Impacts of climate change and socio-economic scenarios on low water in the Rhine River basin

CHR research agenda for knowledge and tools in the field of hydrology of the entire Rhine basin

METEET – online workshop – 6 June 2023

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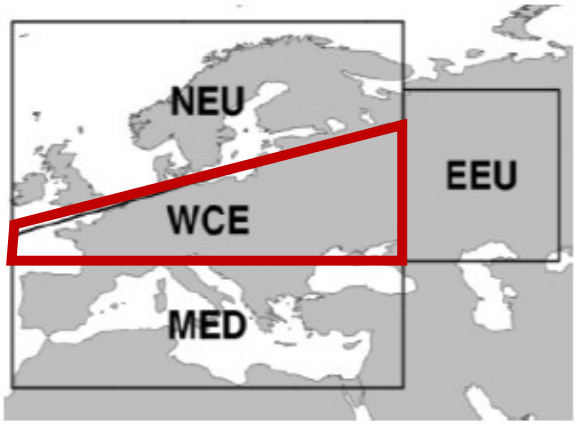
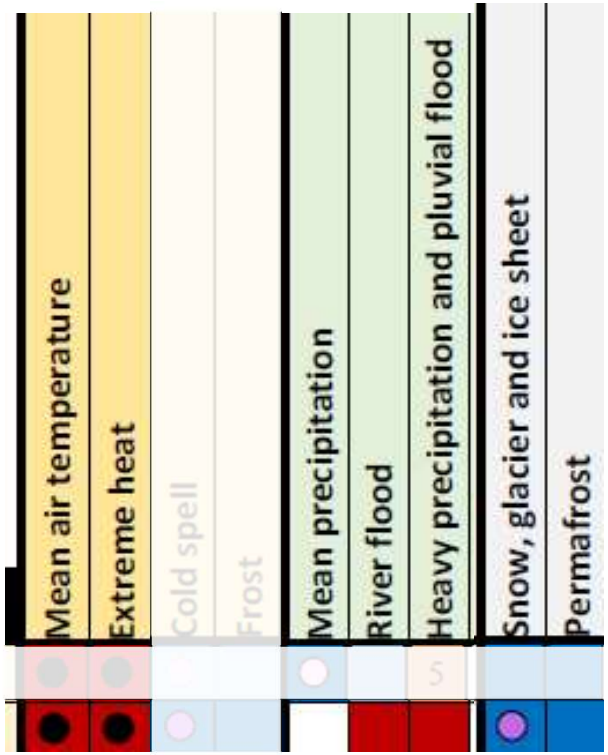
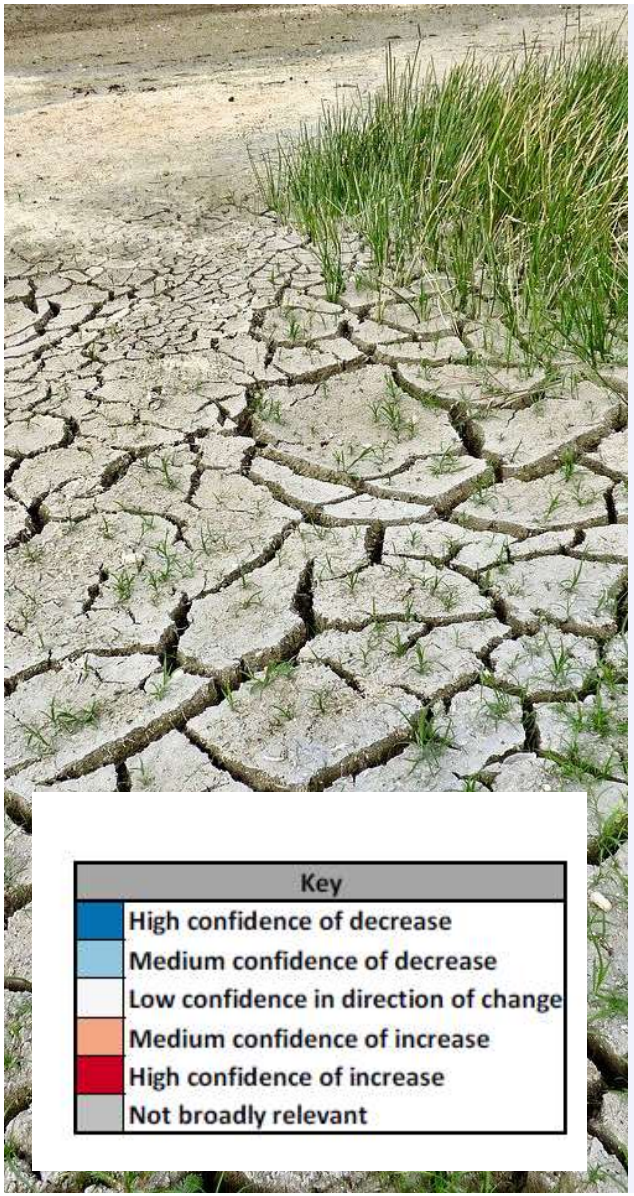
Member of the International Commission for Hydrology of the Rhine Basin (CHR)

High level message from IPCC 6th report



- Warmer
- Wetter
- More extreme temperature and precipitation
- Increased flood likelihood
- Less snow and glaciers





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Joint effort and cooperation in building climate resilience by 3 Rhine commissions

IKSR CIPR ICBR

International Commission for the Protection of the Rhine (ICPR)
(see https://www.iksr.org/)

CCNR
CENTRAL COMMISSION FOR THE NAVIGATION OF THE RHINE

Central Commission for Navigation of the Rhine (CCNR)
(see https://www.ccr-zkr.org/)

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International Commission for the Hydrology of the Rhine basin (CHR)
(see https://www. https://www.chr-khr.org/)

The CHR research agenda

The **International Commission for the Hydrology of the Rhine basin** (CHR) is an organization in which the scientific institutes of the Rhine riparian states develop and disseminate knowledge and tools in the field of hydrology of the entire Rhine catchment area to support decision making about sustainable development of the Rhine basin.

Melt water from glaciers and snow is missing in the future

More often low-water situations in the Rhine from Basel to the North Sea. We need to be prepared for longer extreme drought periods and more extreme events.

The CHR research messages

Fraction Snow and Glacier melt in the discharge of the Rhine and its tributaries in a changing climate (ASG)

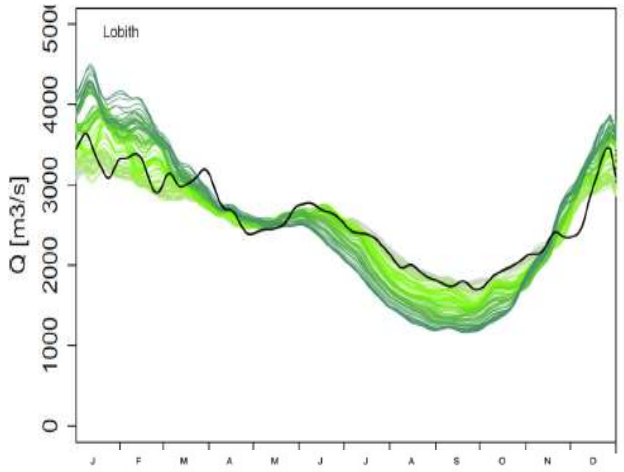
- With its source in the Alps, the hydrological regime of the Rhine is influenced by meltwater in spring and summer.
- Under the influence of a warming climate the surface of glaciers in the Alps is rapidly shrinking.
- Climate change influences weather patterns and also the distribution of solid and liquid precipitation.
- This is important for water availability in the entire catchment area.

ASG1 (past) and ASG2 (future) studies conducted by Uni Freiburg, Uni Zurich and Hydron (project duration 2012-2016 resp. 2018-2022).

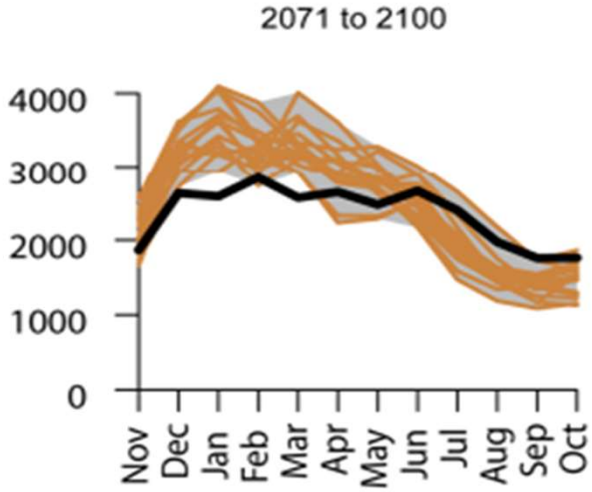
ASG2 projections in line with earlier projections from Rheinblick2010

Selection from EURO-CORDEX for Rhine river flow projections:
- Only RCP8.5 considered (worst case)
- 7 scenarios from the CORDEX ensemble developed for Europe were used.

- Decrease in end of summer discharge Lobith
- Increases in winter discharge and spring



CHR ASG2 – reference (black), future projections (green)
(Stahl, K. et al, 2022)



CHR Rheinblick – reference (black), future projections (orange)

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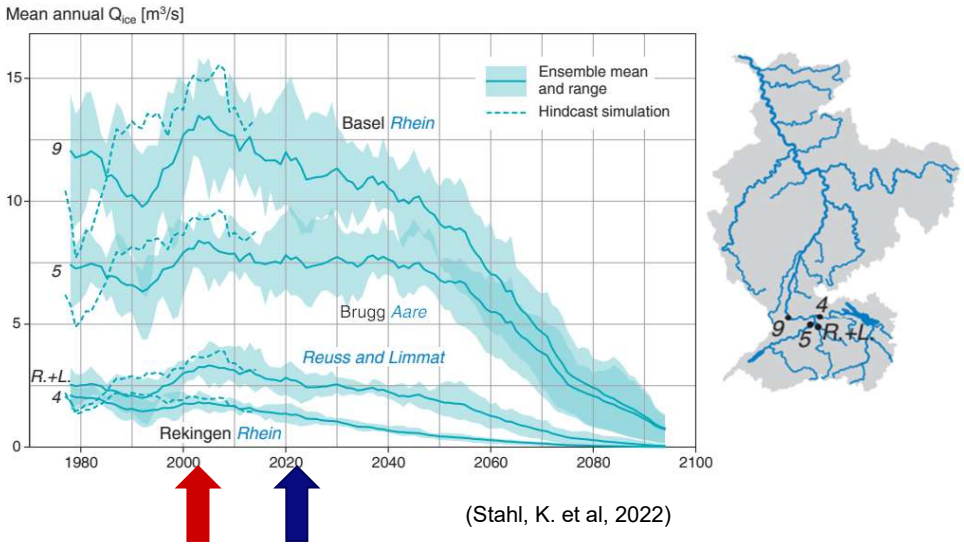
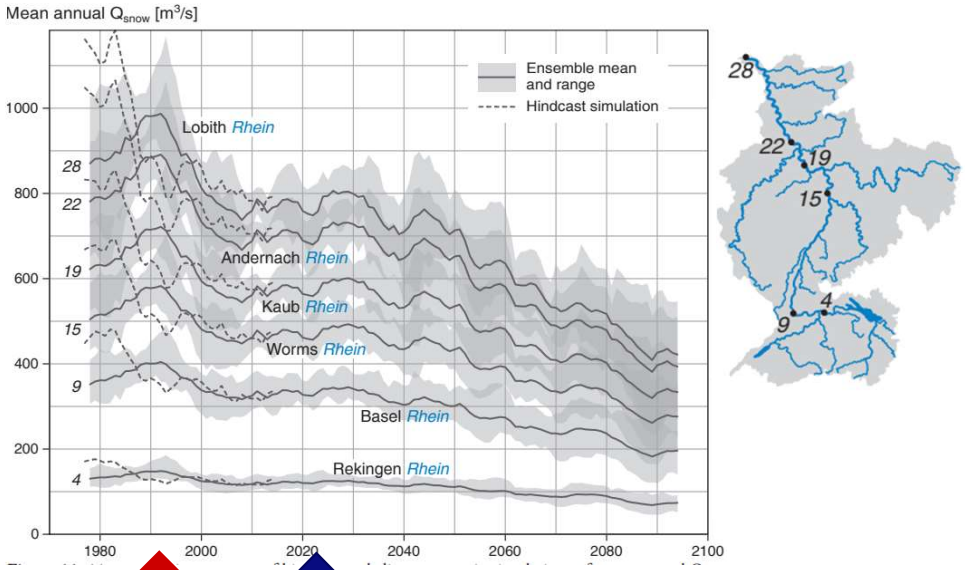
ASG2 results (1): ice and snow

ICE



(Stahl, K. et al, 2022)

SNOW



(Stahl, K. et al, 2022)

The turnaround for the max. contribution of ice has already passed. Similar is valid for snow.
The fraction of ice melt is rapidly decreasing after 2045 and almost disappear by the end of the century.

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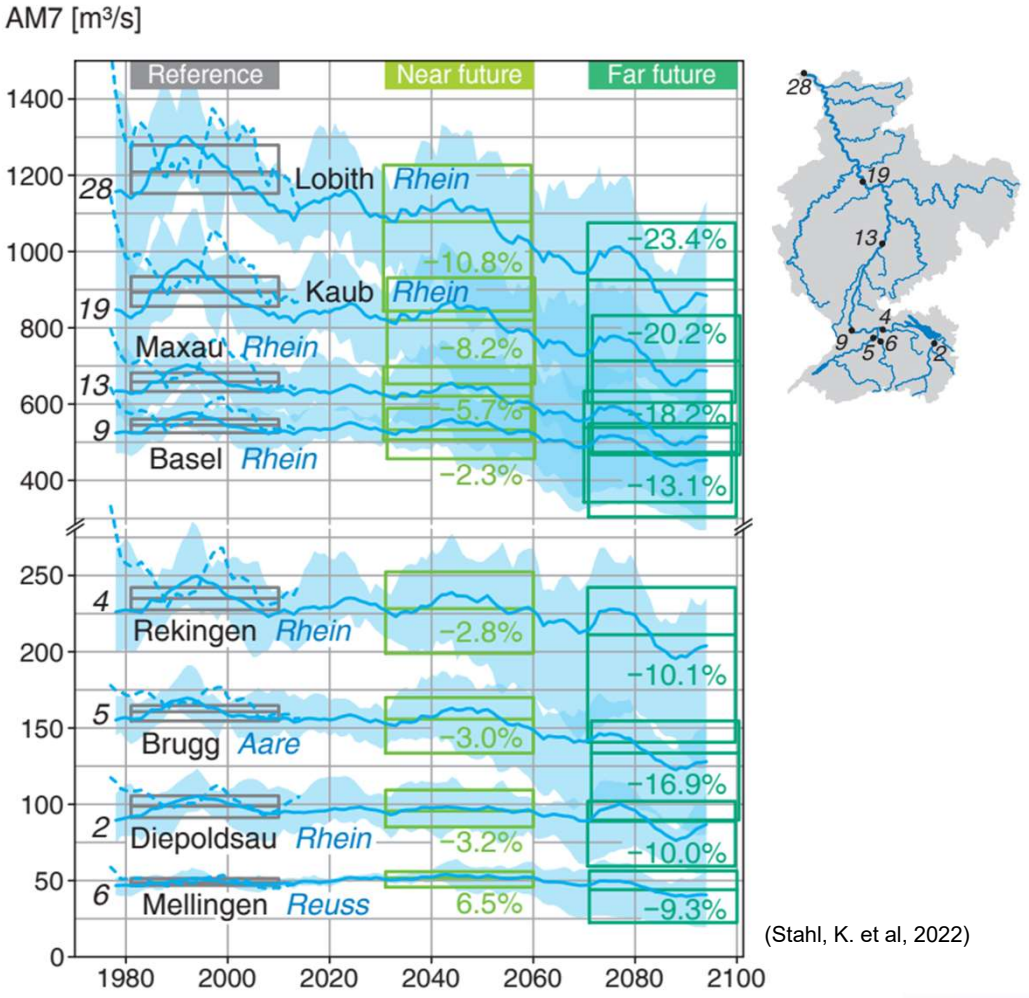
ASG2 results (2): low flow

Around 2045, a turnaround starts, which may lead to a 23% lower minimum discharge at Lobith in 2100.

Conclusion:

Based on used models/scenarios (RCP8.5), we may assume that the total stream flow will be stable - also in the long run - and that the low flows will remain in the familiar range during the next three decades, after which they will decrease quite rapidly during the next 50 years.



(Stahl, K. et al, 2022)

Time series of modeled low flows (annual 7-day-minima, AM7) at gauging stations in the Rhine basin (11-year moving averages).

(Stahl, K. et al, 2022)

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ASG2 results (3): impact for navigation example

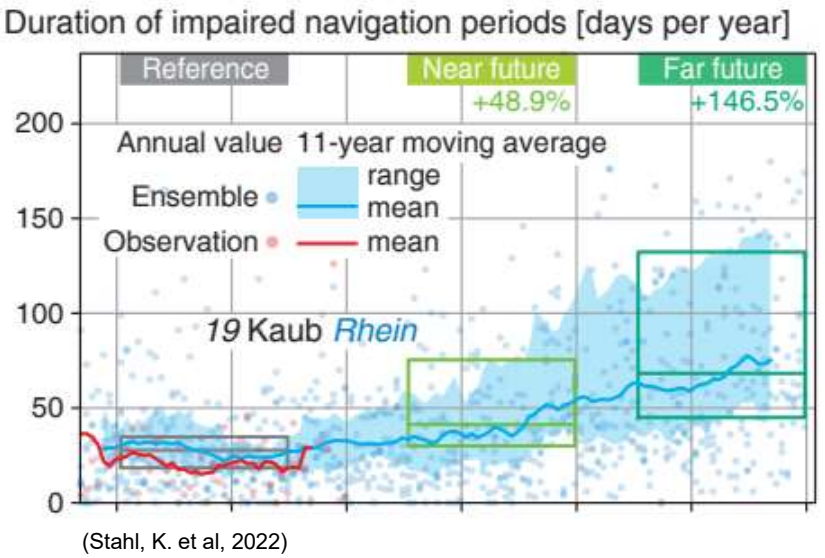
Assumptions: Impaired navigation based on gauge Kaub

Water level below 78cm (GIW 2015)
GIQ =784 m^3/s

Exceedance of HSW: Hochwassermarke I
water level > 460 cm, Q > 3445 m^3/s

Based on these applicable thresholds, restrictions to navigation could prevail, on average, for more than two months per year at the end of the century.

ASG II Report is available on CHR website



(Stahl, K. et al, 2022)

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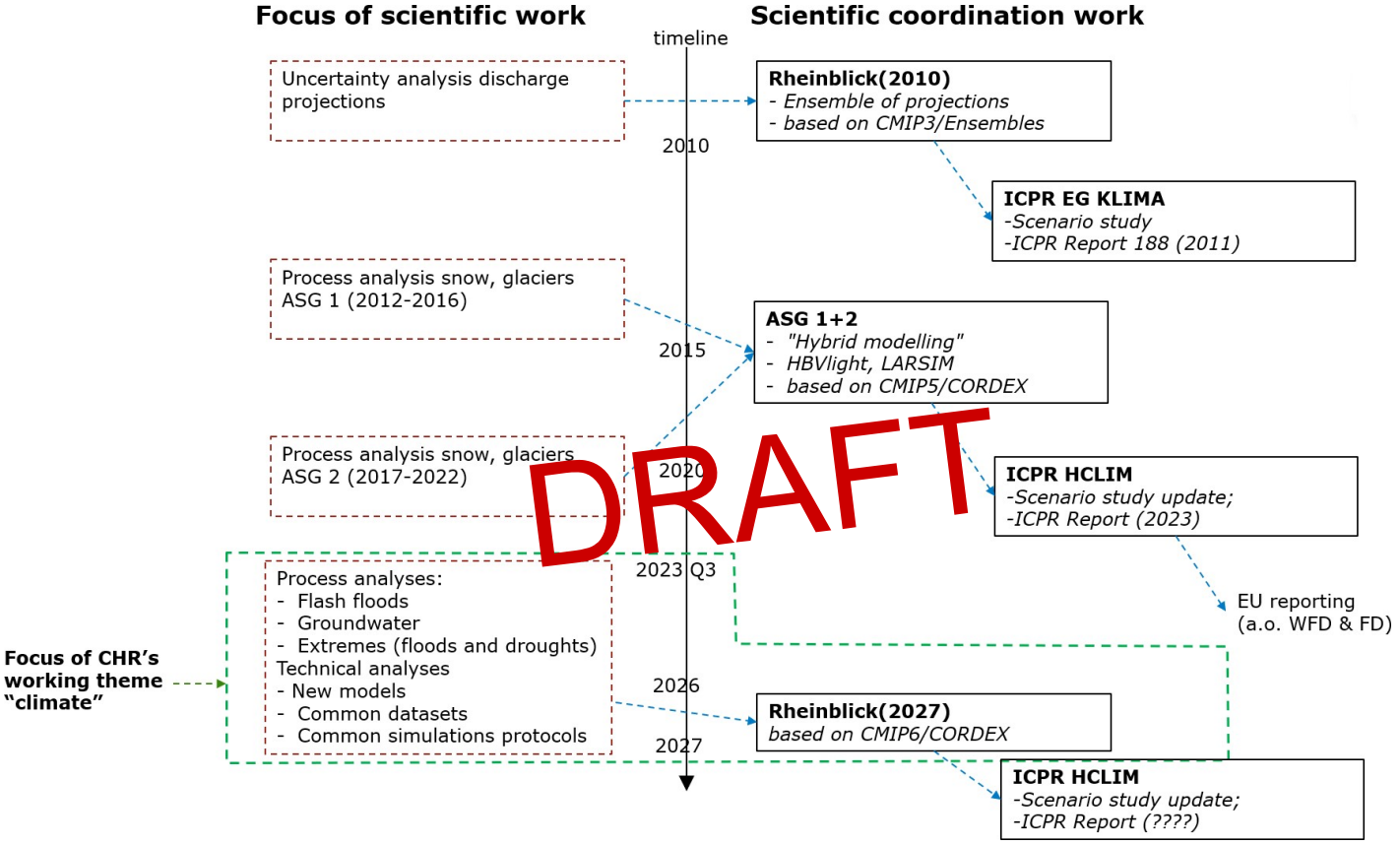
Rheinblick2027 – project in preparation

Main research question: What are the (major) impacts of future climate change on discharge of the Rhine River and its major tributaries?



Melt water from glaciers and snow is missing in the future

More often low-water situations in the Rhine from Basel to the North Sea. We need to be prepared for longer extreme drought periods and more extreme events.

Growing water demand from nature, society and economic sectors will increase low flow risks

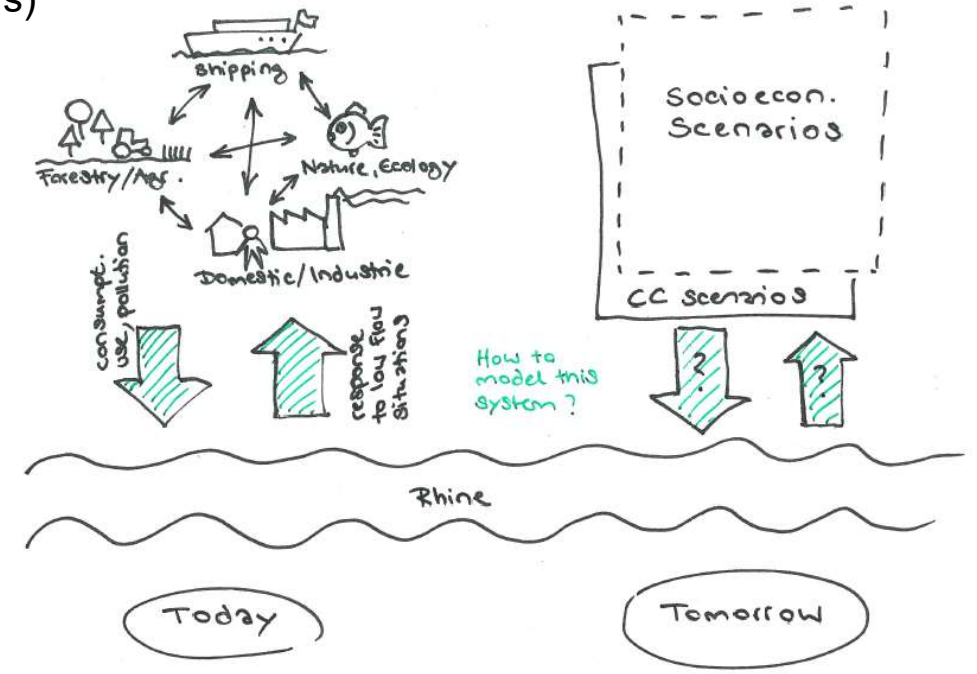
Cross-sectoral linkages and trade-offs in water use and allocation under climate change must be identified and incorporated in river basin planning.

The CHR research messages

Socio-Economic Scenarios

- Project duration: 2013 – … (Deltares, Netherlands, with BfG, Germany and others)

- Several results online available on CHR website, e.g.:
  - Integrated overview
  - RIBASIM scenario tool development report



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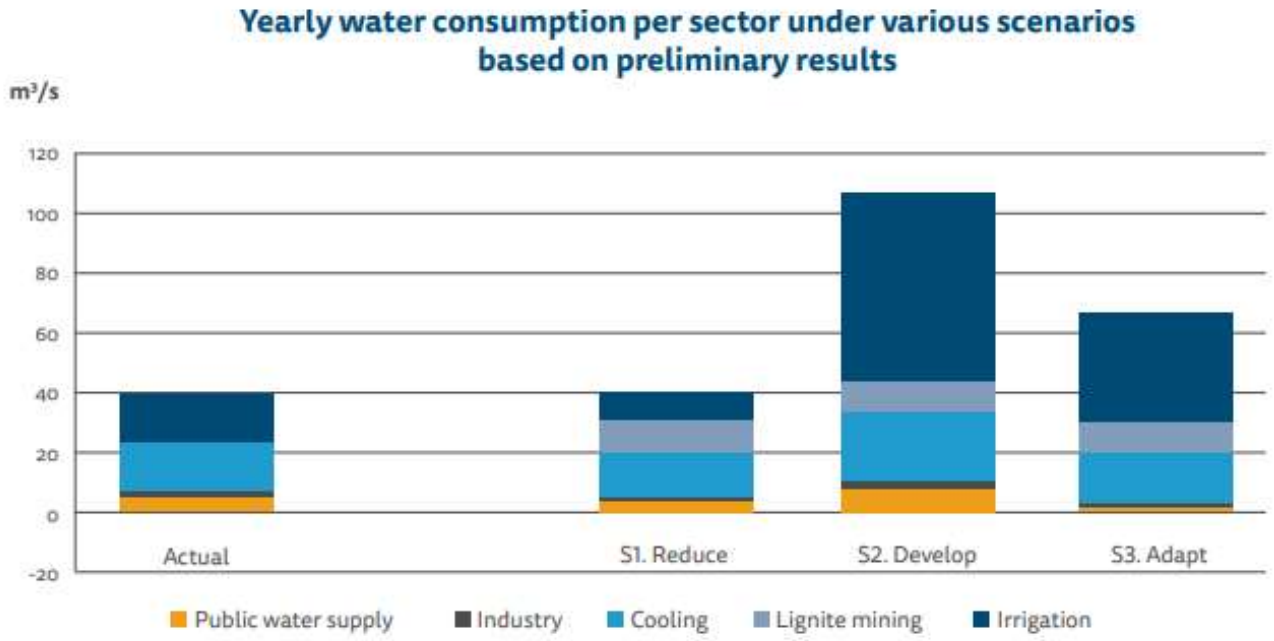
First integrated overview of effects of socio-economic scenarios on the discharge of the Rhine (2019)
– expert workshop and open data

Under future scenarios, water consumption in the Rhine river basin could increase from **50-75 m^3/s to 200-250 m^3/s in summer**.



(Ruijgh et al, 2019)

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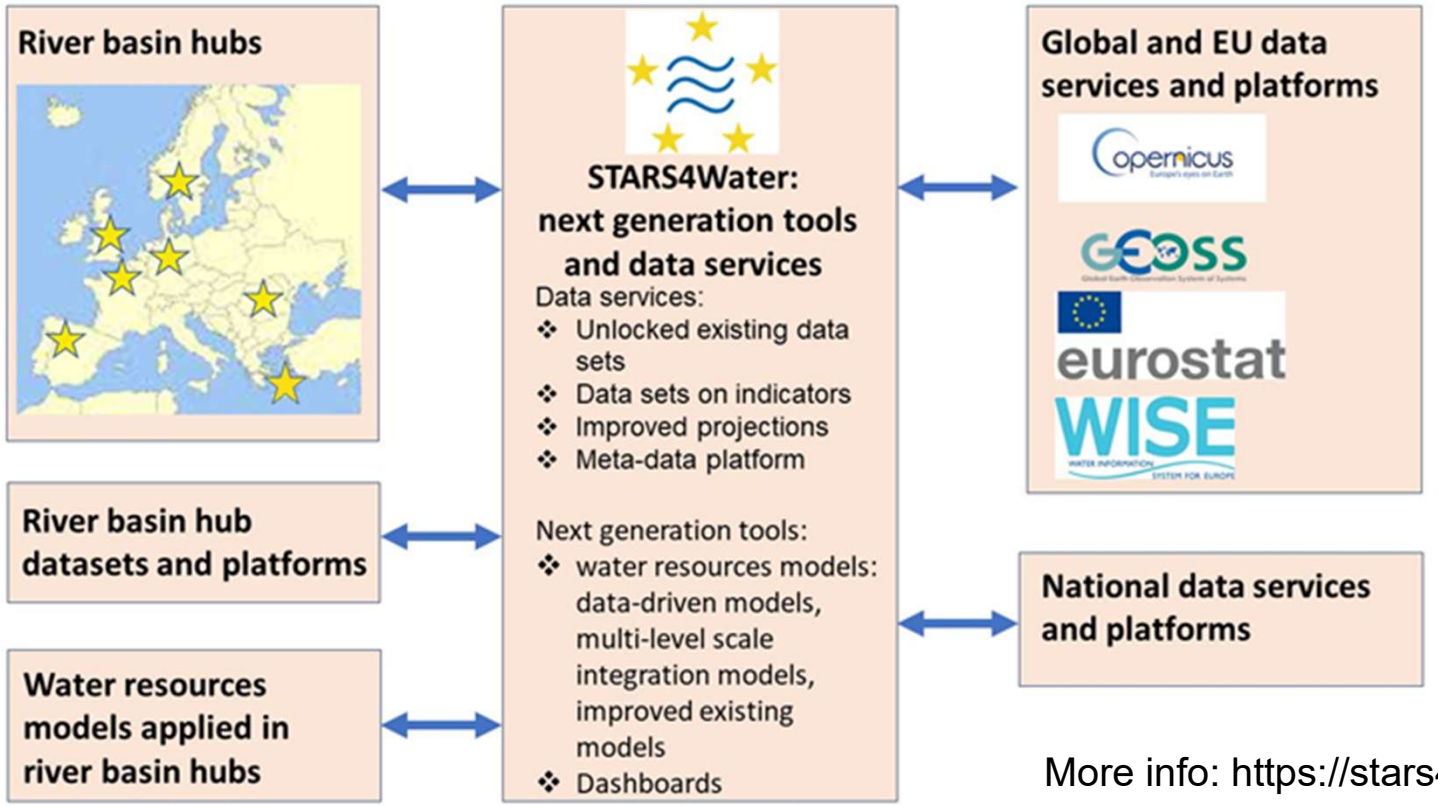
Modelling and evaluating “What if…?” scenarios
– CHR SES, ICPR EG LW, CCNR and EU horizon Stars4Water

Figure RIBASIM scenario planning tool (Van der Krogt, W. et al, 2022)

Supporting Stakeholders for Adaptive, Resilient and Sustainable Water Management (STARS4Water)



Demand-driven by 7 River basin hubs, including **Rhine and Danube**

Period: Oct 2022 – Sept 2026

More info: https://stars4water.eu/

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Cross-sectoral linkages and trade-offs in water use and allocation under climate change must be identified and incorporated in river basin planning.

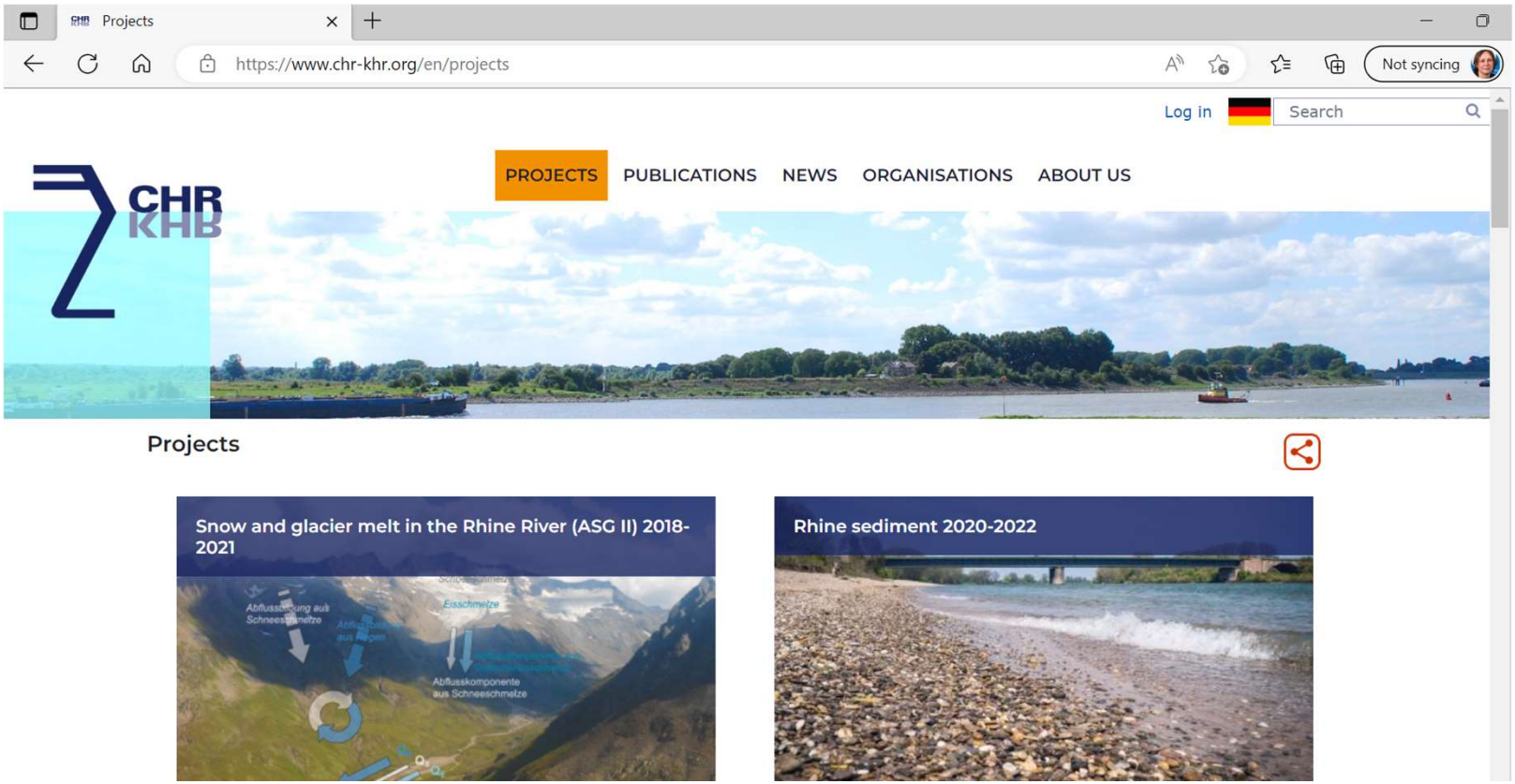
Catalyzing collaborative actions for fair and sustainable use of the river system and adaptation to climate change

Evidence–based support for informed decision making require data sharing and open information system.

The CHR research messages

CHR information system
- making datasets from/for research available

More information? Publications | International Commission for the Hydrology of the Rhine basin (CHR) (chr-khr.org)



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Any questions?
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