Co-developing a data and knowledge portal to support stakeholder risk assessments with uncertain, global, multi-model based information on hydrological hazards of climate change

F. Kneier[1], D. Cáceres[2], D. Schwanenberg[3], S. Dietrich[2], H. Köthe[2], P. Döll [1,4]

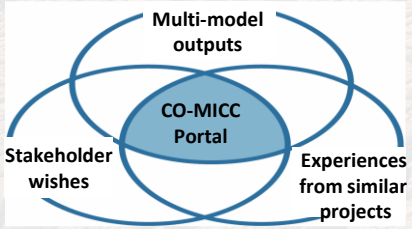
I. Objective & Background

- Co-developing a **knowledge platform** with **stakeholders**
- Enabling users worldwide to freely access relevant information for **assessment of water-related climate change hazards including uncertainties**

more…

II. Approach

- State-of-the-art: **global-scale** multi-model ensemble **information**
- 3 **Stakeholder dialogs**: Integration into decision-making process in a participatory manner



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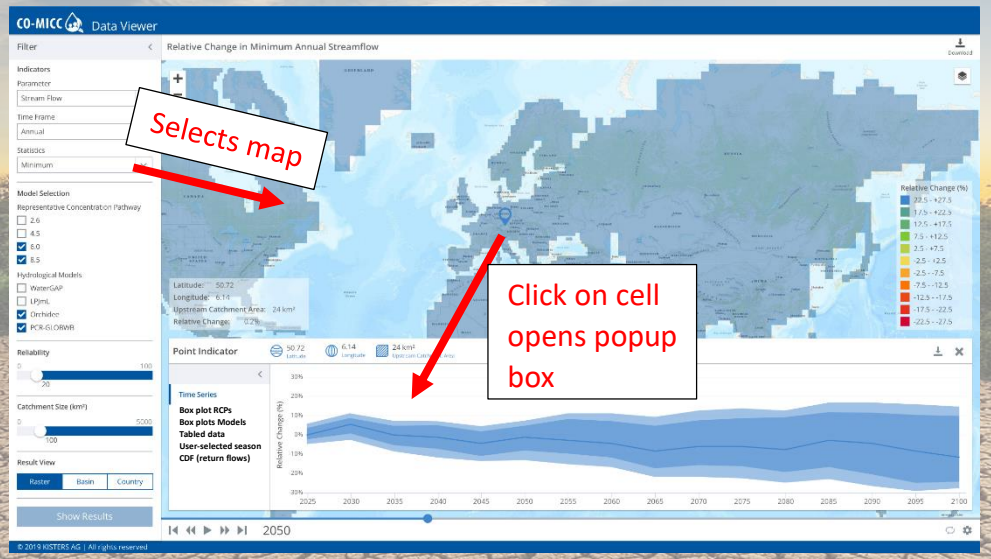

III. Results

1) Elicited relevant **hydrological hazard indicators** (for 15 variables)
2) Represented **uncertainty** scientifically correct and utilizable to diverse users of hazard information
3) Explanations:
   - Meta-information on a **knowledge portal**
   - Guidance: to integrate the uncertain global information into regional assessments

more…

IV. Conclusions

- Participatory co-development of tool: co-produces **relevant** modelling **output** and **appropriate** end-user **visualization**
- Co-design of necessary meta-information **ensures utilization**
- **Supports** local **risk assessment** of climate change impacts on water **globally**

more…

(1) Goethe University Frankfurt, (2) International Centre for Water Resouces and Gobal Change (UNESCO), (3) Kisters AG, (4) Senckenberg Biodiversity and Climate Research Centre (SBiK-F)

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Objective & Background

Background

- Successful adaptation to climate change worldwide will require many local climate change risk assessments.
- However:
  (1) Appropriate and tailored climate services and information tools are lacking, particularly in developing countries.
  (2) Lacking studies on how to integrate global-scale multi-model ensembles information into water-related climate change adaptation measures in a participatory manner.
- Co-produced, user-driven climate services:
  (1) are a recognized means for effective generation and provisioning of relevant climate information.
  (2) support the utilization by decision-makers, enabling them to account for climate change in their risk portfolios.

Purpose & Objective

- Co-developing a **data** and **knowledge platform** with **stakeholders**
- Based on **global-scale multi-model simulations** of hydrological variables.
- Enabling users worldwide to freely access relevant information for **assessment of water-related climate change hazards including uncertainties** (Döll et al., 2017)

Click for **Acknowledgements**

Click to go back: Objectives

Acknowledgements

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UNESCO

United Nations Educational, Scientific and Cultural Organization

International Centre for Water Resources and Global Change under the auspices of UNESCO

KISTERS

Acknowledgements:

The project CO-MICC is part of ERA4CS, an ERA-NET project initiated by JPI Climate, and is funded by BMBF (DE), BMWFW (AT) and ANR (FR), with co-funding by the European Union (Grant O1LS1709A).

JPI Climate

ERA4CS European Research Area for Climate Services

SPONSORED BY THE Federal Ministry of Education and Research

AGENCE NATIONALE DE LA RECHERCHE ANR

bmwfw Bundesministerium für Wissenschaft, Forschung und Wirtschaft

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Approach

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Expert/scientist dialogues for iteratively **co-developing** optimal ways of

1) presenting multi-model output of hydrological hazards and their uncertainty on a web portal with a global user community, and
2) utilizing them in CC risk assessment and development of CC adaptation strategies.

at three scales:

- Global scale: Globally operating companies
- Transboundary scale: Morocco, Algeria, Tunisia
- Basin scale: Ebro basin (Spain)

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Approach

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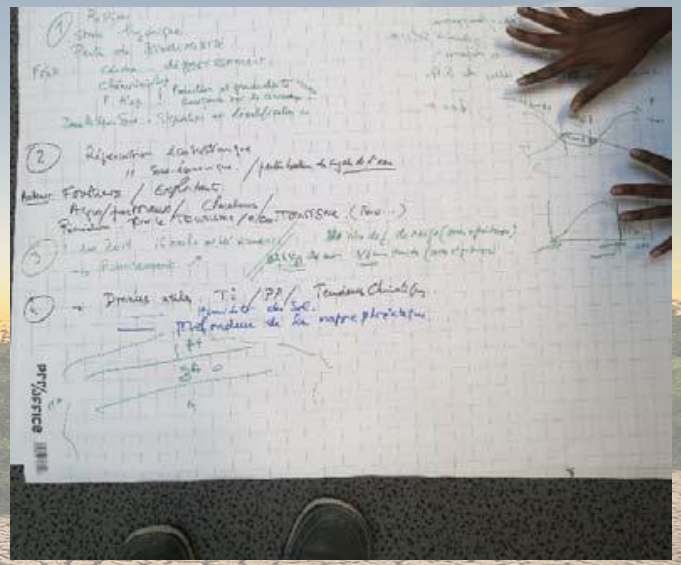
- Participants:
  - Scientists: hydrological modelers, sociologists, transdisciplinary methods, communication
  - Experts: national administrations (water supply, irrigation, basin management), research facilities, meteorological services
- Iterative co-development (tandem framework of the Swedish Environmental Institute, SEI; Daniels et al., 2019[1])
- Integration: 1) multi-model output of hydrological hazards,
  2) uncertainty, and
  3) local expert knowledge



2018: Expert interviews (12) → Workshop I → Fall 2019: Workshop II → Covid-19… → 2021: Online Event III → ? → Online Event IV

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[1] Daniels et al. (2019). The Tandem framework: a holistic approach to co-designing climate services. SEI Discussion Brief. Stockholm Environment Institute.

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Results

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Visualization Tool overview

Indicator Selection

RCP & Aggregation

Uncertainty Integration: map

Uncertainty: Cell box

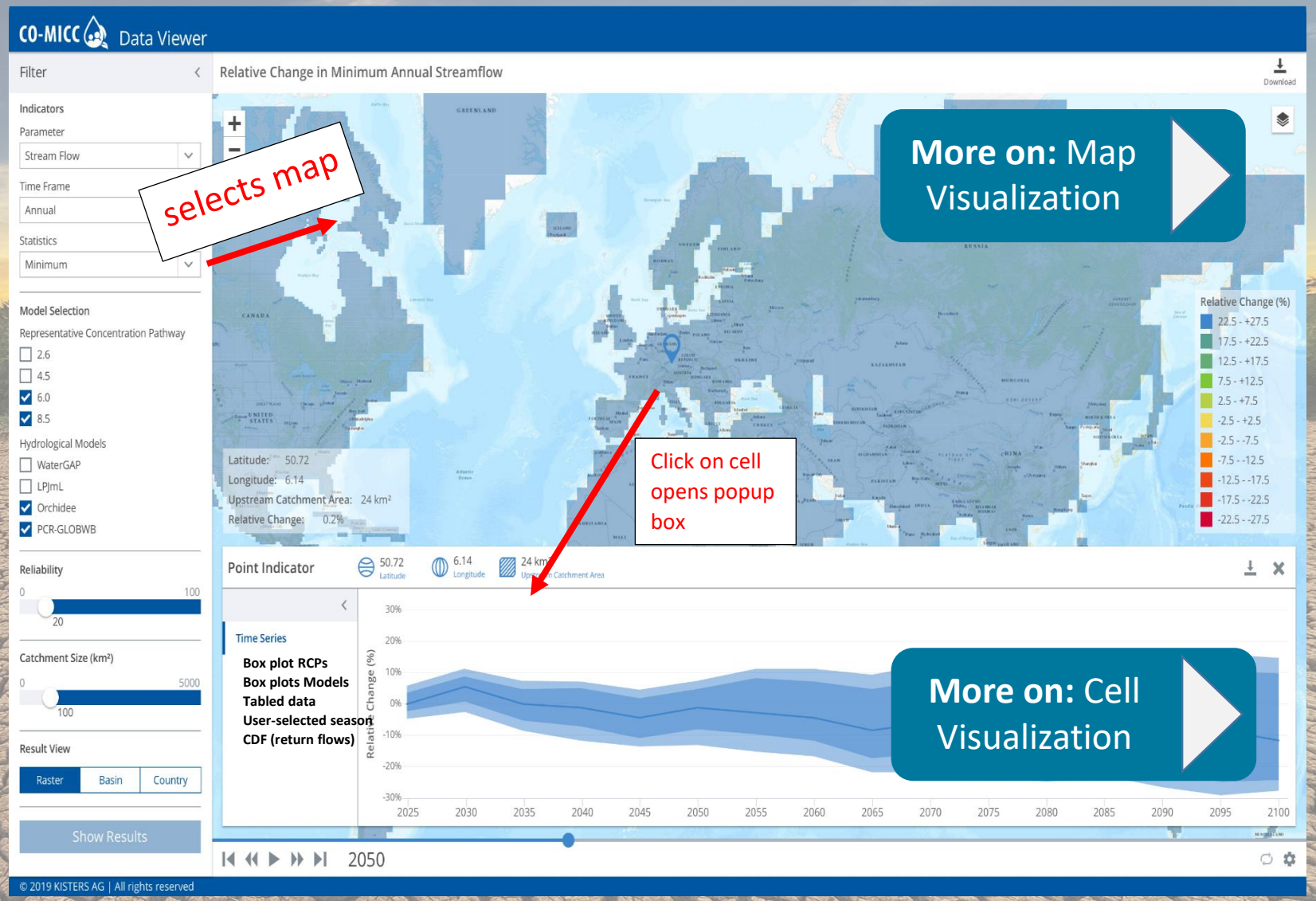
Knowledge Portal

Indicator Selection

Ensemble choice

Options

- **Reliability**
- **Uncertainty**
- **Aggregation**



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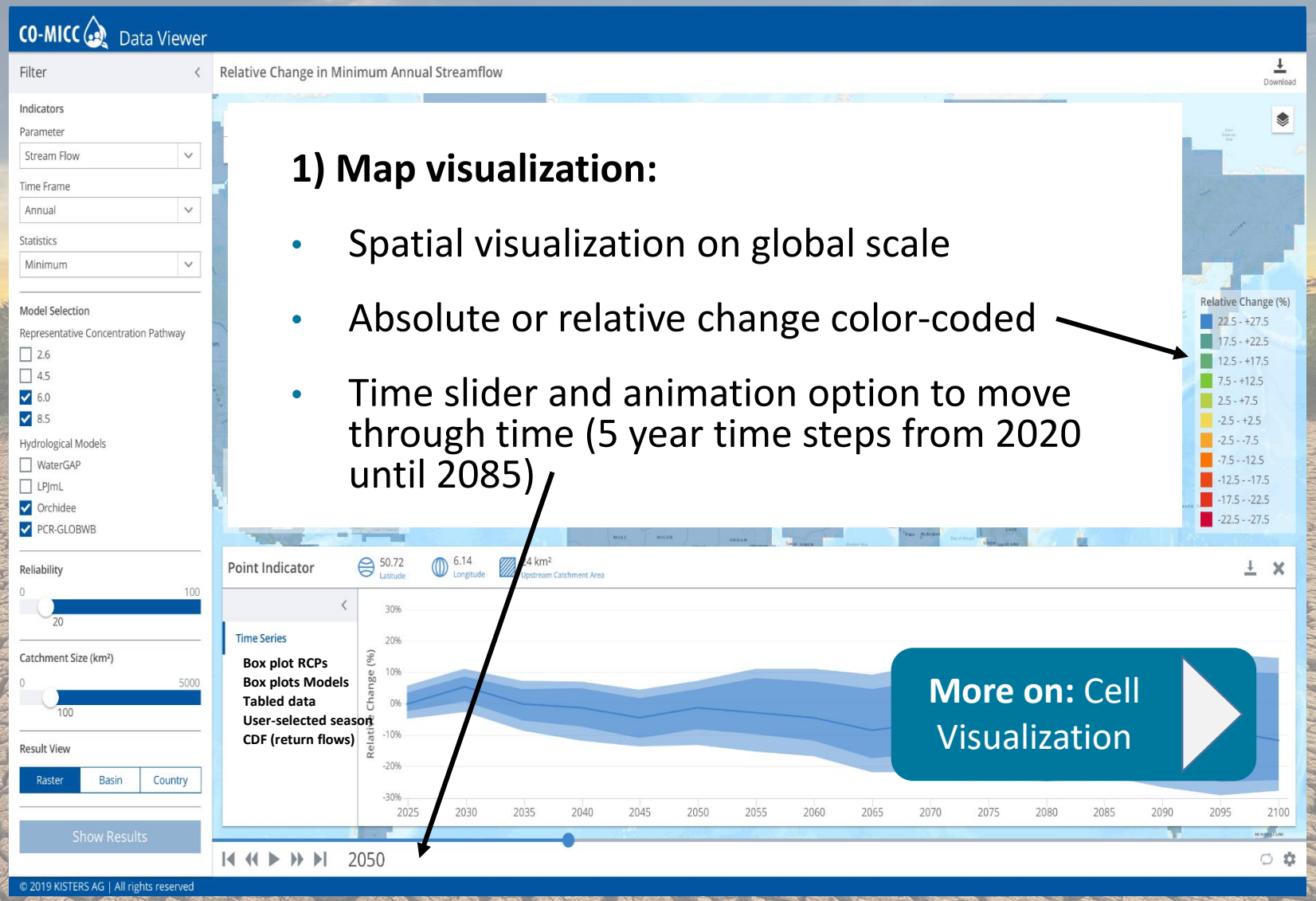

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Results

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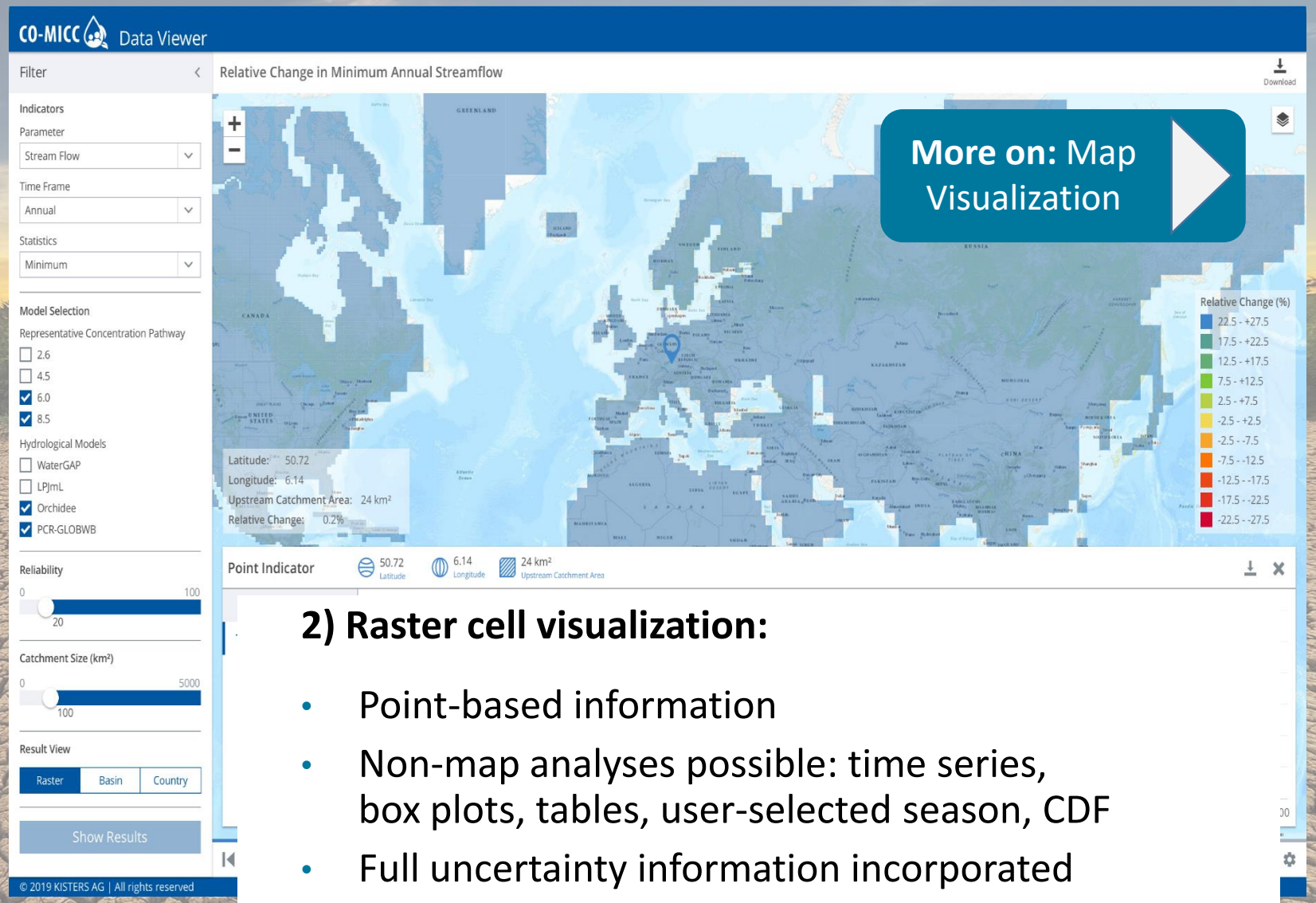
- **Visualization Tool** overview
- **Indicator Selection**
- **RCP & Aggregation**
- **Uncertainty Integration**: map
- **Uncertainty**: Cell box
- **Knowledge Portal**

Indicator Selection

Ensemble choice

Options

- **Reliability**
- **Uncertainty**
- **Aggregation**



More on: Map Visualization

2) Raster cell visualization:

- Point-based information
- Non-map analyses possible: time series, box plots, tables, user-selected season, CDF
- Full uncertainty information incorporated

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Visualization Tool overview

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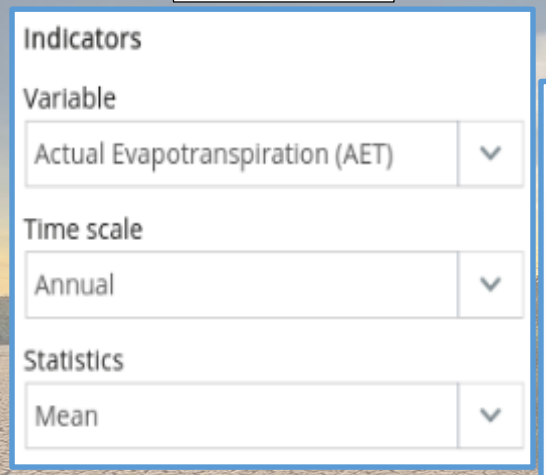
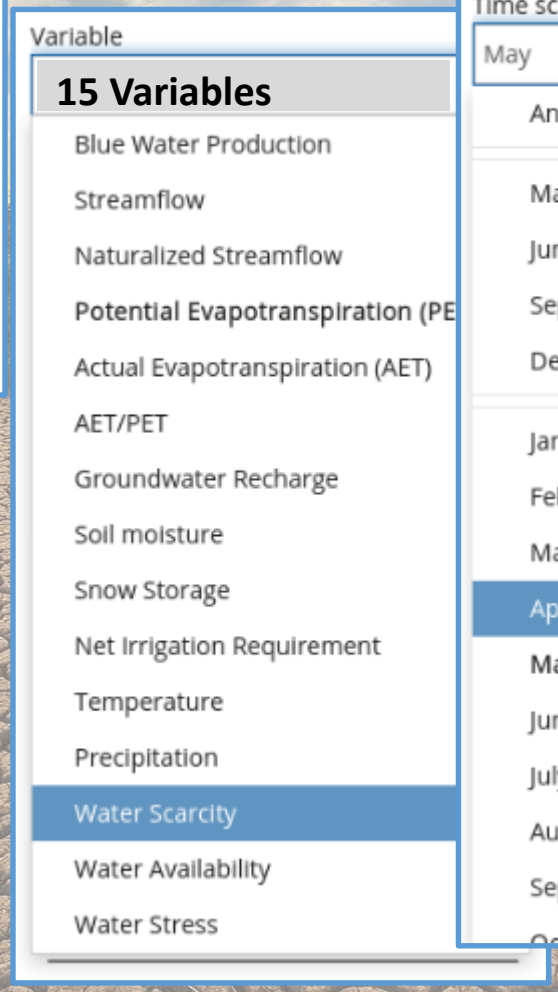
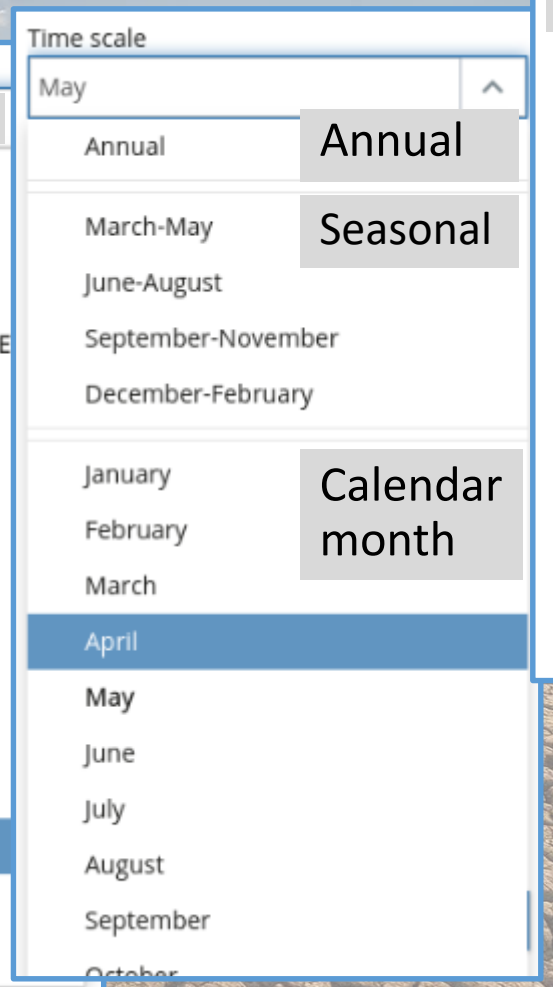
Knowledge Portal

Indicator Selection

Provided: Relative change – absolute change – absolute reference value







Statistics

- Mean
- Annual High/Low flow (Q10, Q90, Q80)
- Year-to-year variability
- Monthly High/Low flows (Q10, Q90)
- Shift in high flow/precipitation month
- PET/P and AET/P
- Number snow months

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Results

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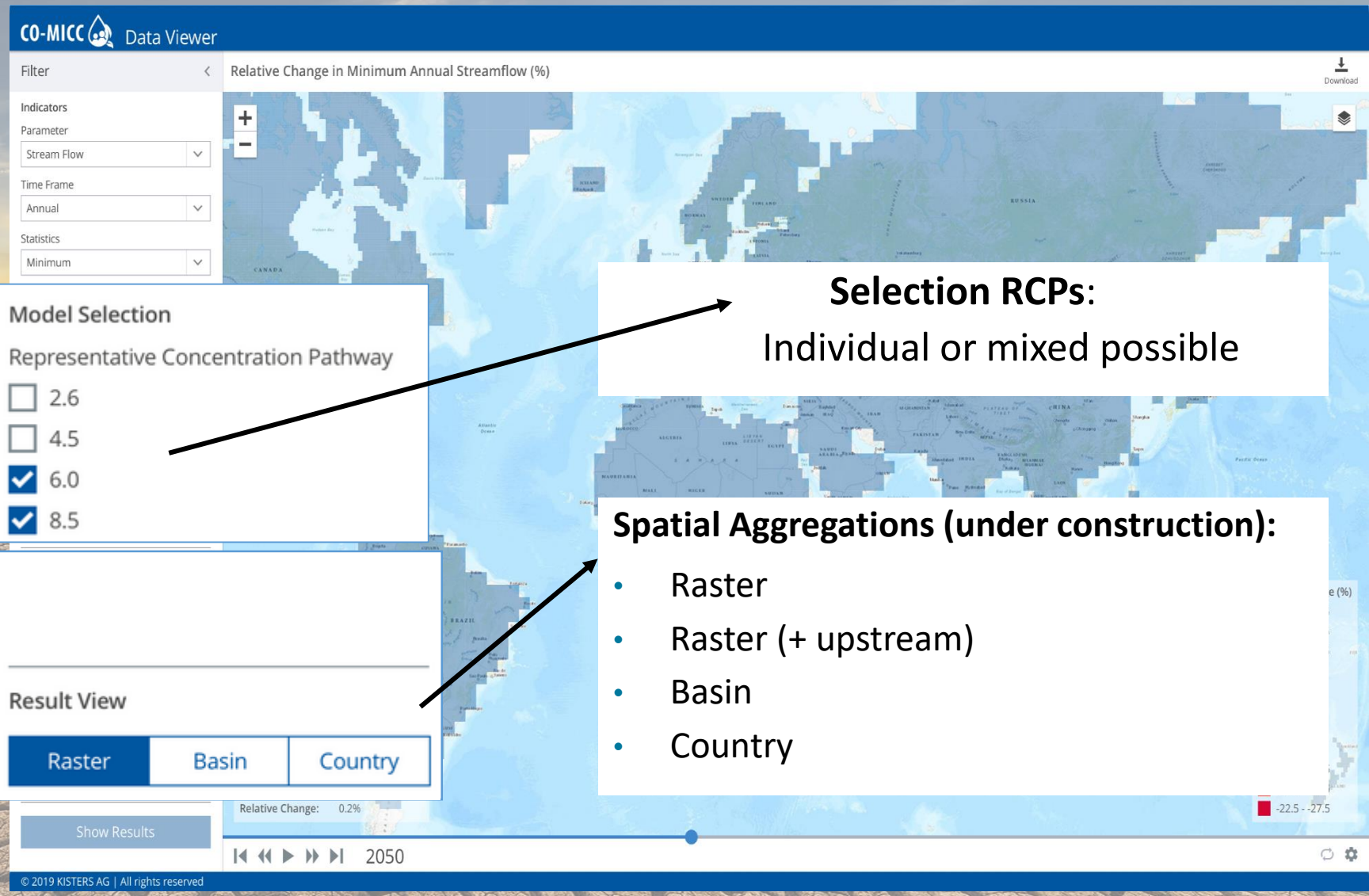
Ensemble choice

Options



Selection RCPs:
Individual or mixed possible

Spatial Aggregations (under construction):

- Raster
- Raster (+ upstream)
- Basin
- Country

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- **Visualization Tool** overview
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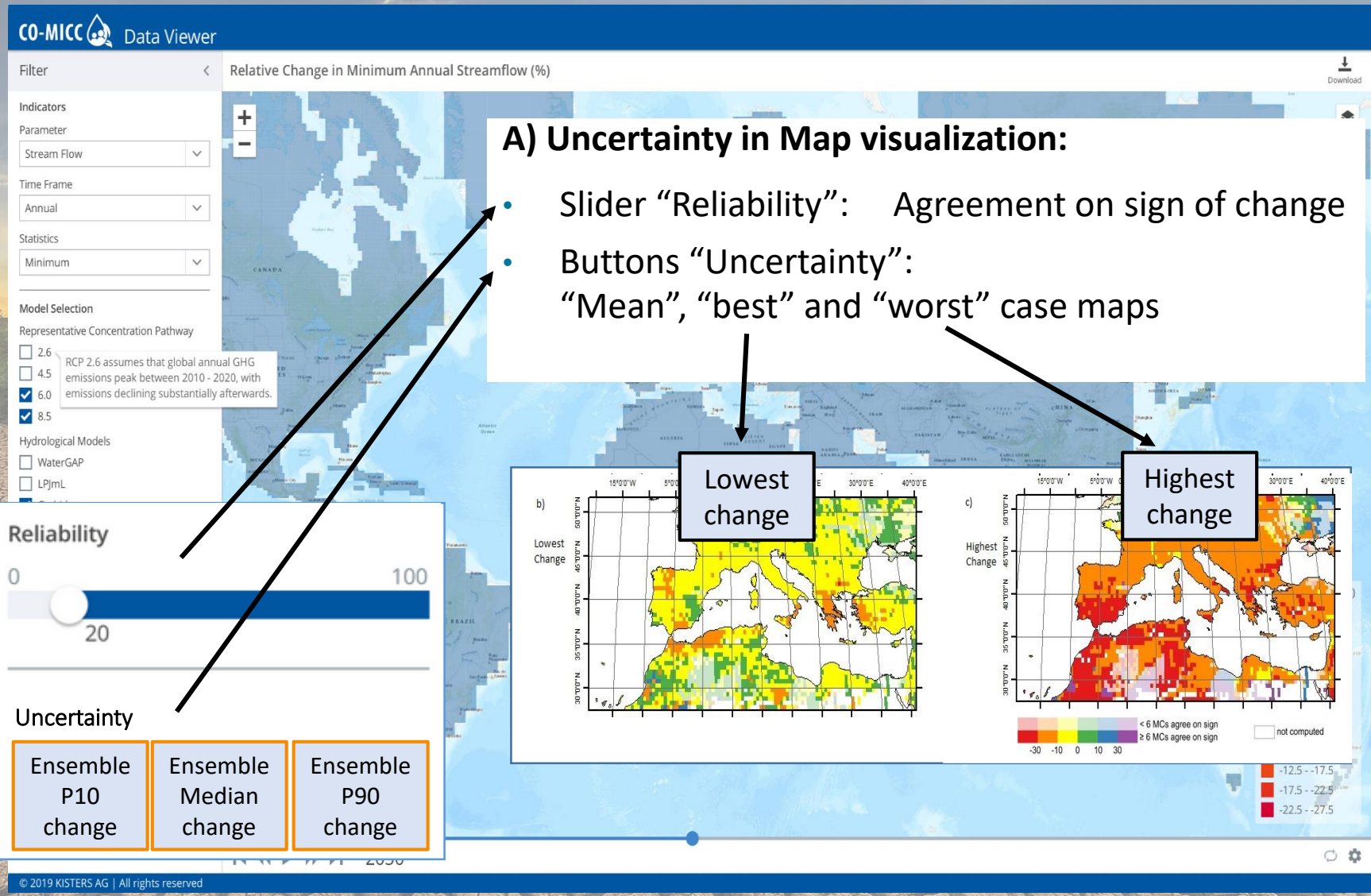
- **Uncertainty**: Cell box
- **Knowledge Portal**

Options



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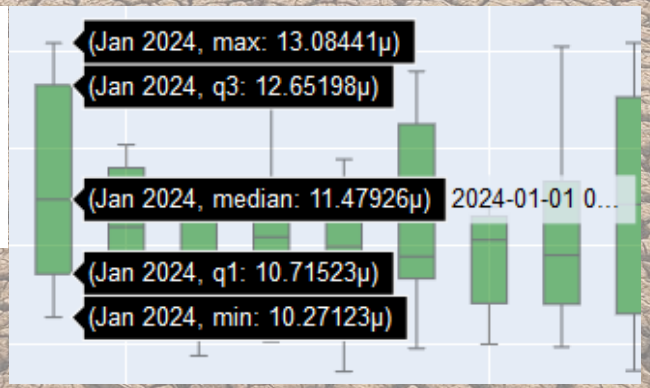
- Planification based on single number vs. MME information → Table

Emissions Scenario	Historical Baseline		% Change from GCM Baseline							
	Observed	GCM	Current		Future Periods					
	Annual avg. 1986 – 2005	Median annual avg. 1986 – 2005	2006 – 2025		2030 – 2049		2055 – 2074		2080 – 2099	
RCP2.6	739 mm/yr	758 mm/yr	-3%		-2%		0%		6%	
			-9%	0%	-9%	-0%	-7%	3%	-4%	12%
RCP8.5			1%		-5%		-14%		-23%	
			-7%	4%	-12%	0%	-17%	-8%	-27%	-19%

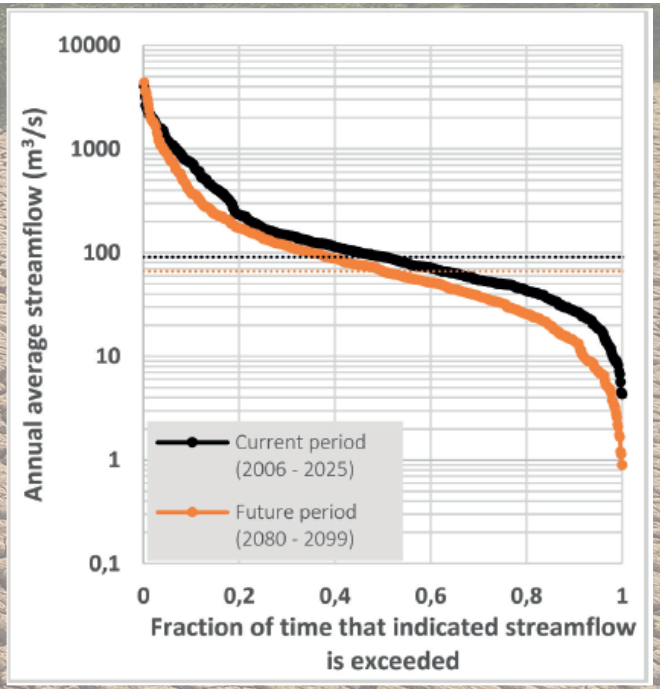
Legend: *median*; *min* | *max*

- RCP Comparisons → Box plots



- Cumulative distribution functions (CDF) such as flow duration curves preferred over probability density functions (PDF)

→ CDFs for Precipitation, Total runoff generation, Streamflow



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Uncertainty: Cell box

Knowledge Portal

- Data viewer with data analysis tools
- Hydrological climate change scenarios
- Global map and pixel box displays
- Embedded in the knowledge portal

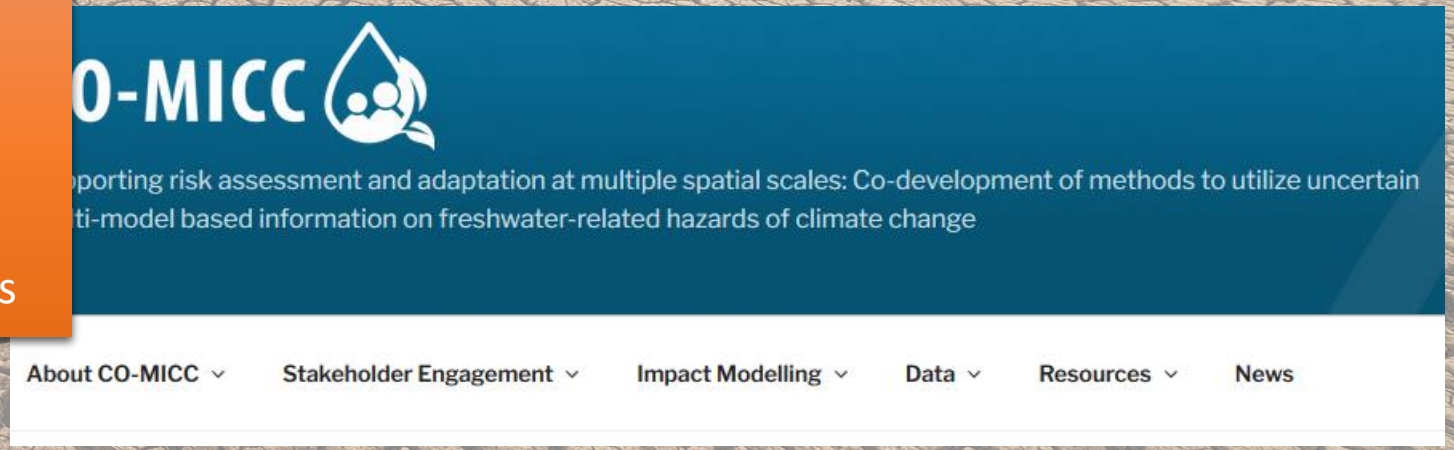
WHAT?

Data Portal

Knowledge Portal

HOW?

- Meta information
- Tutorials, User Stories
- PUNI methods
- Main project outcomes



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Conclusions

- Multi-model ensembles are state-of-the-art to estimate **hydrological hazards of climate change**
- Participatory **stakeholder dialogues** serve to integrate the ensemble information with the various experiences, needs and expectations of various regions and diverse users
- Participatory co-development of our tool can
  - co-produce the **relevant** modelling **output** as well as **appropriate** end-user products (**visualization** tool), with appropriate visualization of **uncertainty**
  - co-design the necessary meta-information, tutorials and guidelines transparently and understandable (**ensure utilization**)
  - **support local risk assessment** of climate change impacts on water (**globally**)
- Service will reach a broad range of stakeholders from around the world (policy makers, practitioners NGOs, the private sector, the research community, the public in general)