



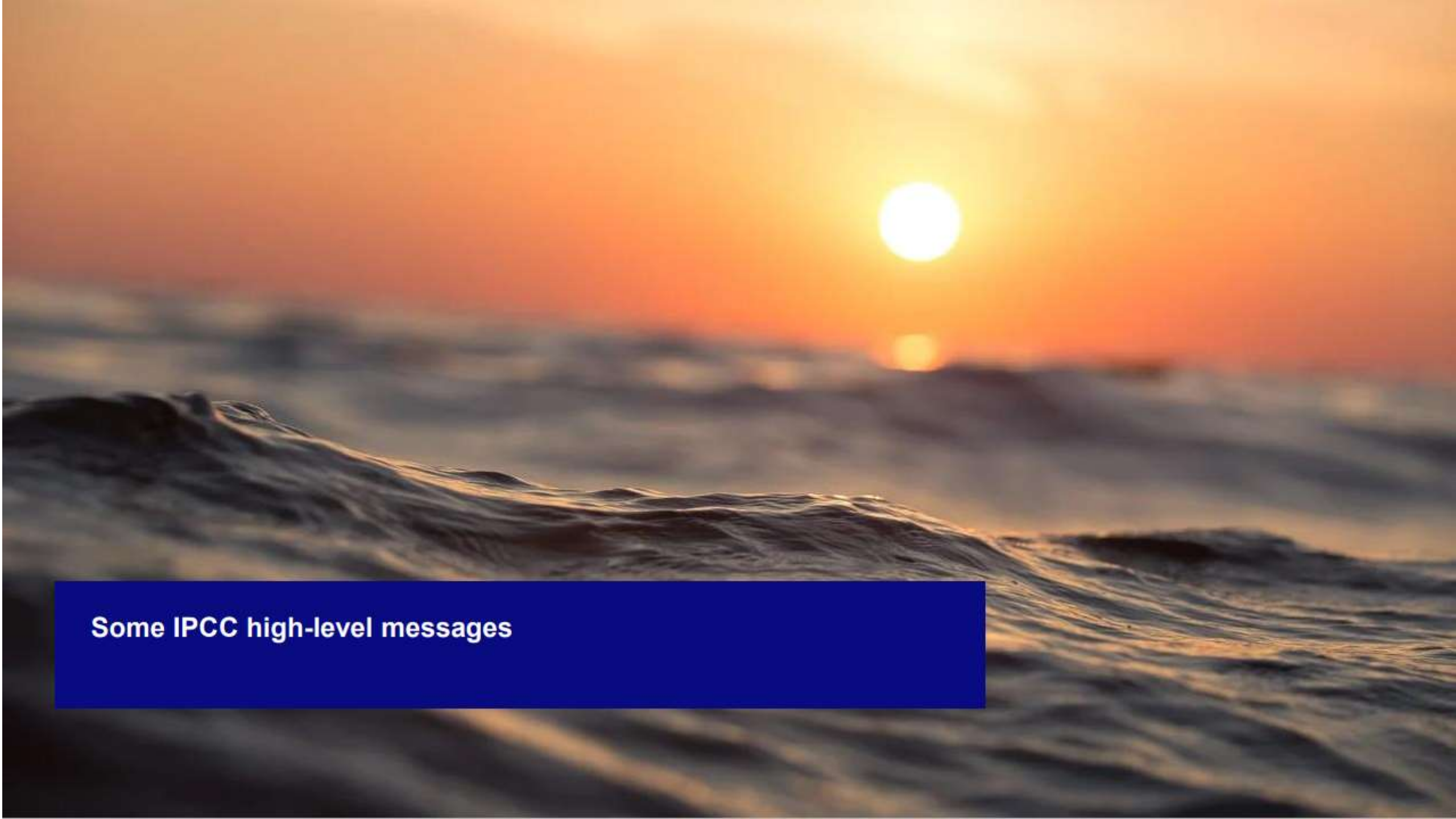
AIW/W - Dealing with Drought

Impacts of climate change on the future (drought) conditions in Europe – with a focus on the Rhine

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A photograph of a sunset over the ocean. The sun is a bright, glowing orb in the upper right quadrant, casting a warm orange and yellow light across the sky. The horizon is visible, with the sun's reflection shimmering on the water's surface. The foreground shows the dark, textured surface of a wave with white foam, illuminated by the low sun.

Some IPCC high-level messages

Climate change is **already** affecting every inhabited region on Earth, in multiple ways.



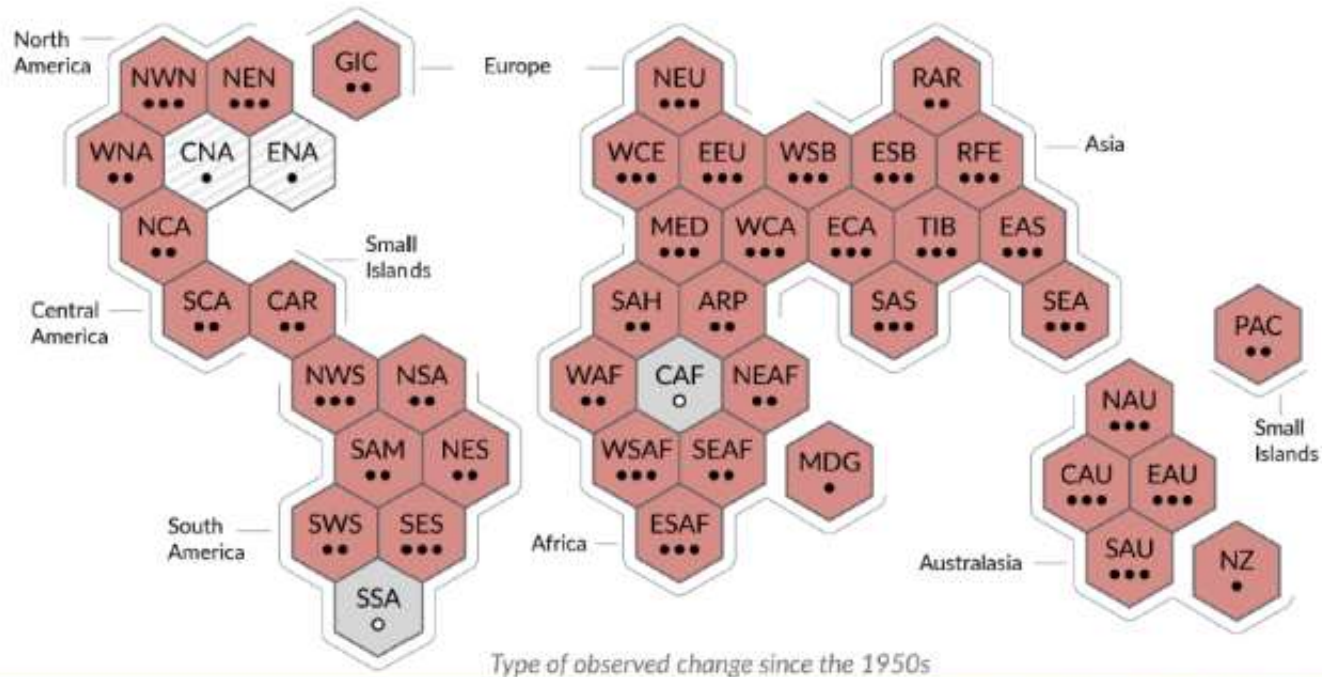
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution to the observed change

- High
- Medium
- Low due to limited agreement
- Low due to limited evidence



Climate change is **already** affecting every inhabited region on Earth, in multiple ways.



c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought

● Increase (12)

● Decrease (1)

▨ Low agreement in the type of change (28)

○ Limited data and/or literature (4)

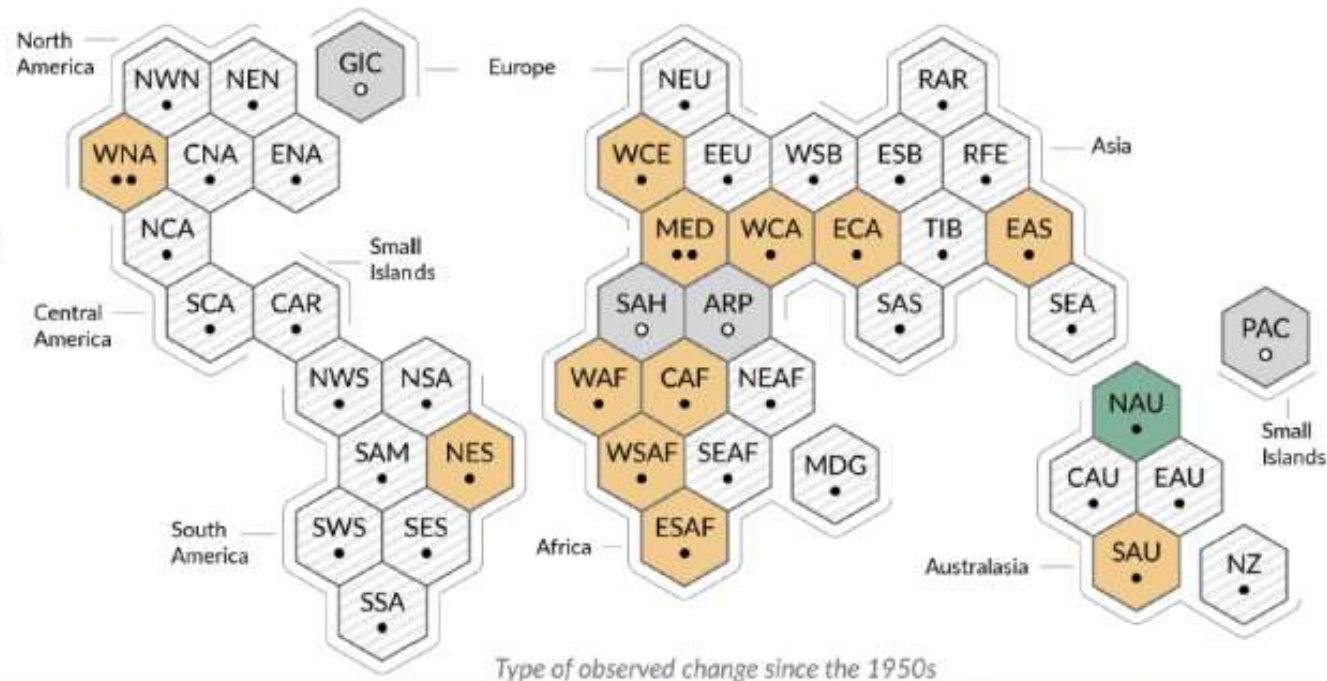
Confidence in human contribution
to the observed change

●●● High

●● Medium

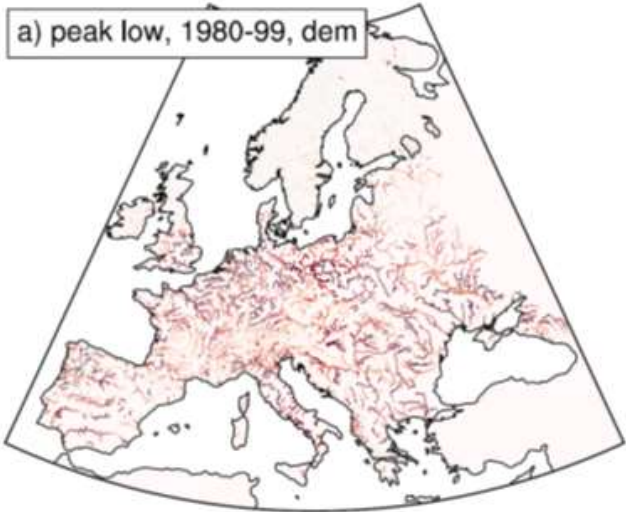
● Low due to limited agreement

○ Low due to limited evidence

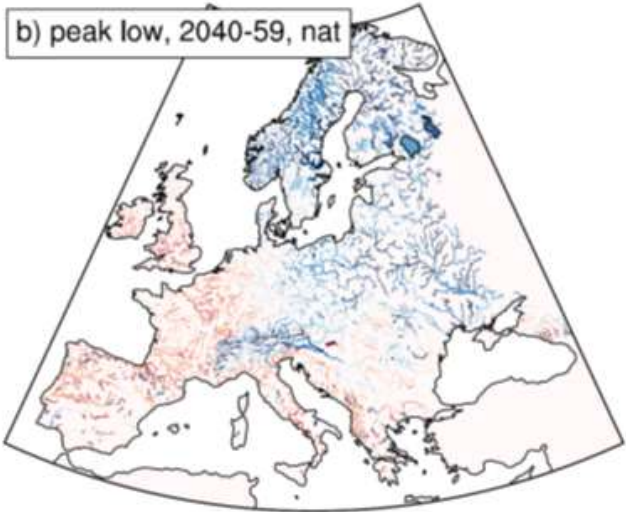


Climate change vs water use

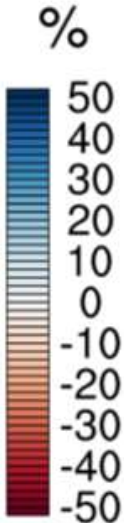
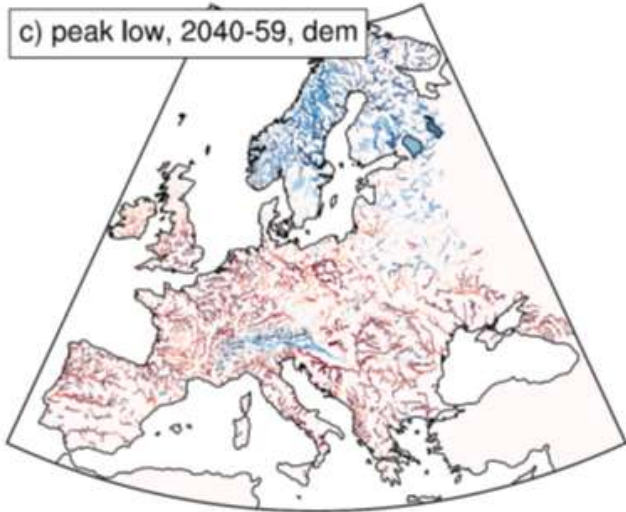
Impact of current water use



Impact of CC



Impact of CC and water use



Source:
IIASA, EUCP,
Greve et al.

Future climate change – Rhine basin

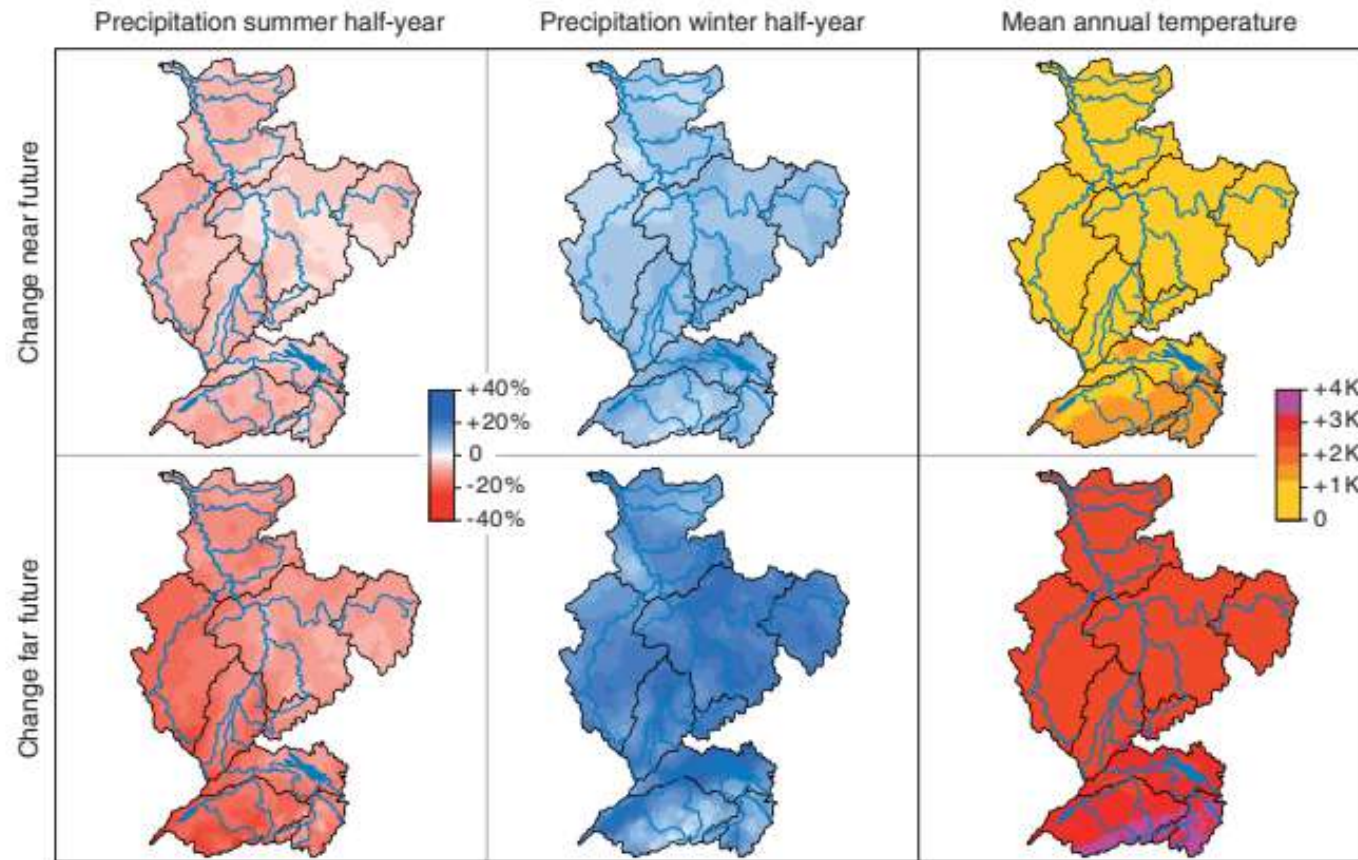


Figure 5: Climatic changes for the ASG ensemble means, i.e. the average change of the bias corrected, spatially interpolated GCM-RCM ensemble members (RCP8.5 scenario). Shown are average changes of the near future (2031–2060) and far future (2071–2100) relative to the reference period (1981–2010). Black lines: Rhine basin and sub basins.

*CHR - ASG study 2021
Stahl et al, 2021*

Decreasing glaciers and snow

- Spring and summer discharge of the Rhine partly originates from snow / glacier melt
- Increasing temperatures:
 - less snow accumulation in the Alps
 - earlier melt
- Rhine river discharge originating from snow will decrease in the future.

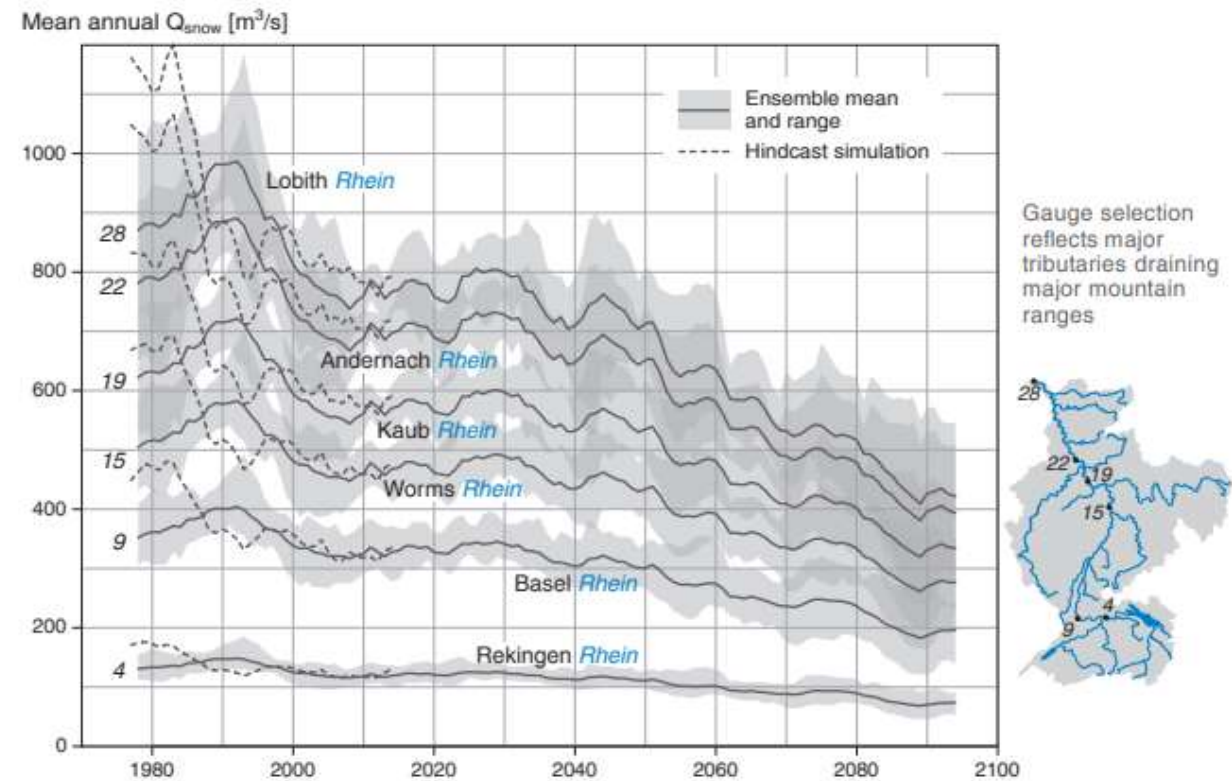
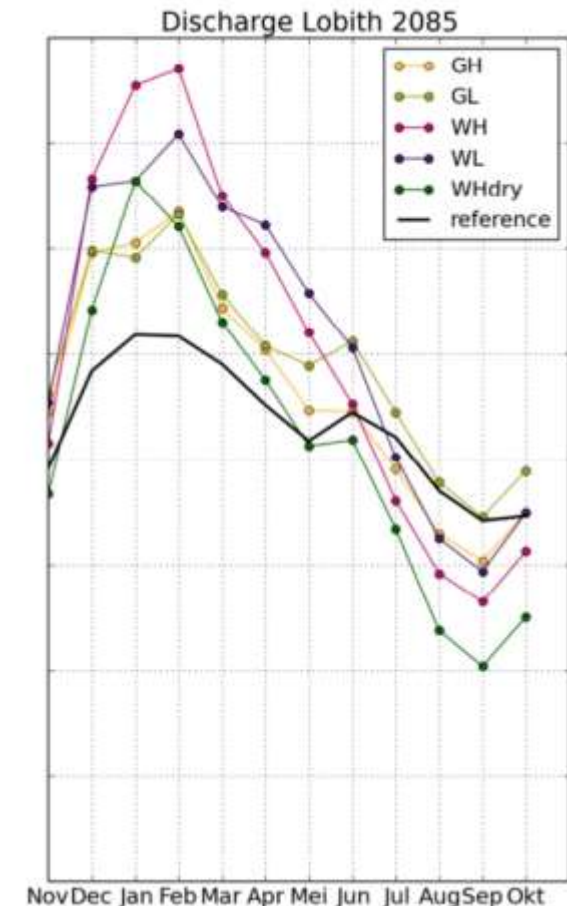
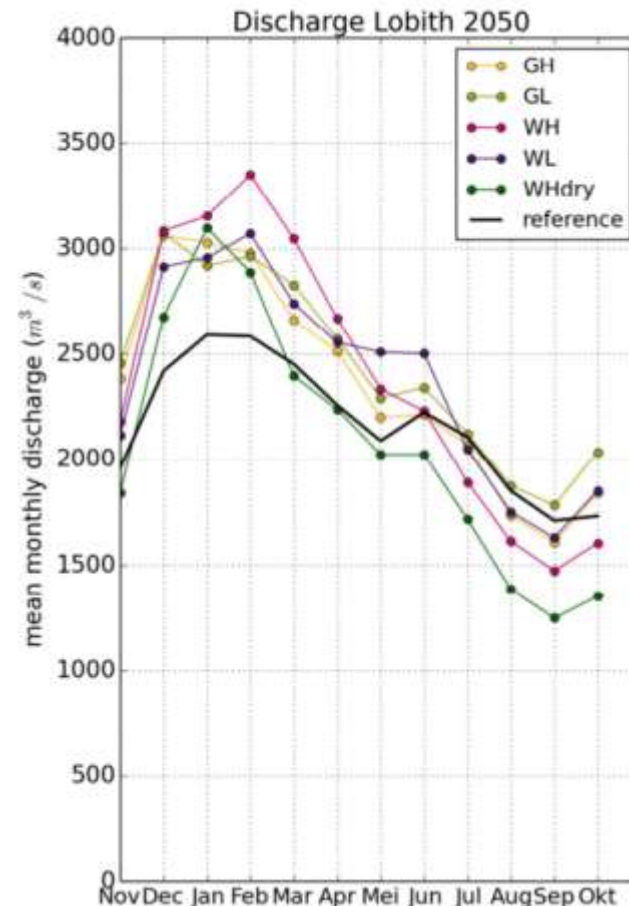


Figure 11: 11-year moving averages of hindcast and climate scenario simulations of mean annual Q_{snow} at different gauges.

CHR - ASG study 2021
Stahl et al, 2021

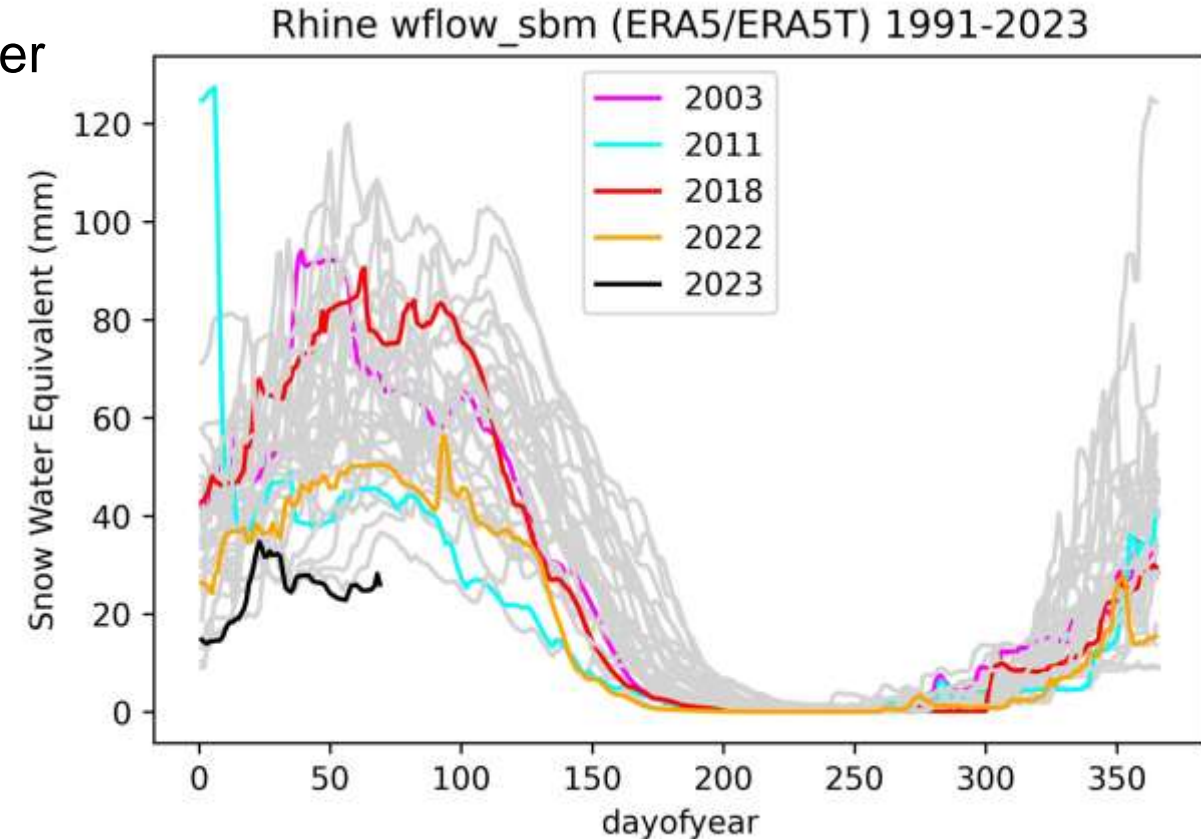
Future discharges river Rhine – KNMI14 – IPCC AR5

- Increases in winter discharge
- Decreases in late summer discharge
- Mean discharge – little change and large uncertainty
- Similar pattern for the Meuse



Snow cover in the Alps

- Simulation of snow water equivalent for the Rhine basin
- Annual cycles of mean snow water equivalent in the basin
- 2023 is a year with very little snow → less melt water



Impacts in the Netherlands

- Restrictions for irrigation water use
 - Limitations for navigation
 - Salt water intrusion – effecting drinking / irrigation water
 - Restrictions for cooling water intake
- Need for freshwater buffers



Take home messages

- We ourselves should be part of the change – water use can have a larger impact than climate change
- Seasonal outlooks can help us get prepared in time

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