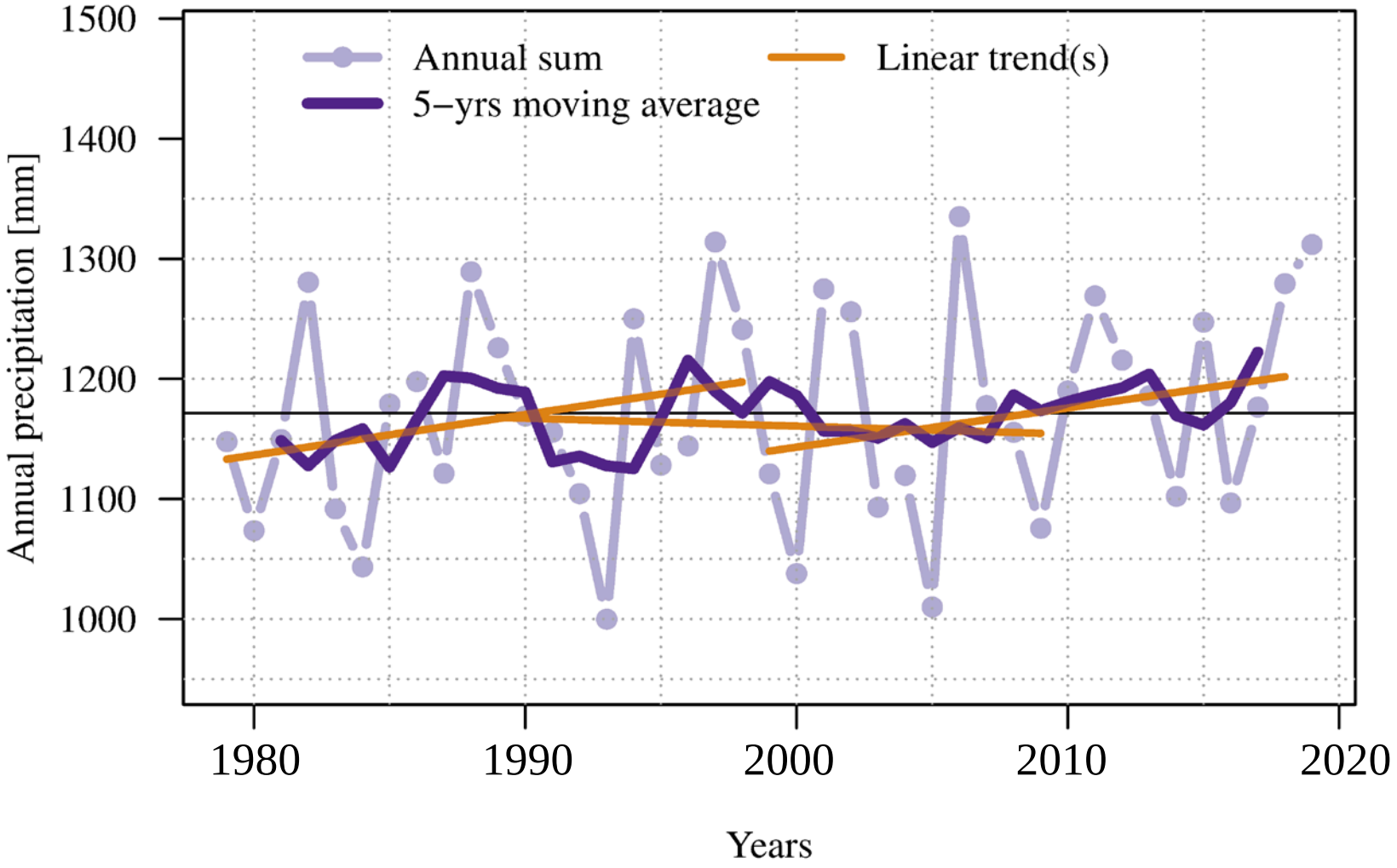
“Erratic”

“Changed patterns”

“Rainy season”

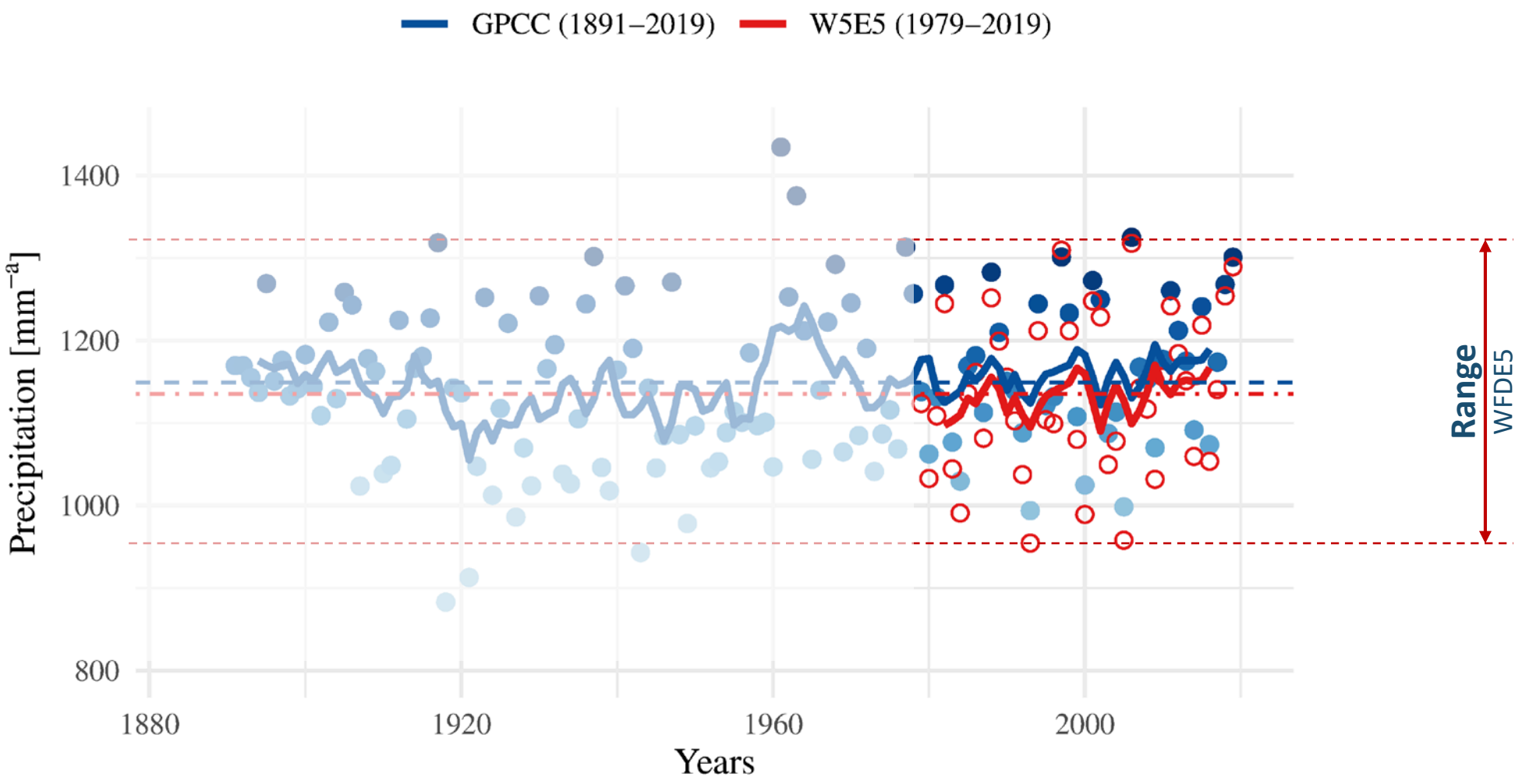
Average annual rainfall (Lake Victoria basin)

WFDE5: 1979-2019



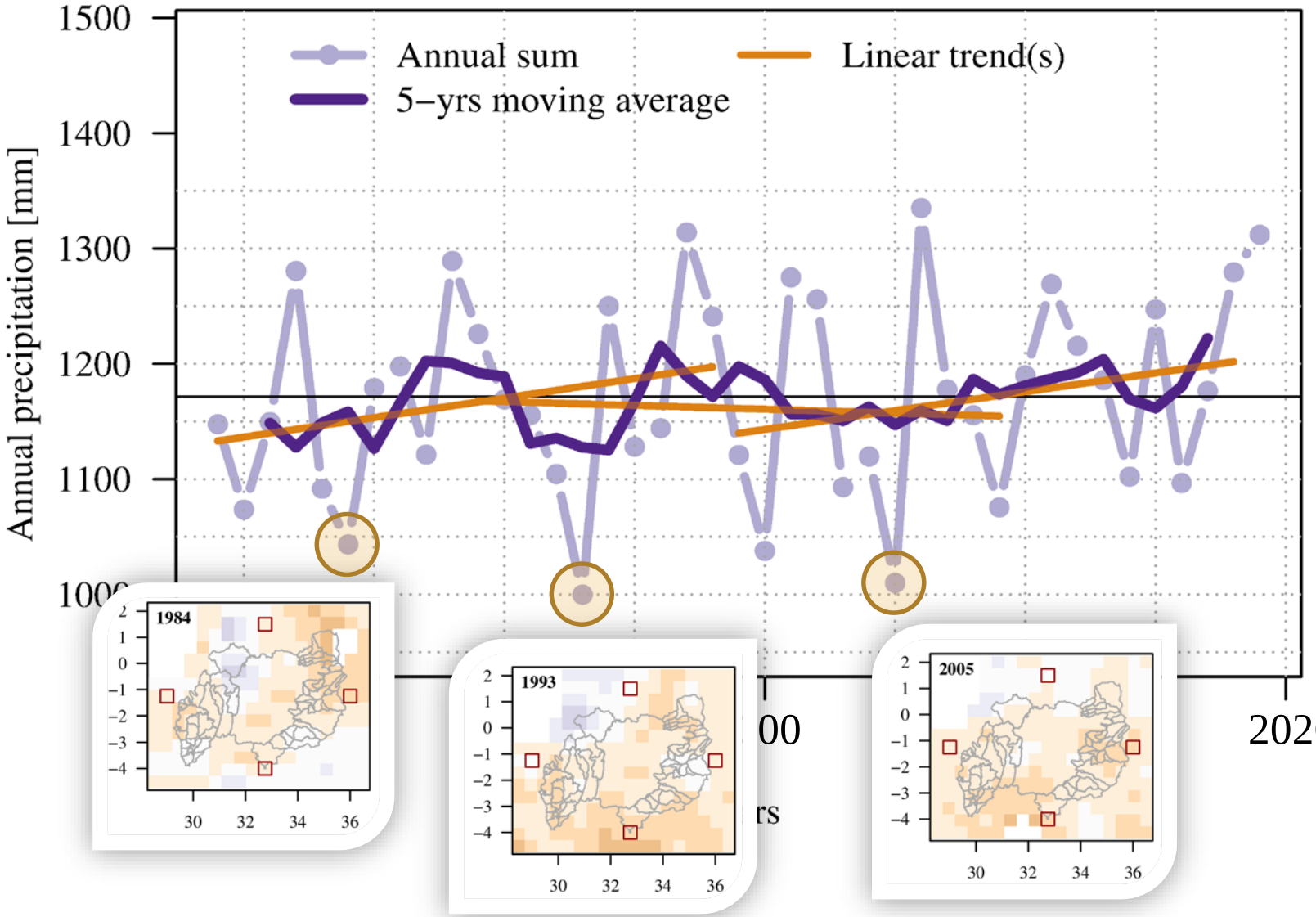
WFDE5 rainfall in the long perspective

1891 – 2019



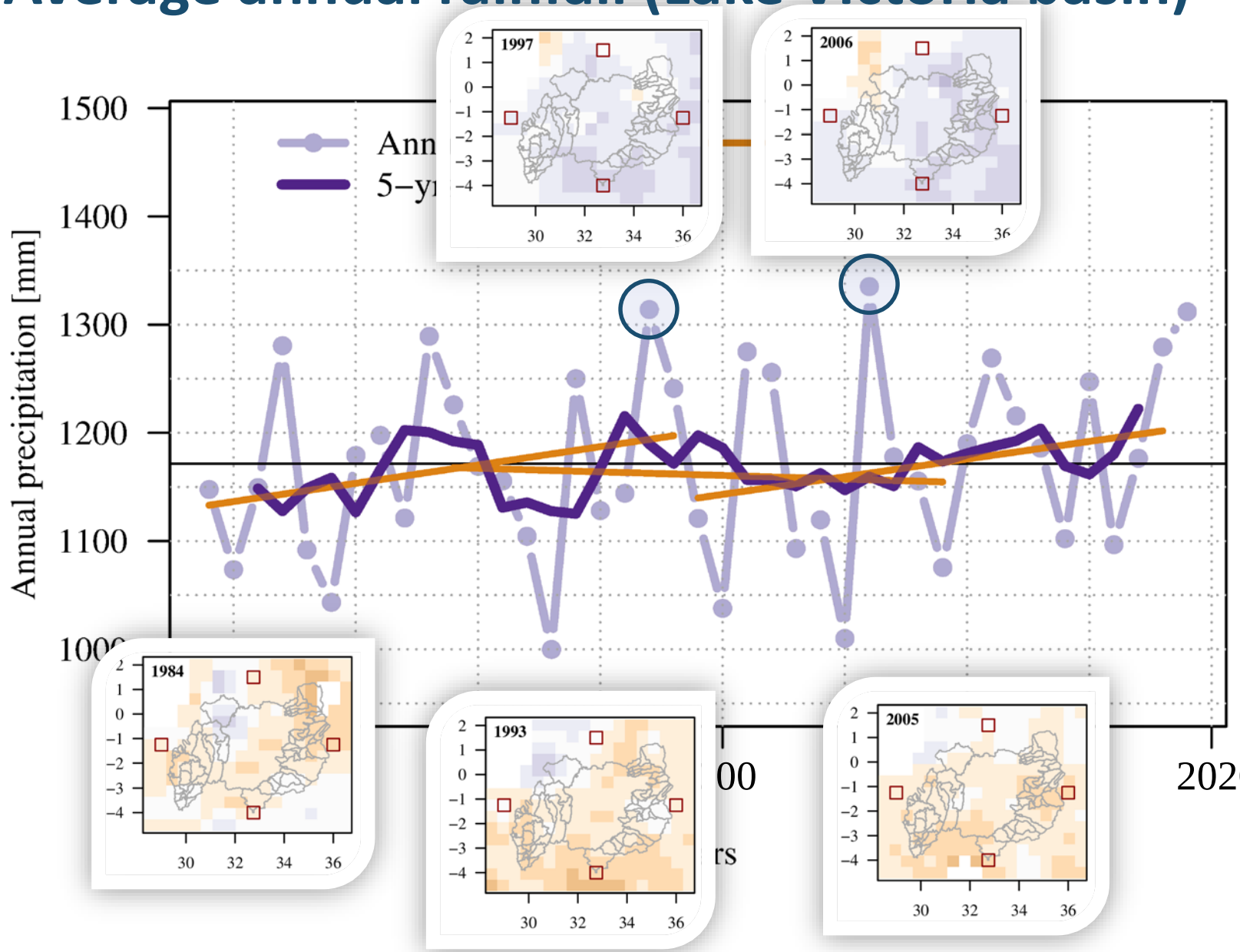
Average annual rainfall (Lake Victoria basin)

WFDE5 1979-2019



Dry years

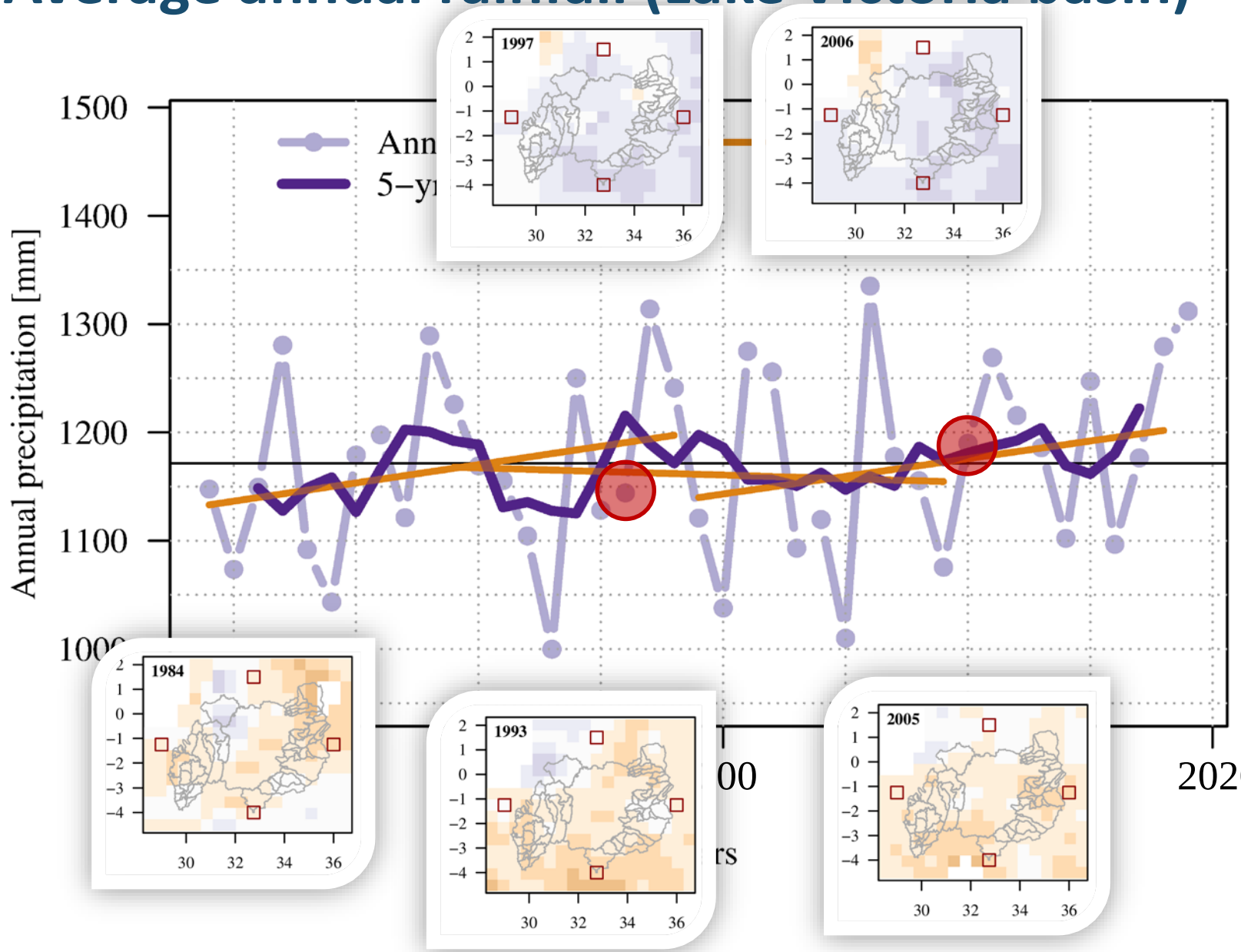
Average annual rainfall (Lake Victoria basin)



Wet years

Dry years

Average annual rainfall (Lake Victoria basin)



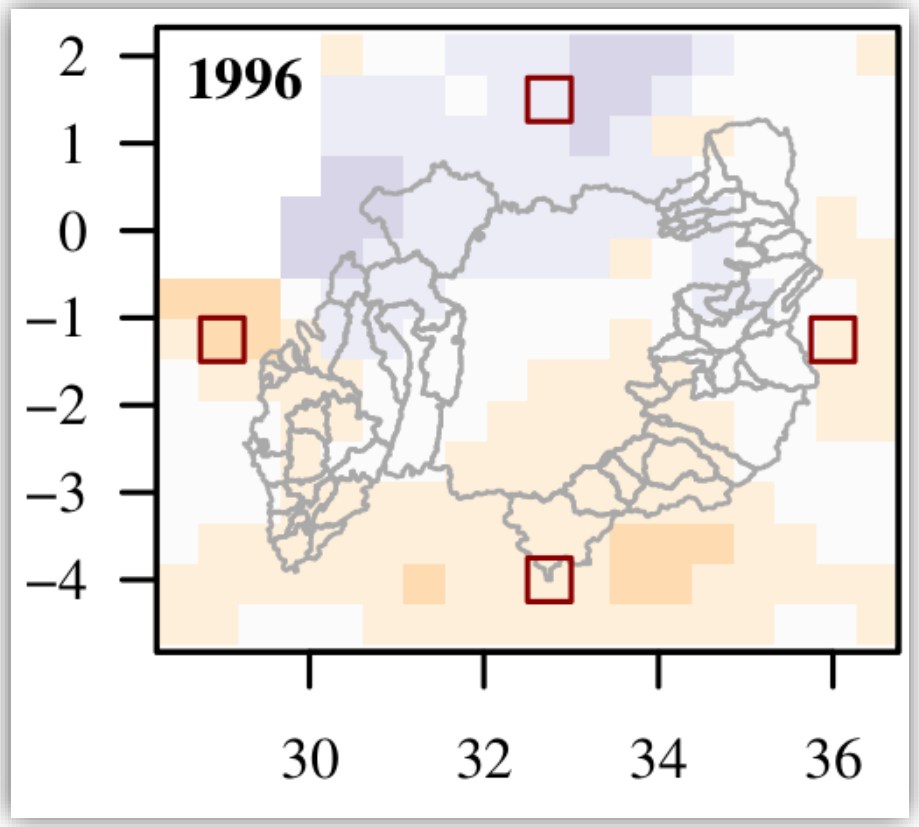
Wet years

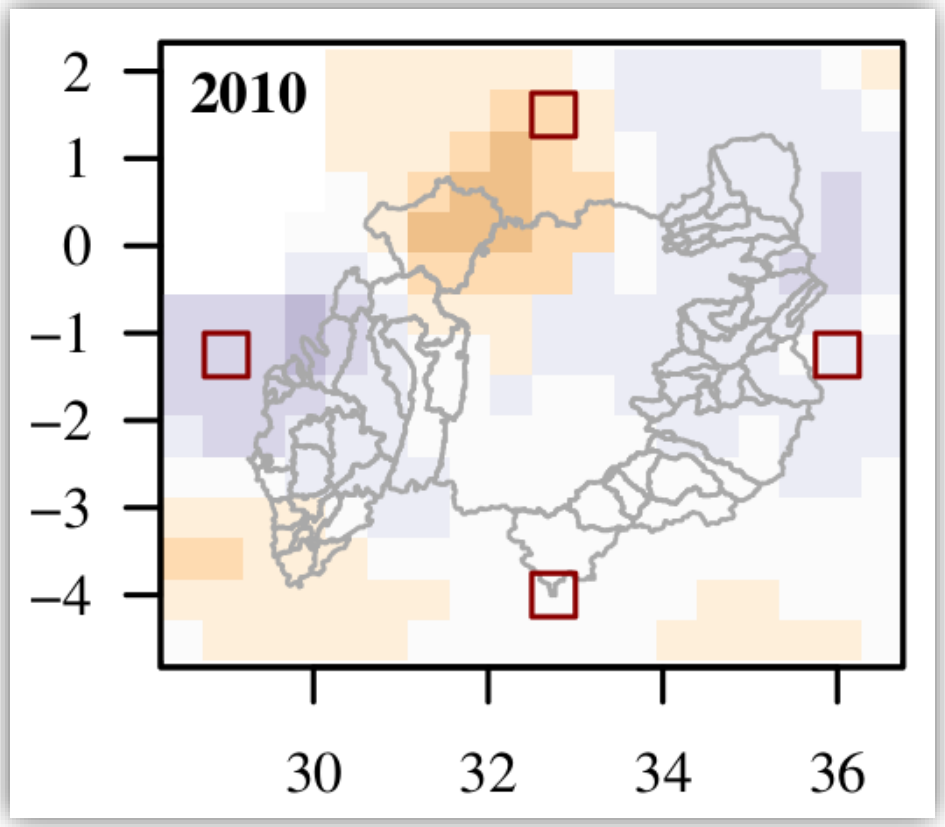
Average years

Dry years

Average years

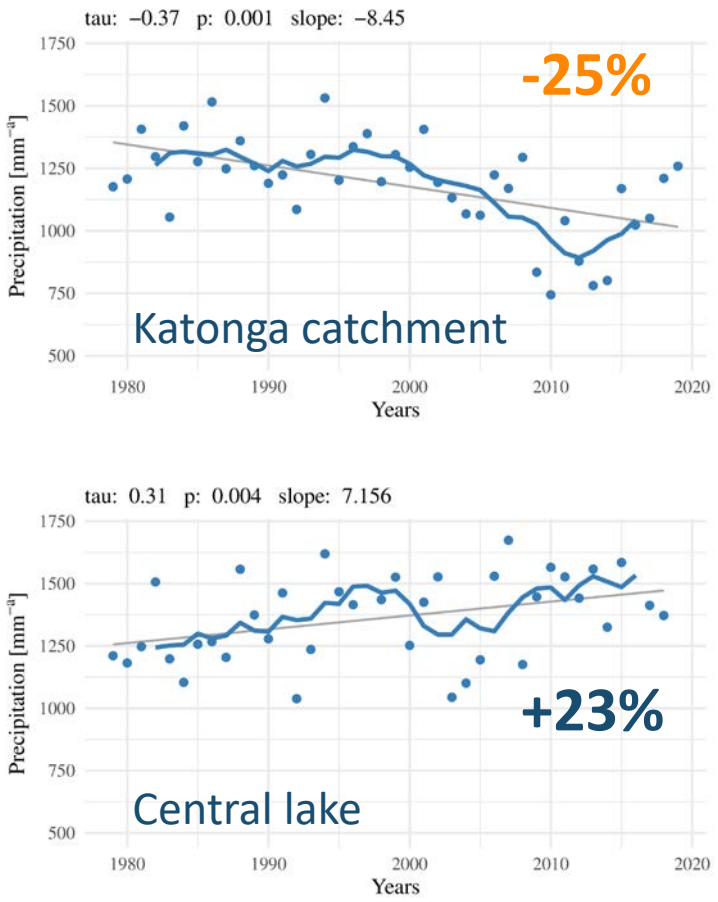
Different spatial patterns possible
Wet in the north / dry in the south
or vice versa

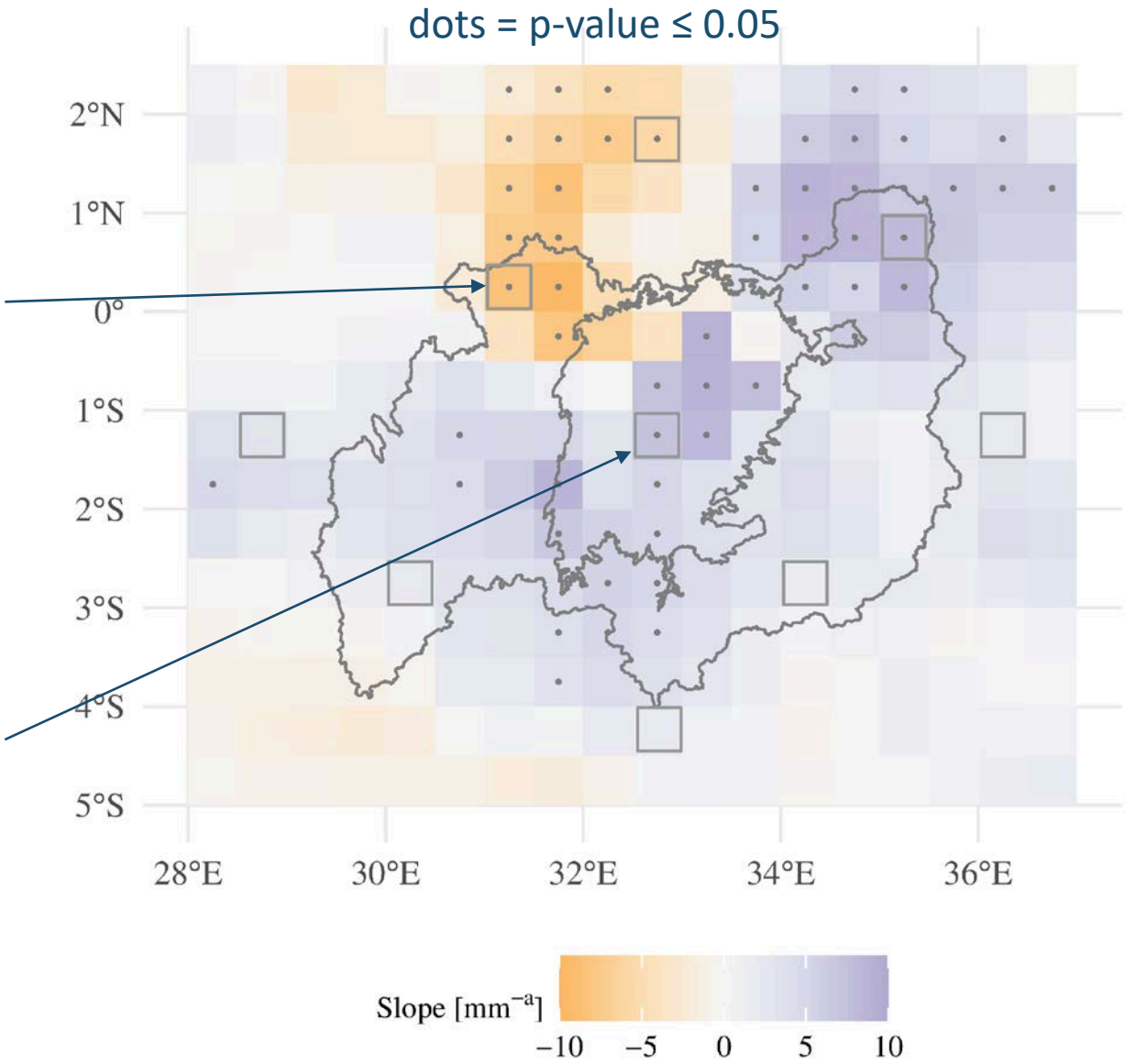




Trend of annual rainfall (past climate)

WFDE5: 1979 - 2019



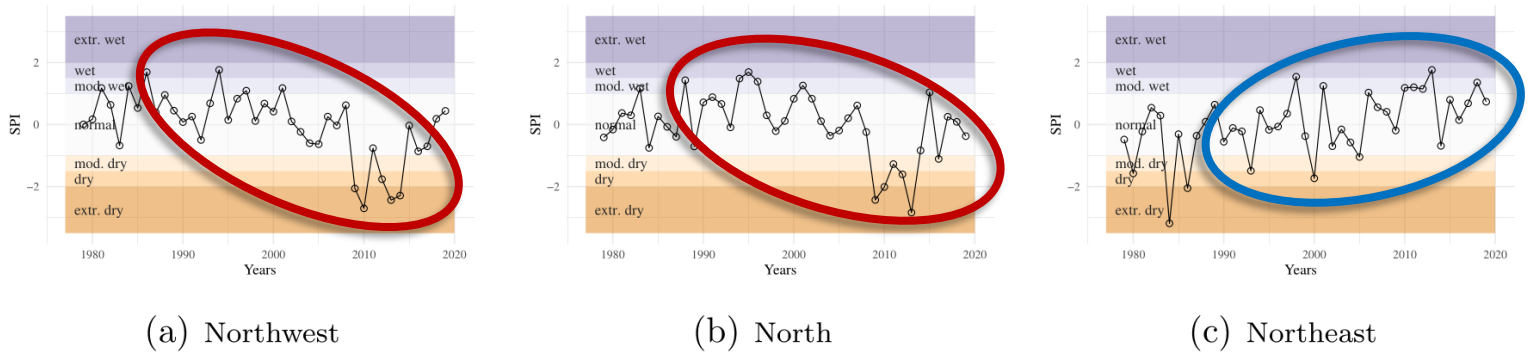


Droughts: Standardized Precipitation Index

December, SPI = 12 months (1979 – 2019)

Wet conditions

Dry conditions



(a) Northwest (b) North (c) Northeast

(d) West (e) Central (f) East

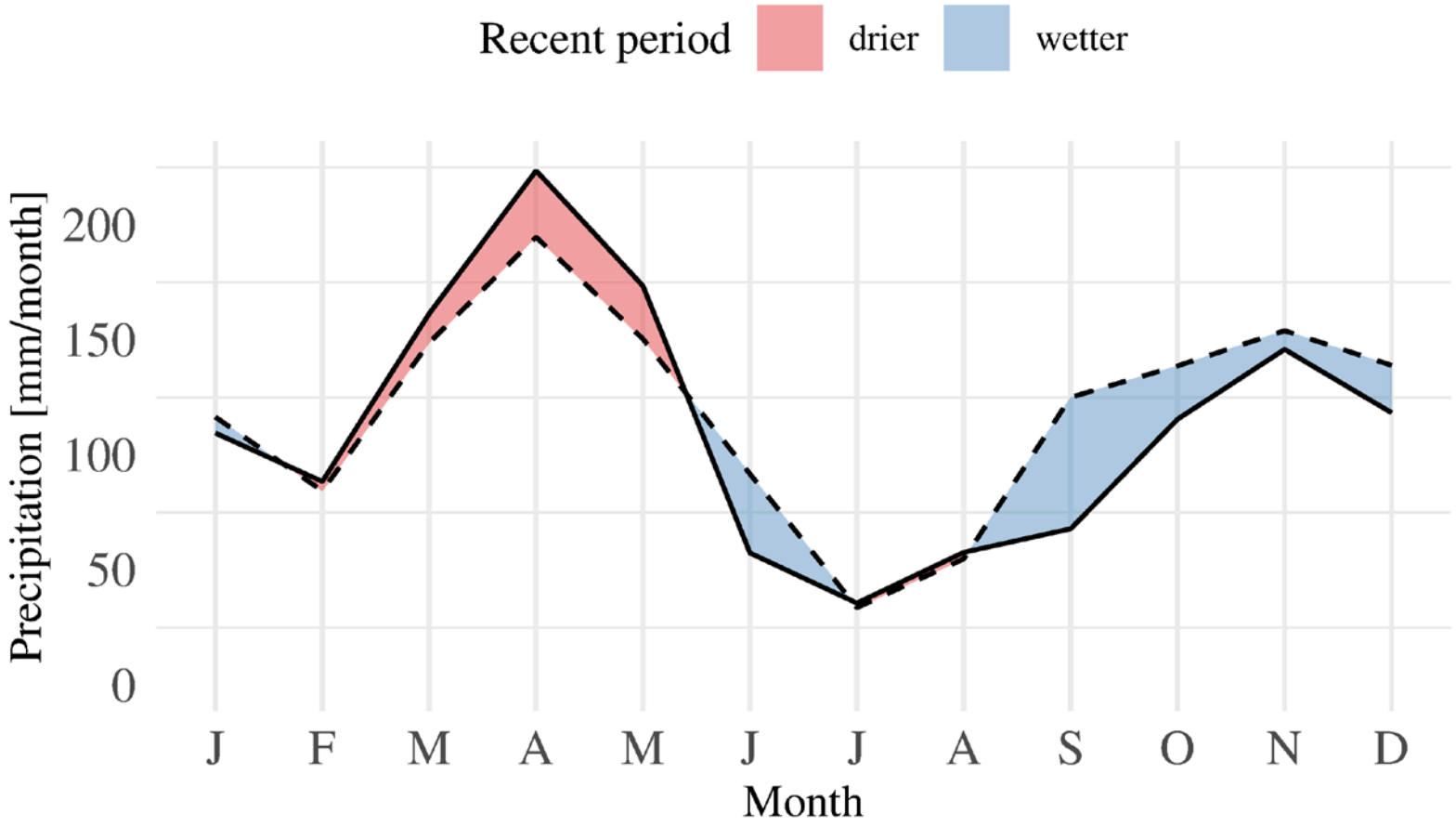
(g) Southwest (h) South (i) Southeast

More **dry and extremely dry** conditions **only in N, NW**

Clearly increasing trends of **wetter conditions**, less or no occurrence of dry conditions **in recent past**.

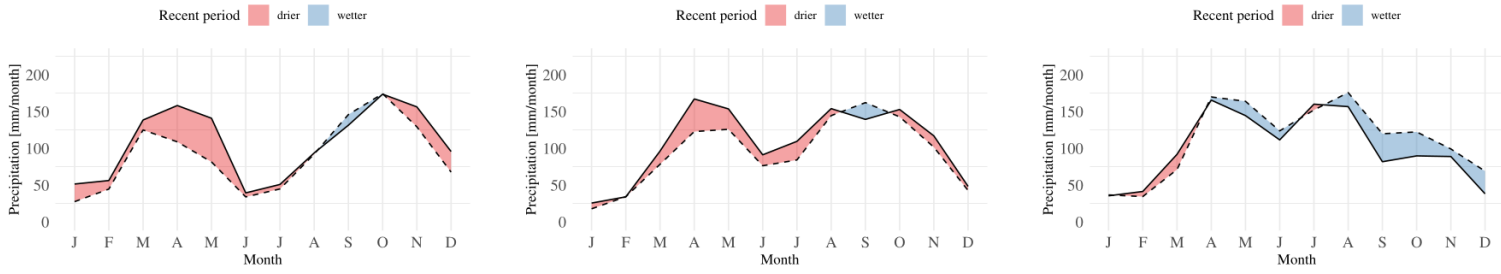
Rainfall seasonality

Early past (1980-1999) versus recent past (2000-2019)



Rainfall seasonality

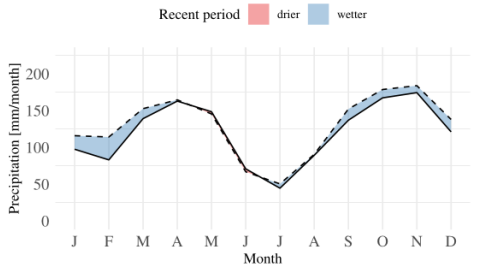
Early past (1980-1999) versus recent past (2000-2019)



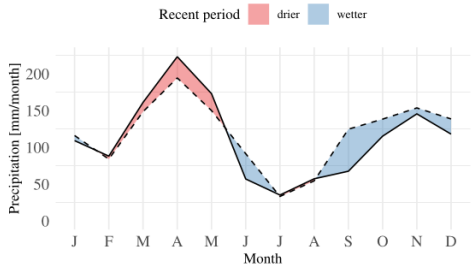
(a) Northwest

(b) North

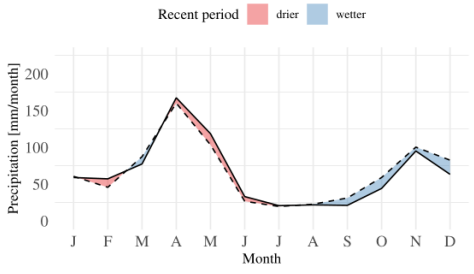
(c) Northeast



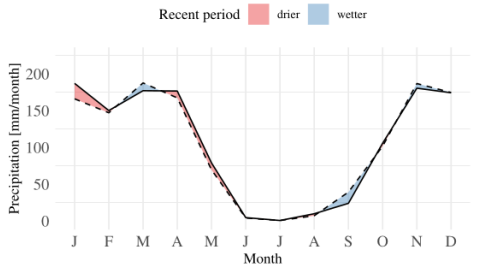
(d) West



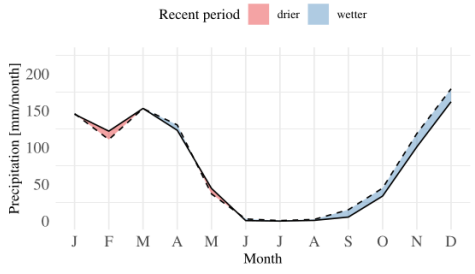
(e) Central



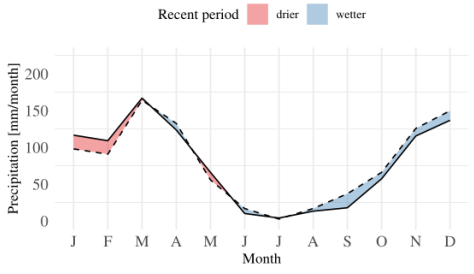
(f) East



(g) Southwest



(h) South



(i) Southeast

Beside the tendency towards **higher annual rainfall** in most parts of the basin

Reduction more likely

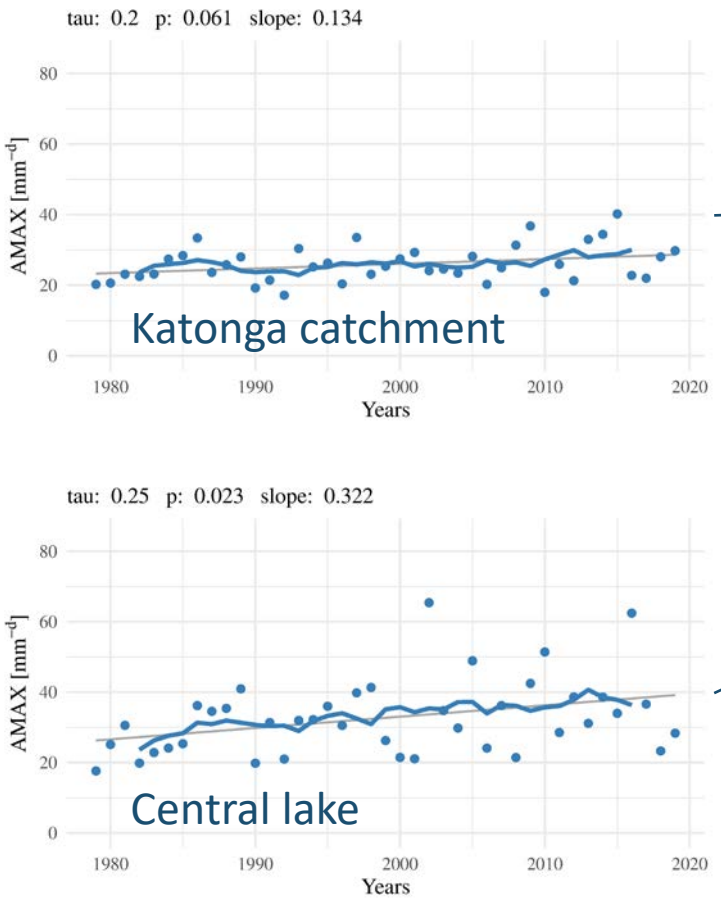
- in **MAM** season „long rains“

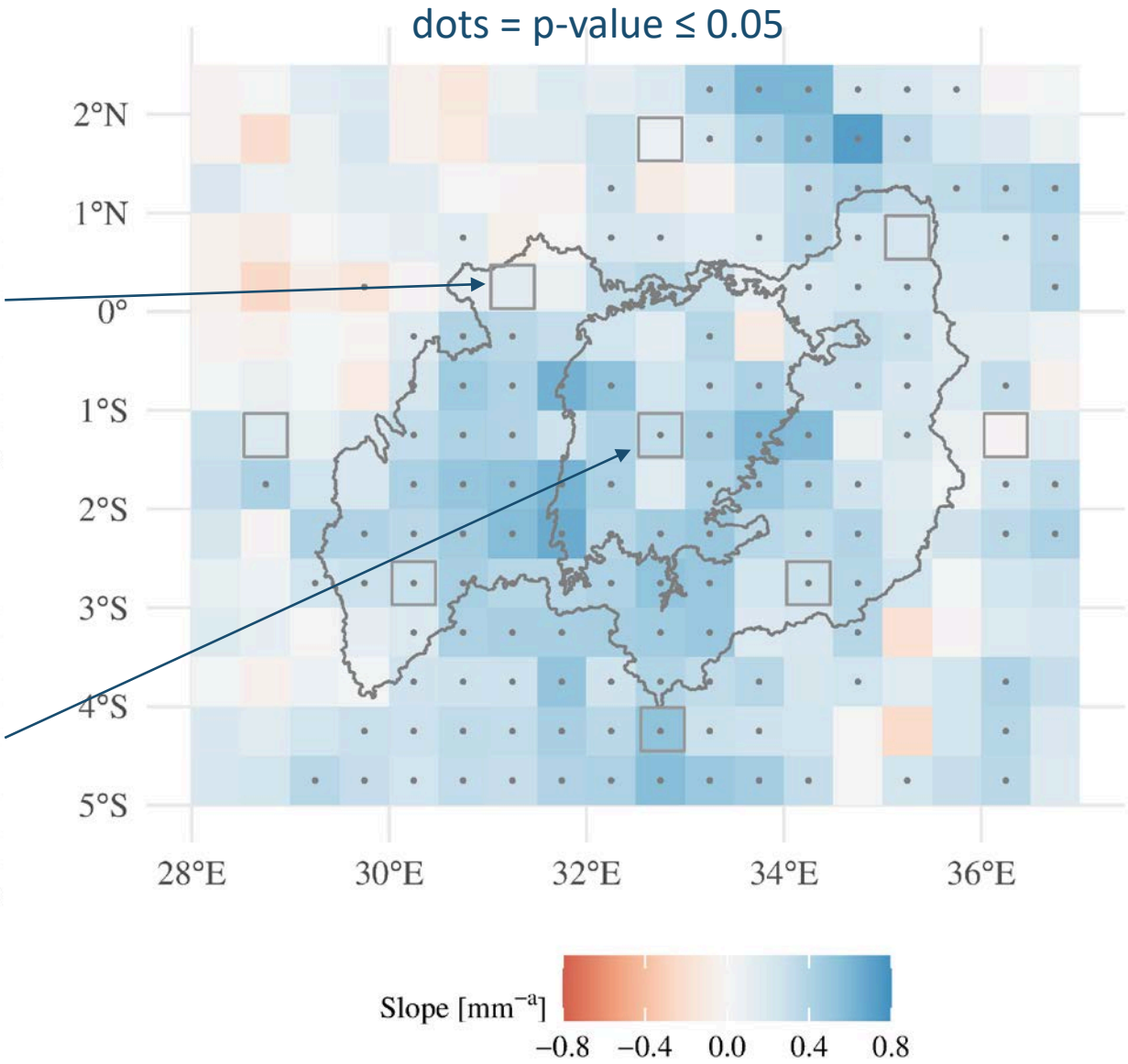
Tendency to **increase**

- in **OND** season „short rains“

Trend of annual maximum rainfall (past climate)

WFDE5: 1979 - 2019



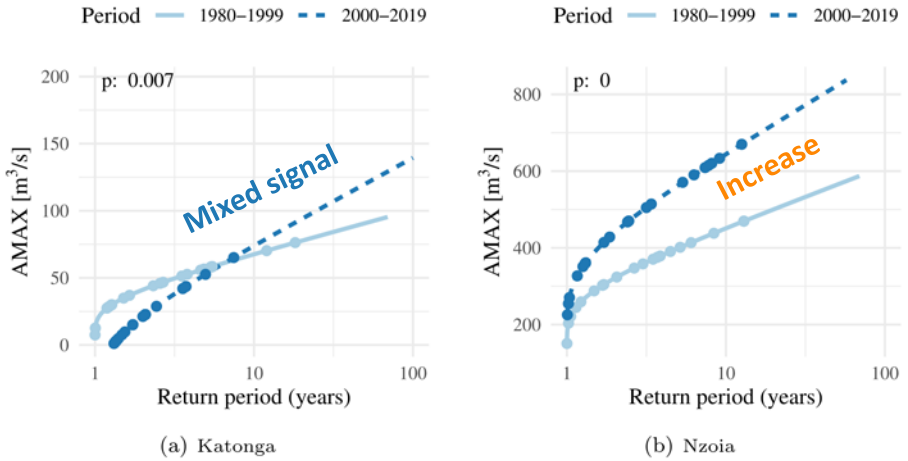


Annual maximum flood peak (return periods)

Gumbel distribution Type 1

Early past 1980 – 1999

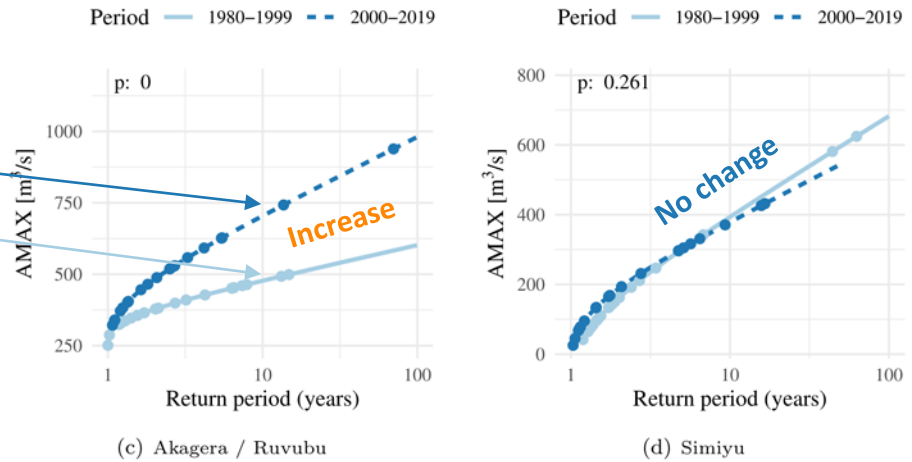
Recent past 2000 – 2019



(a) Katonga

(b) Nzoia

Flood peak associated to
10-years return period
750 m³/s
500 m³/s



(c) Akagera / Ruvubu

(d) Simiyu

Short summary of perceptions vs. observations

Temperature

"Increase"

"High"

"Hot"

Rainfall

Intensity

"Increase"

"Intense"

"Heavy rains"

Rainfall

Patterns

"Unreliable"

"Erratic"

"Changed patterns"

"Rainy season"

...depending on region

Floods & droughts

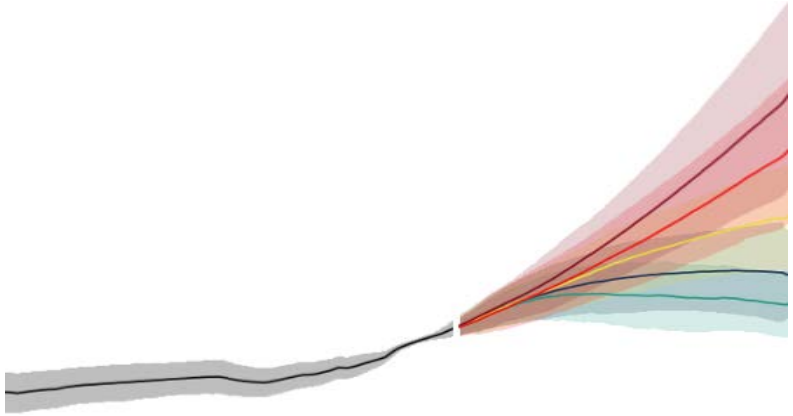
Droughts increased only in the north

Floods severity increased only in NE and SW

...depending on region

What will the future bring?

Expectations versus projections...



Uncertainties

Which climate scenario?

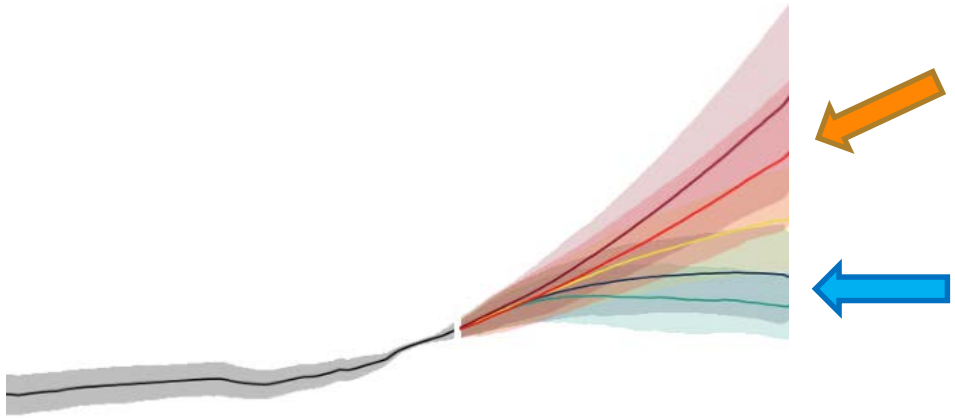
Near or far future?

Regional heterogeneity

Dealing with „*crazy*“ models?

What will the future bring?

2 scenarios, 10 bias-adjusted GCMs



SSP370: Regional Rivalry – A Rocky Road

- Medium to high end of future forcing pathways
- **~4°C warming by 2100**

SSP126: Sustainability – Taking the Green Road

- Low end of the range of future forcing pathways
- **Less than 2°C warming by 2100**

Consequences future

Expectations versus projections

Variables explaining >=50%

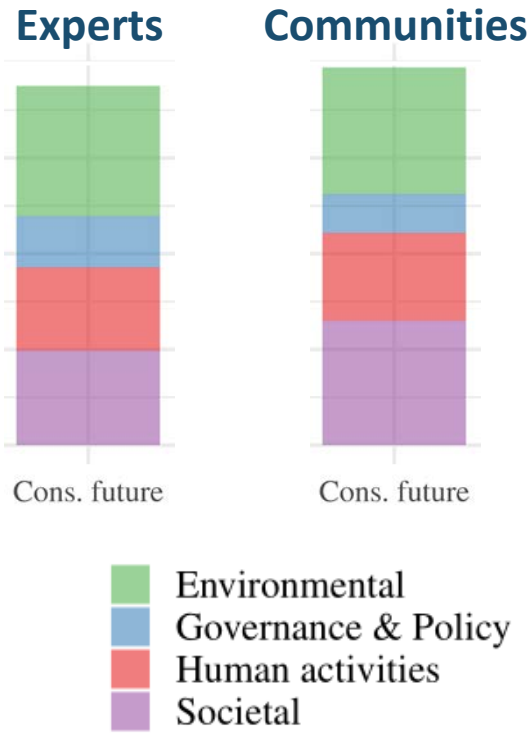
Meteorological data: 10 GCMs, ISIMIP3b (1980-2100)

Environmental

- Changing lake water level
- Temperature change
- Droughts
- Access to water resources
- Flooding (only communities)

Societal

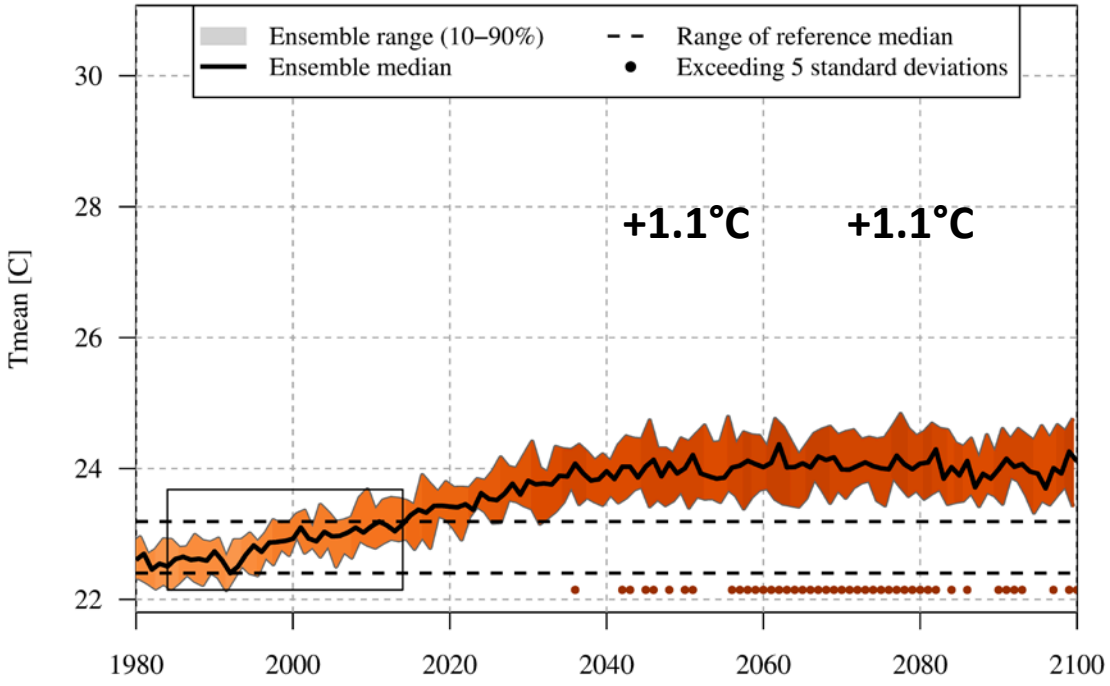
- Food security
- Disease (human)
- Poverty



Temperature development (LVB)

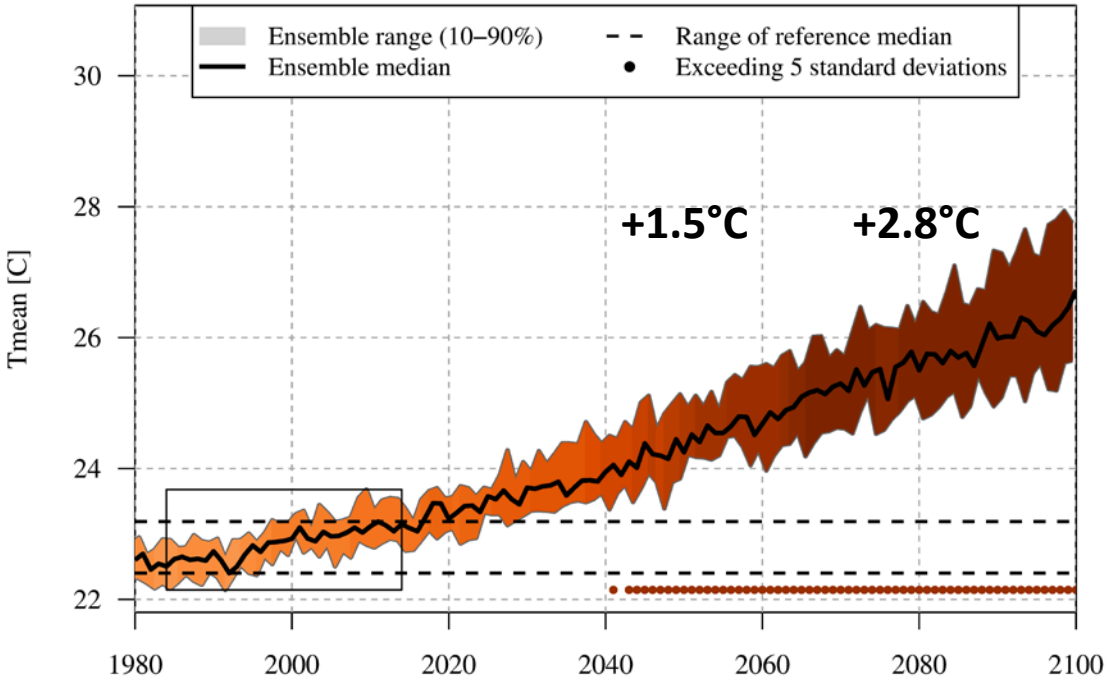
10 GCMs, 2 climate scenarios

Moderate: SSP126



Sustainability – Taking the Green Road

High-end: SSP370



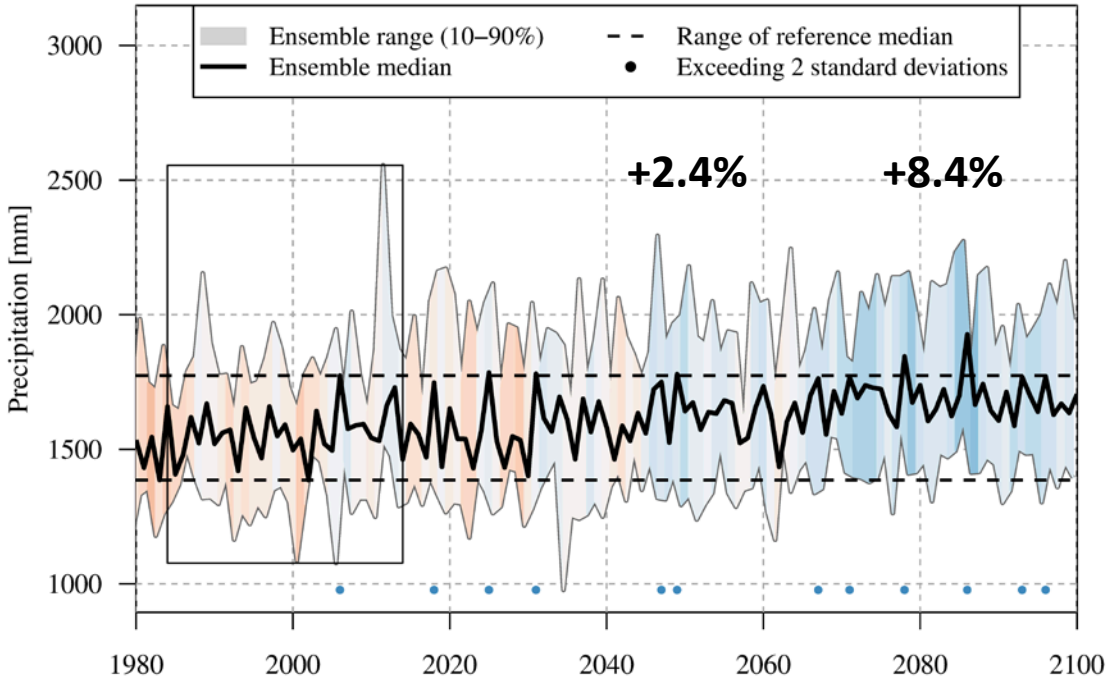
Regional Rivalry – A Rocky Road

Add 1°C to account for changes to pre-industrial era

Rainfall development (LVB)

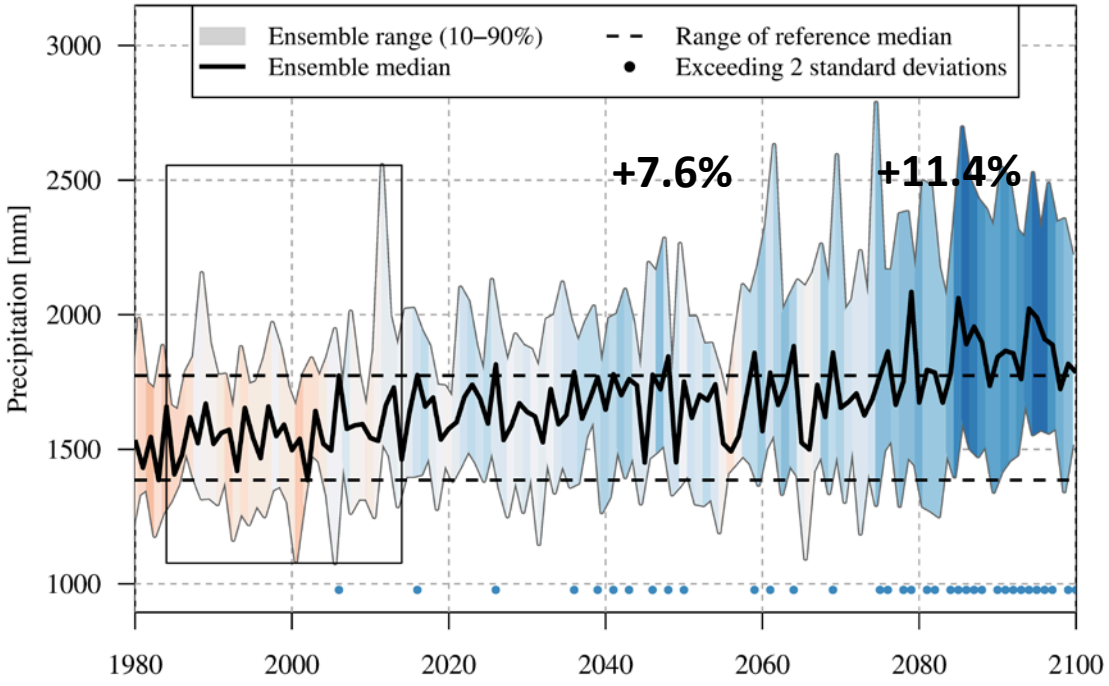
10 GCMs, 2 climate scenarios

Moderate: SSP126



Sustainability – Taking the Green Road

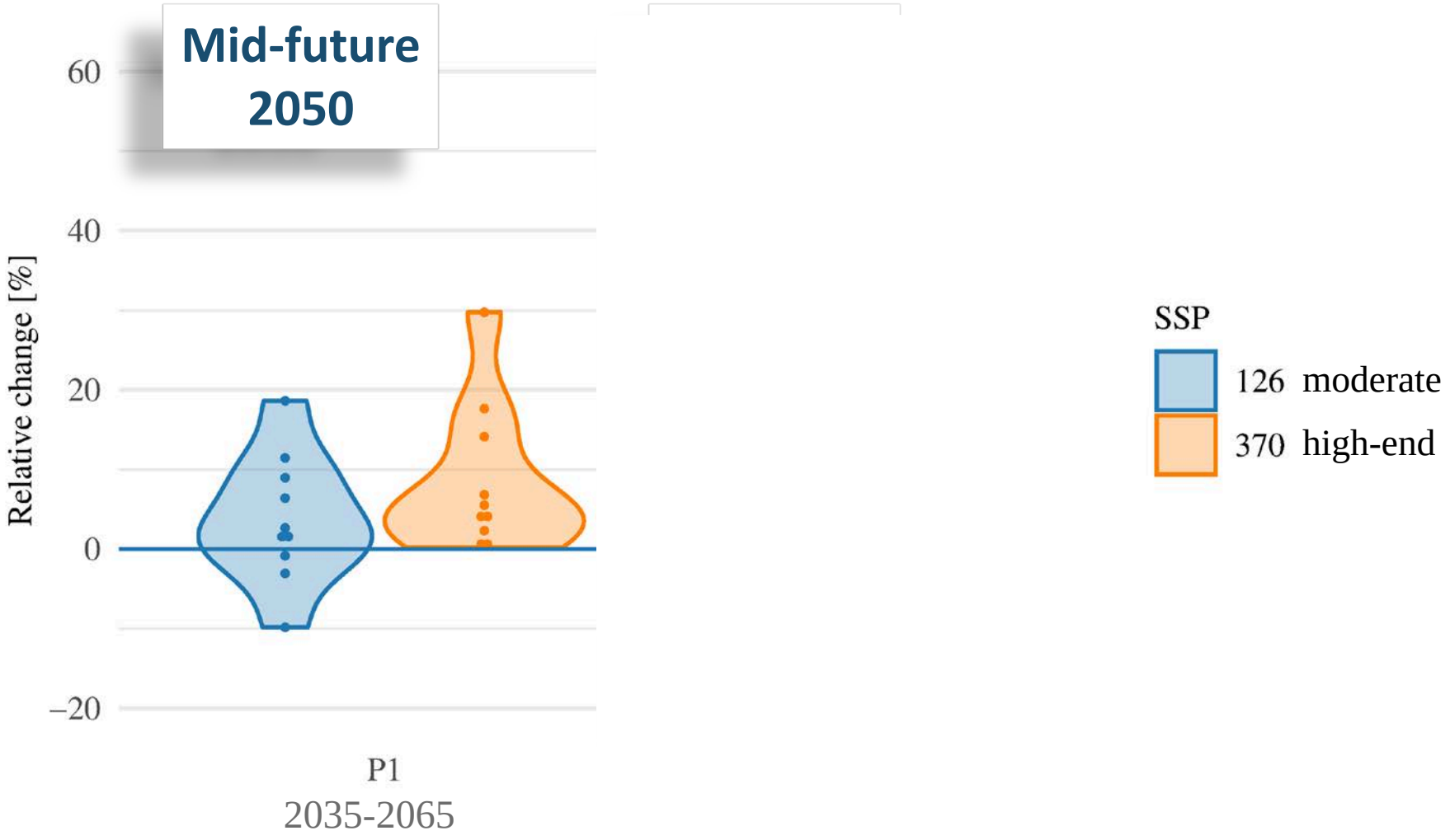
High-end: SSP370



Regional Rivalry – A Rocky Road

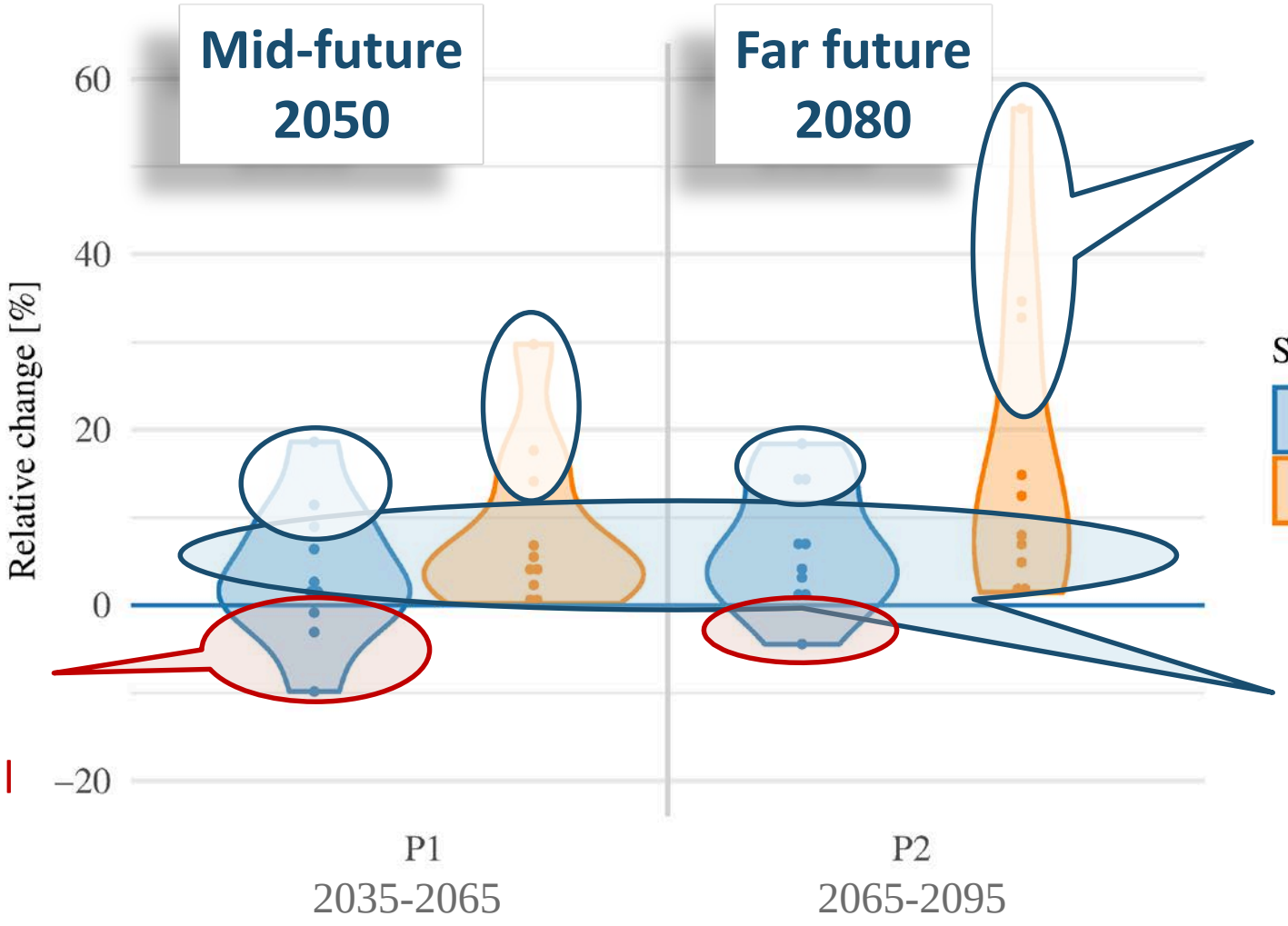
Change in mean annual rainfall (Basin avearge)

Compared to P0 (1984 – 2014), 10 GCMs



Change in mean annual rainfall (Basin avearge)

Compared to P0 (1984 – 2014), 10 GCMs



Three outliers?

Only 1 of 10 simulations
→ Lower rainfall

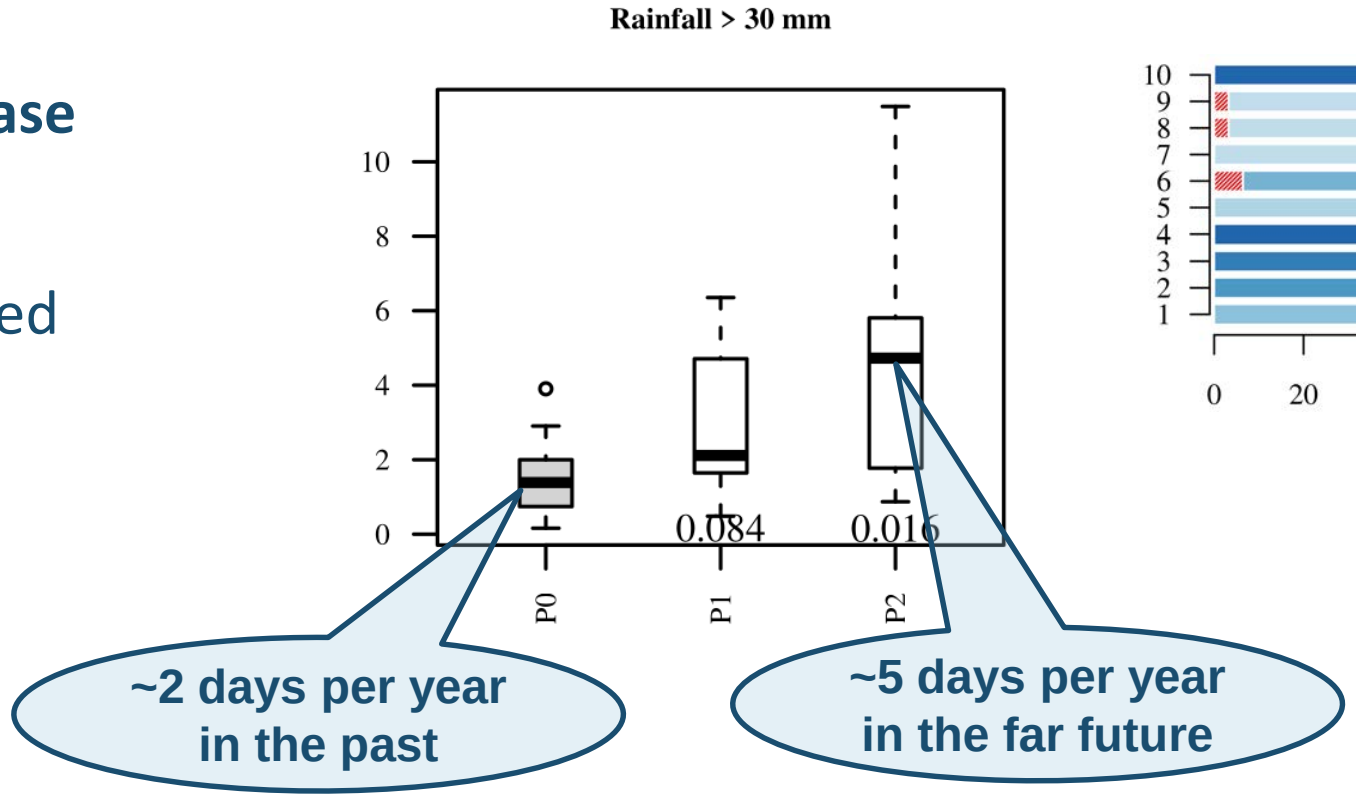
Majority of simulations
→ Up to 10% higher mean annual rainfall

Future rainfall extremes (over Lake Victoria)

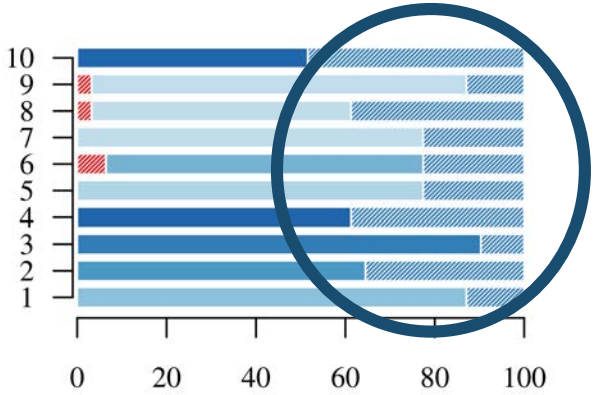
Compared to P0 (1984 – 2014), 10 GCMs

- Annual max. rainfall
  → **new extremes possible**
- *n* rainy days **> 30 mm**
  → projected to **increase**
- *n* rainy days **> 50 mm**
  → **no change** projected

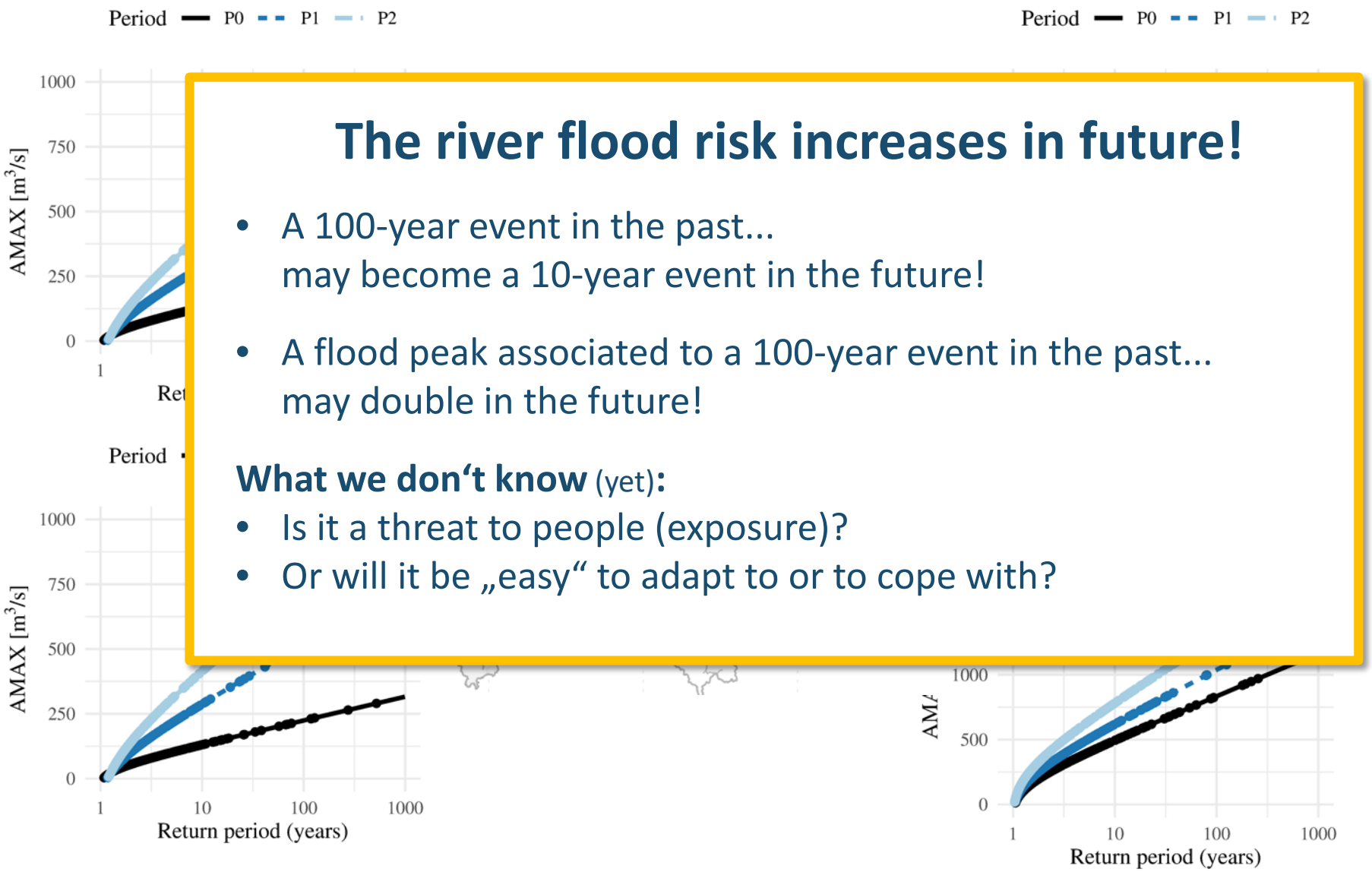
Number of days (SSP370)



AMAX rainfall change (~2080, SSP370)



River flood risk



The river flood risk increases in future!

- A 100-year event in the past...
  may become a 10-year event in the future!
- A flood peak associated to a 100-year event in the past...
  may double in the future!

What we don‘t know (yet)**:**

- Is it a threat to people (exposure)?
- Or will it be „easy“ to adapt to or to cope with?

High-end scenario SSP370

River flood peak
(return periods)

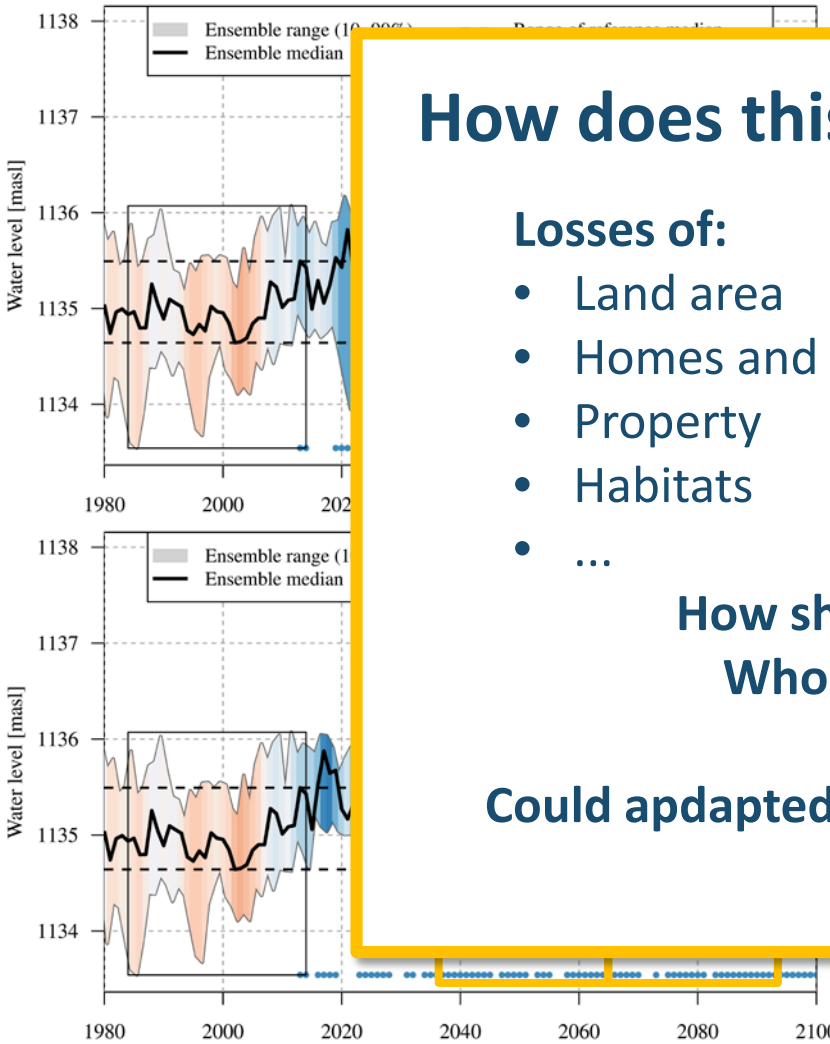
- General **increase**
- Stronger in the north
- Signal stronger than in moderate scenario

Lake Victoria water level

Future simulations (1980 - 2100), 10 GCMs

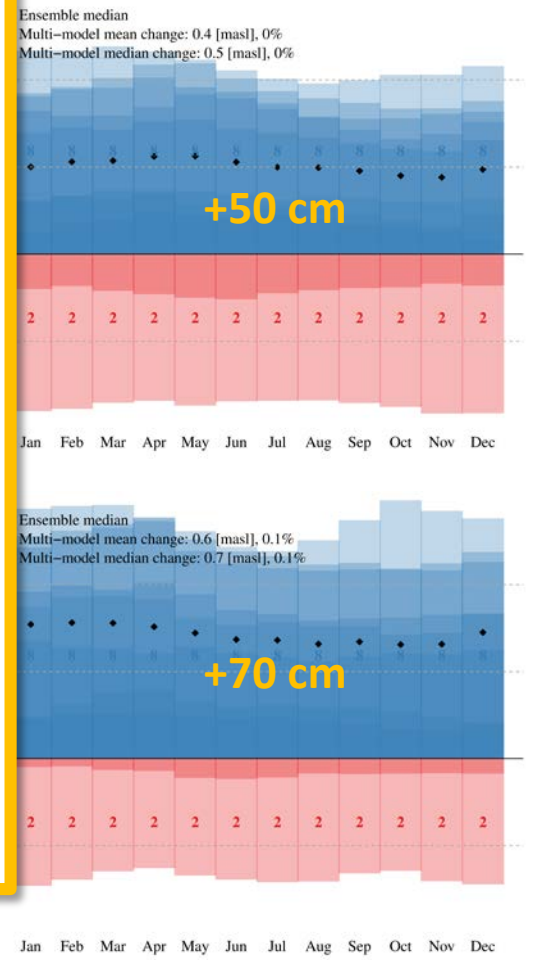
Moderate: SSP126

High-end: SSP370



2035 – 2065

2065 – 2095



How does this translate into impacts?

Losses of:

- Land area
- Homes and livelihoods
- Property
- Habitats
- …

How should it be compensated?
Who would be responsible?

Could apdapted outflow management reduce the inundation risk?

Conclusions on expectations and projections

Expectations

- Temperature change
- Changing lake water level
- Droughts
- Access to water resources
- Flooding
  (only mentioned by communities)

Projections

- **T increase:** Severity depending on scenario
- **WL:** Increasing trend (20-70cm), decrease = 2/10
- **Droughts:** Context-specific indicators required (SPI not sufficient or praxis-relevant), general increase in mean annual rainfall is not a suitable indicator
- **Access WR:**
  Depends on many factors (land use, infrastructure, technology...).
  Projections indicate a general increase in water availability (wetter future).
- **Flooding**
  - Higher risk of river floods (increasing magnitude and return periods)
  - Higher risk of flooding / inundation at the shores of Lake Victoria

Why is it relevant to know that...

...experts and non-experts share certain views on climate change or not?

- **Agre**
  - At l
  - Alt
  - Acc
- **Discr**
  - Bas
  - **Dif**
    The
  - Ma
  - **Exp**

May these insights contribute to:

- **A more holistic understanding of society's perspectives on climate change**
- **Sensitising experts and decision-makers to the realities of community members**
- **Giving community members a stronger voice to influence and demand climate action (adaptation)**

Why is it relevant to know that...

...perceived consequences felt today agree or disagree with observations?

- **Agreement**
  - The obvious: Perceptions match the data & **Climate change communication works well(?)**
  - **Climate change is happening!** *Otherwise there would be nothing to report...*

- **Don‘t forget the other variables contributing to change!**

  Sometimes falsely attributed to climate change

  → **E.g., land use change & deforestation** contribute to **worsening the impacts of extreme events**

  → Lower water holding capacity of the landscape → increasing flood and drought risk!

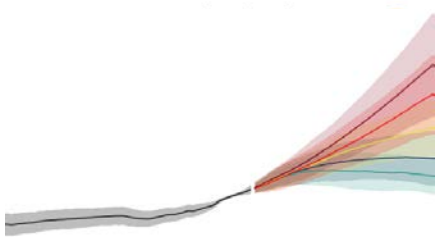
Why is it relevant to know that...

...perceived consequences felt today agree or disagree with observations?

- **Disagreement**
  - **Generalization** of assumptions based on hearsay, e.g.,
    „I‘ve heard that droughts have increased due to climate change“
    - Droughts were rated very high (overestimated?)
    - Droughts increased in the recent past only in N / NW
  - **Rethink (science) communication strategies**
  - Observation data not adequately representing reality and / or analysis methods to be expanded
- **Conceptual setup of the survey**
  - Questions not specific enough (e.g., drought indicators, how is drought defined in the mindsets, practically)
  - Maybe the participant‘s scope did not shift from global climate change to the Lake Victoria basin
    from general → specific

Why is it relevant to know that...

…expectations about future consequences agree or disagree with projections?



- A shift in perceived consequences from “Environmental” → “Societal”
  - From hazards towards a **concern for human well-being**
  - Should be taken seriously: *emotions → action / inaction → mental health*
- Well-being not necessarily directly related to climate change
  - Governance & activities: education, land use management, deforestation…
  - Adaptation not only to climate change but to change in general
    ...population growth, resource scarcity, globalization trends...
- Are future hazard risks underestimated?
  - Floods and droughts were important consequences perceived today
  - Focus (importance) taken away by concern for well-being?

Partners


AXIS
JPI Climate
The Research Council of Norway
NWO
Federal Ministry of Education and Research

Annual maximum rainfall (return periods)

Gumbel distribution Type 1

Early past 1980 – 1999

Recent past 2000 – 2019

Same return period
→ higher rainfall in recent past

AMAX rainfall associated to
10-years return period
48 mm
28 mm