Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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Climate Change Effects on Reservoir Inflows and Hydropower Operation

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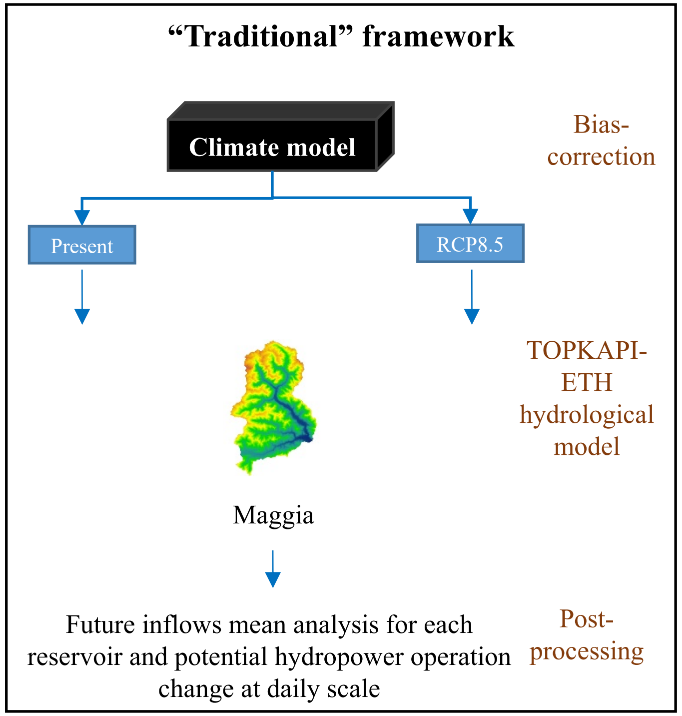
SCCER-SoE Annual Conference 2019

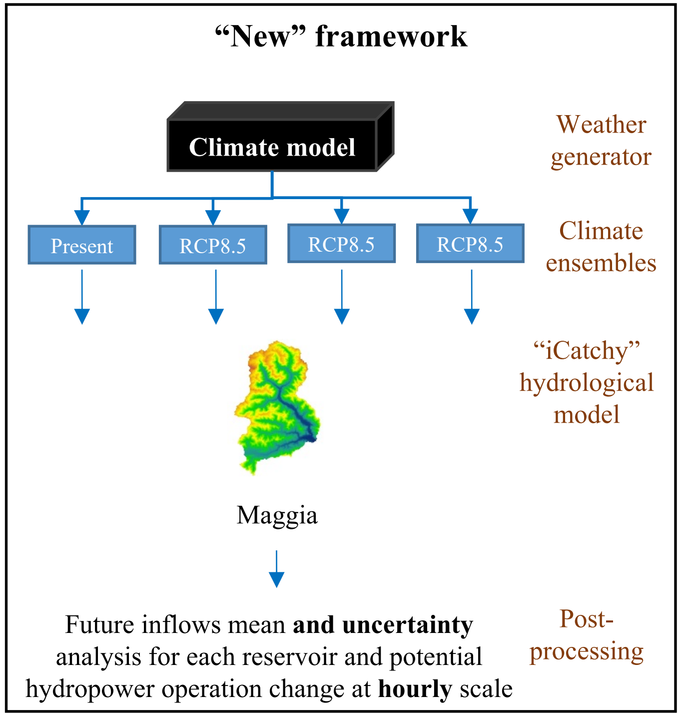
Motivation

1. Estimate climate change effects on reservoir inflows
2. Estimate future hydropower operation strategies



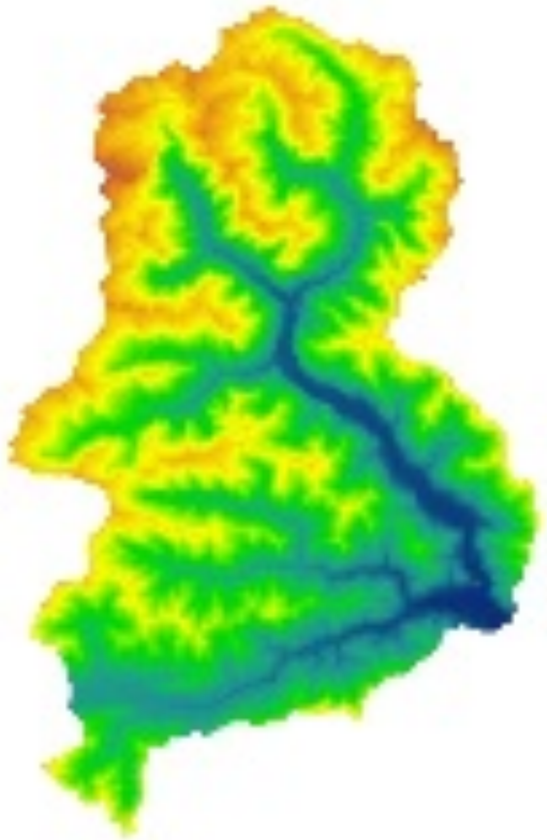
Advantages:

- Retain sub-daily inflow peaks
- Compute inflows for each reservoir/sub-catchment individually
- Embed hydropower policies in the hydrological model



Study area – Maggia valley (OFIMA)

- Total drained area of 840 km^2
- Elevation ranges between 204 and 3208 m
- Present climate precipitation are 1840 mm
- Hydrological data available for pre-dam and post-dam periods



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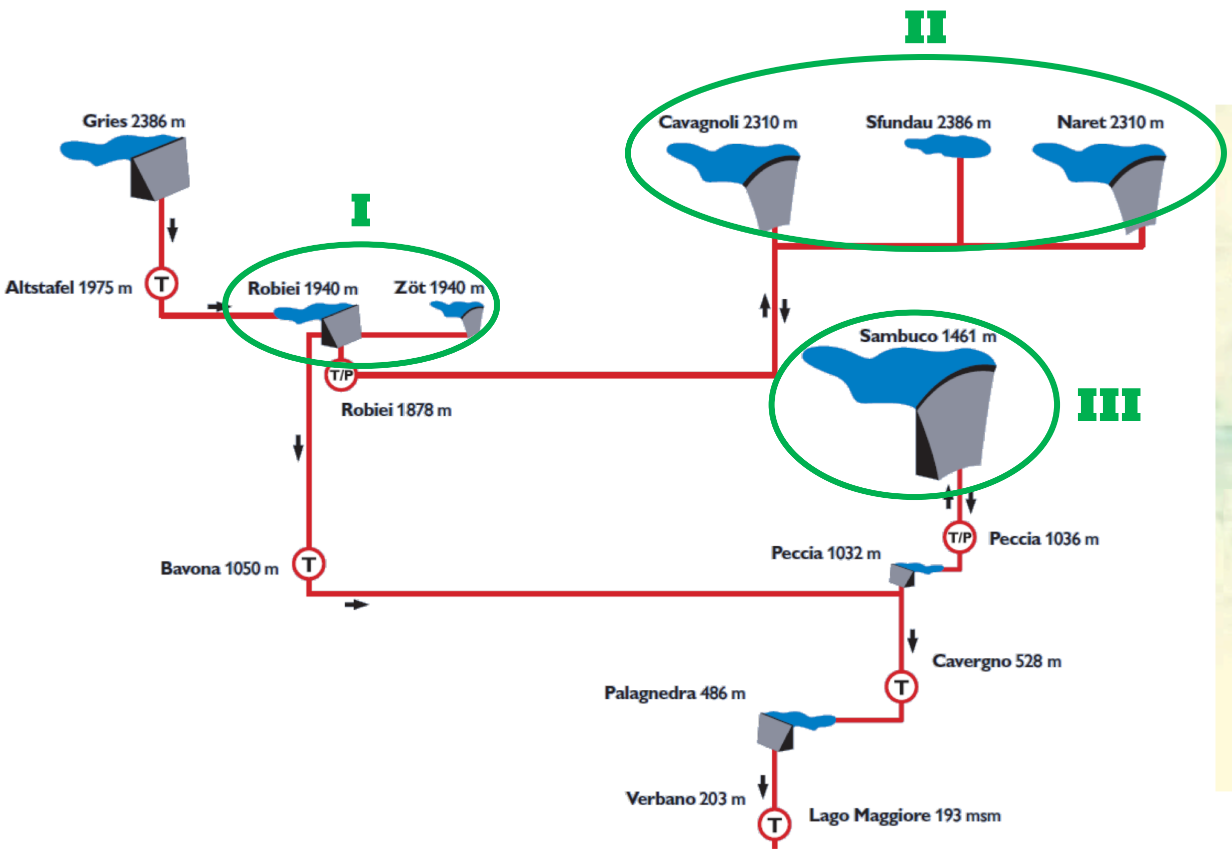
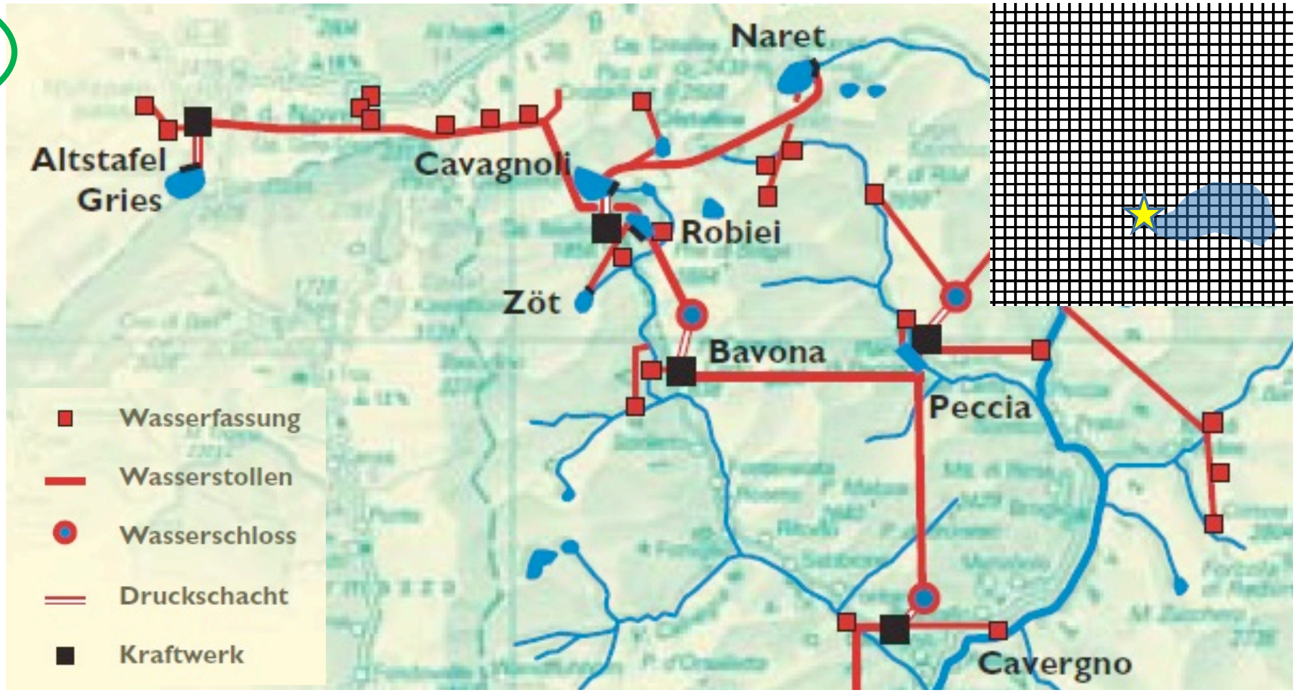




Methods

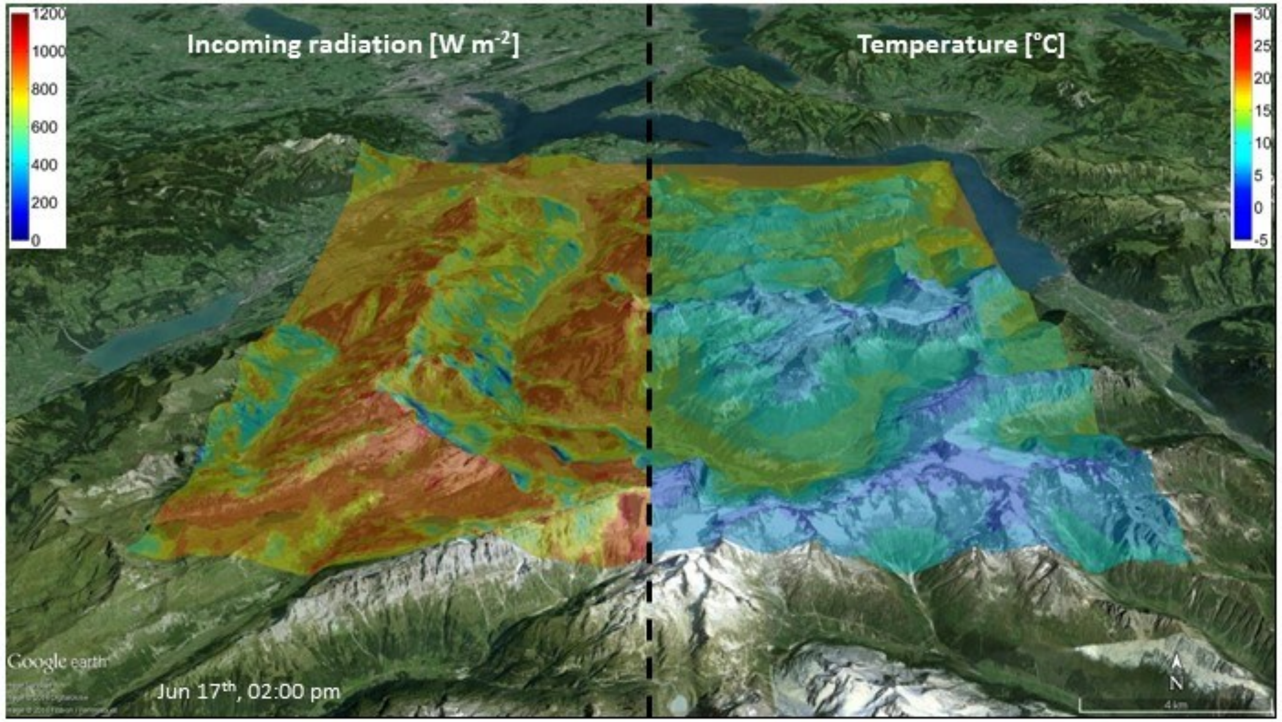
1. Climate downscaling

2. Hydrological simulations

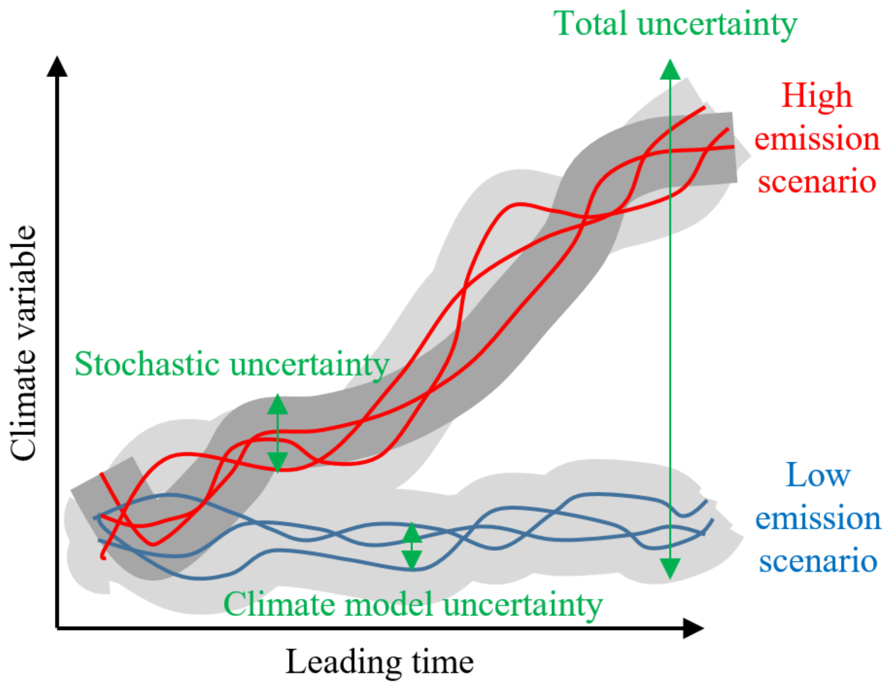
3. Hydropwer operation optimization

Climate downscaling

- The AWE-GEN-2d (**A**dvanced **WE**ather **GEN**erator for **2-D**imensional grid) model



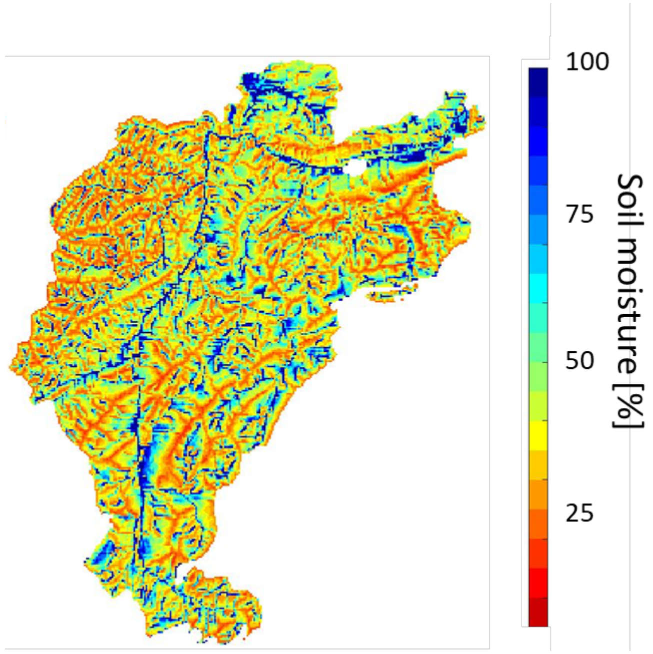
100-m and hourly



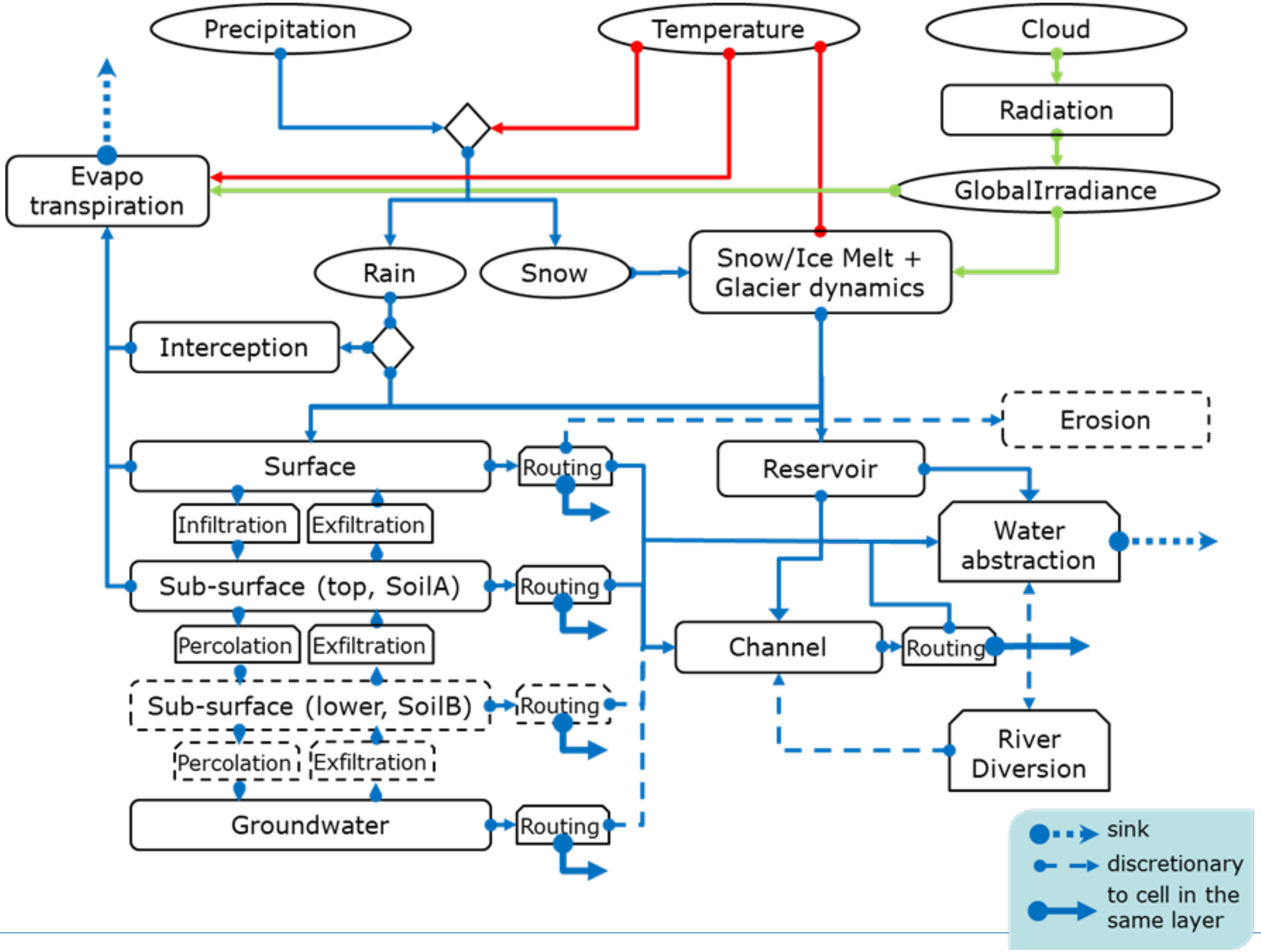
(Peleg et al., 2017 and 2019; see SCCER-SoE annual conference 2018)

Hydrological simulations

- The TOPKAPI-ETH model.
- To be replaced with iCatchy.



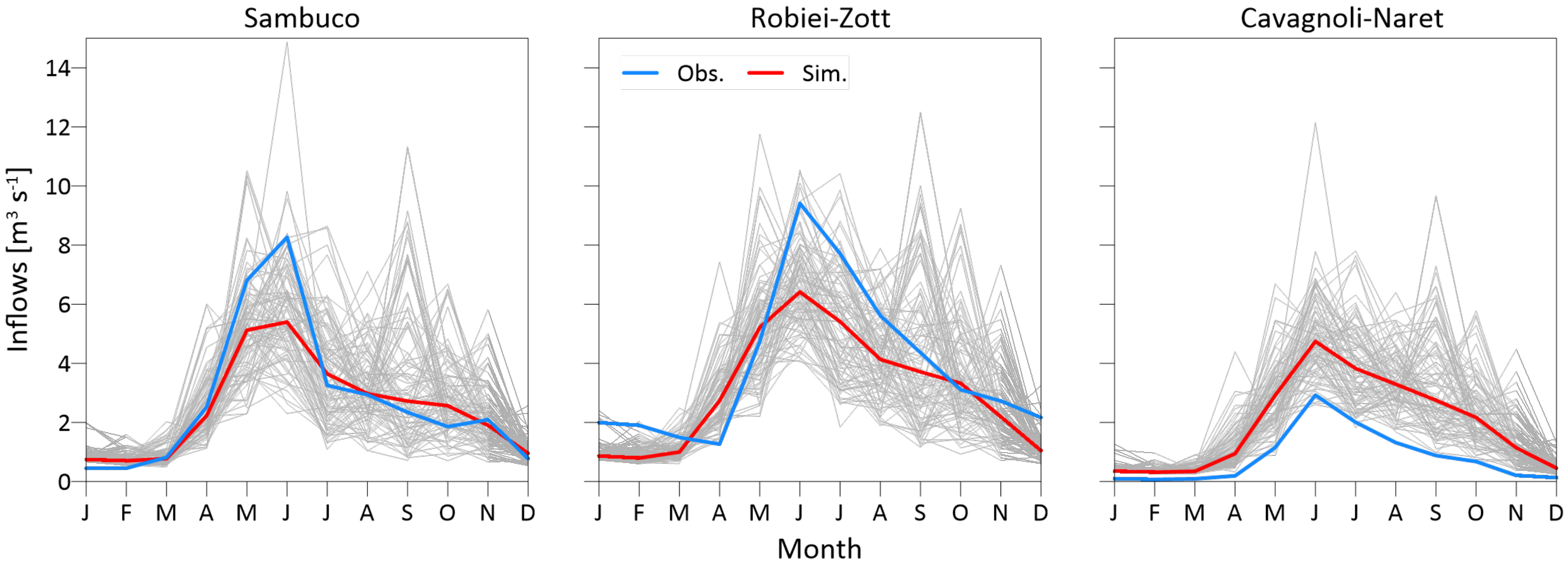
250-m and daily



(see SCCER-SoE annual conference 2018; Anghileri et al.)

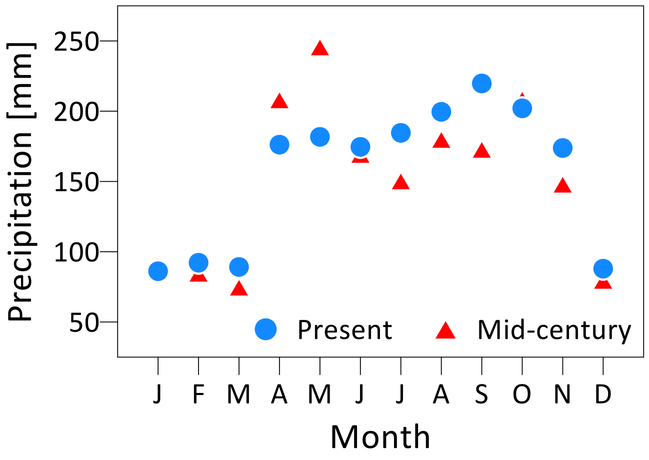
Present inflows to the reservoirs

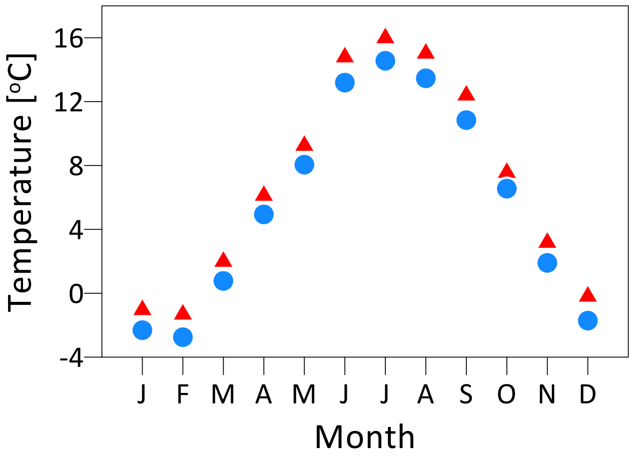
- Inflow data were obtained from OFIMA for the period of 2005-2015.
- Outputs (100 simulations, daily runs) from a preliminary set-up of the Topkapi-ETH model, accounting only for the main diversions and intakes.



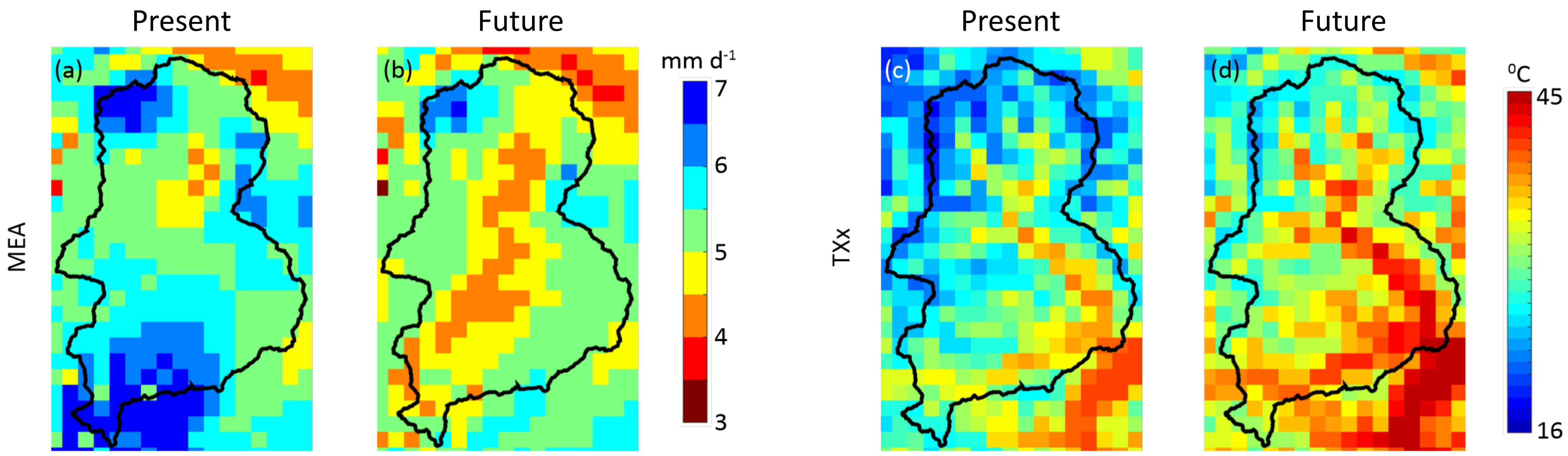
Climate change

- 9 climate models from the CH2018 official climate scenarios for Switzerland
- RCP8.5
- Period of interest 2030-2059





Climate change

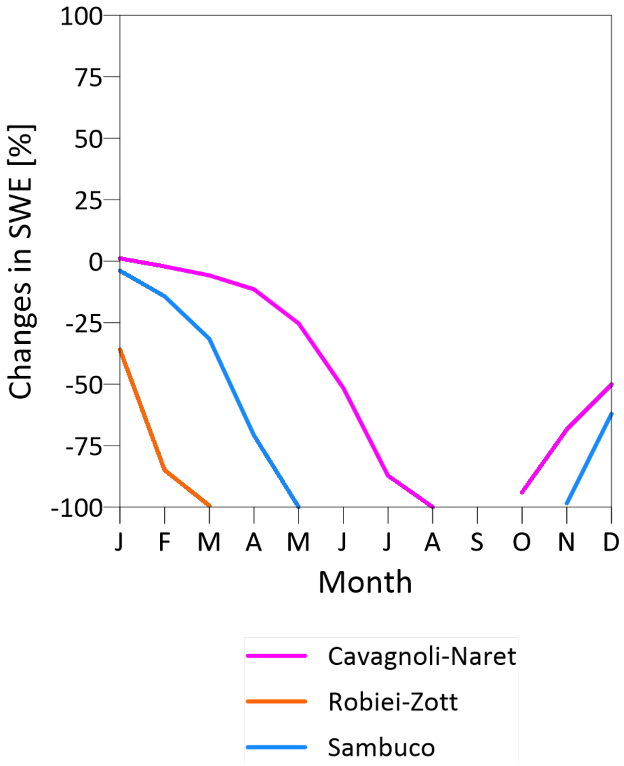


Mean daily precipitation

Hottest day of the year

Future inflows to the reservoirs

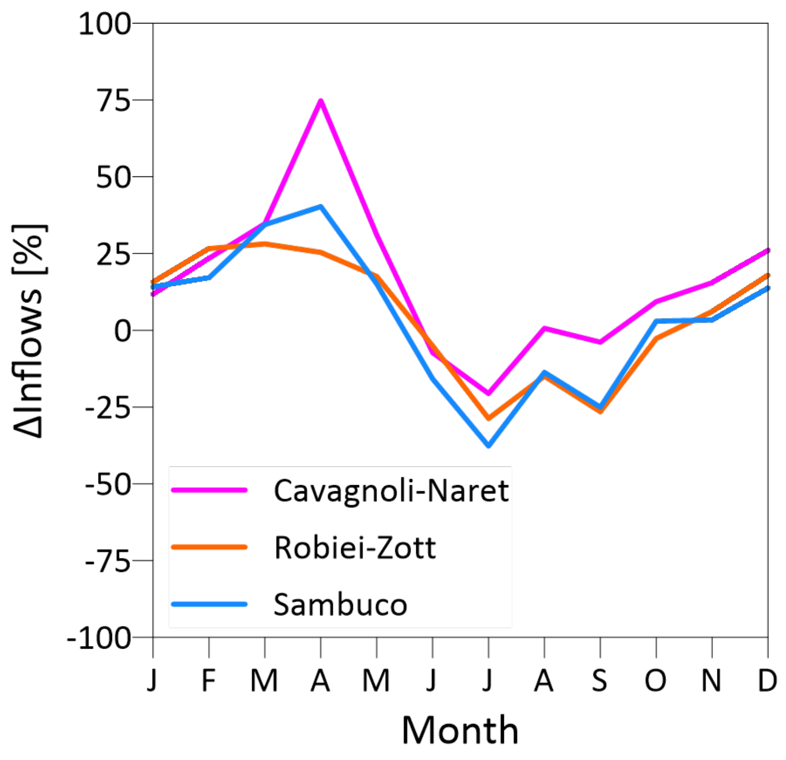
- 200 simulations were conducted to analyze the impacts of climate change on the hydrology for the mid of the century.
- The hydrological system is sensitive to the changes in climate, particularly with respect to the contribution of snow water equivalent, which declines significantly in all reservoirs in the future simulations.



Future inflows to the reservoirs

Results point at a reduction in the total inflows into the reservoirs, with a clear seasonal pattern:

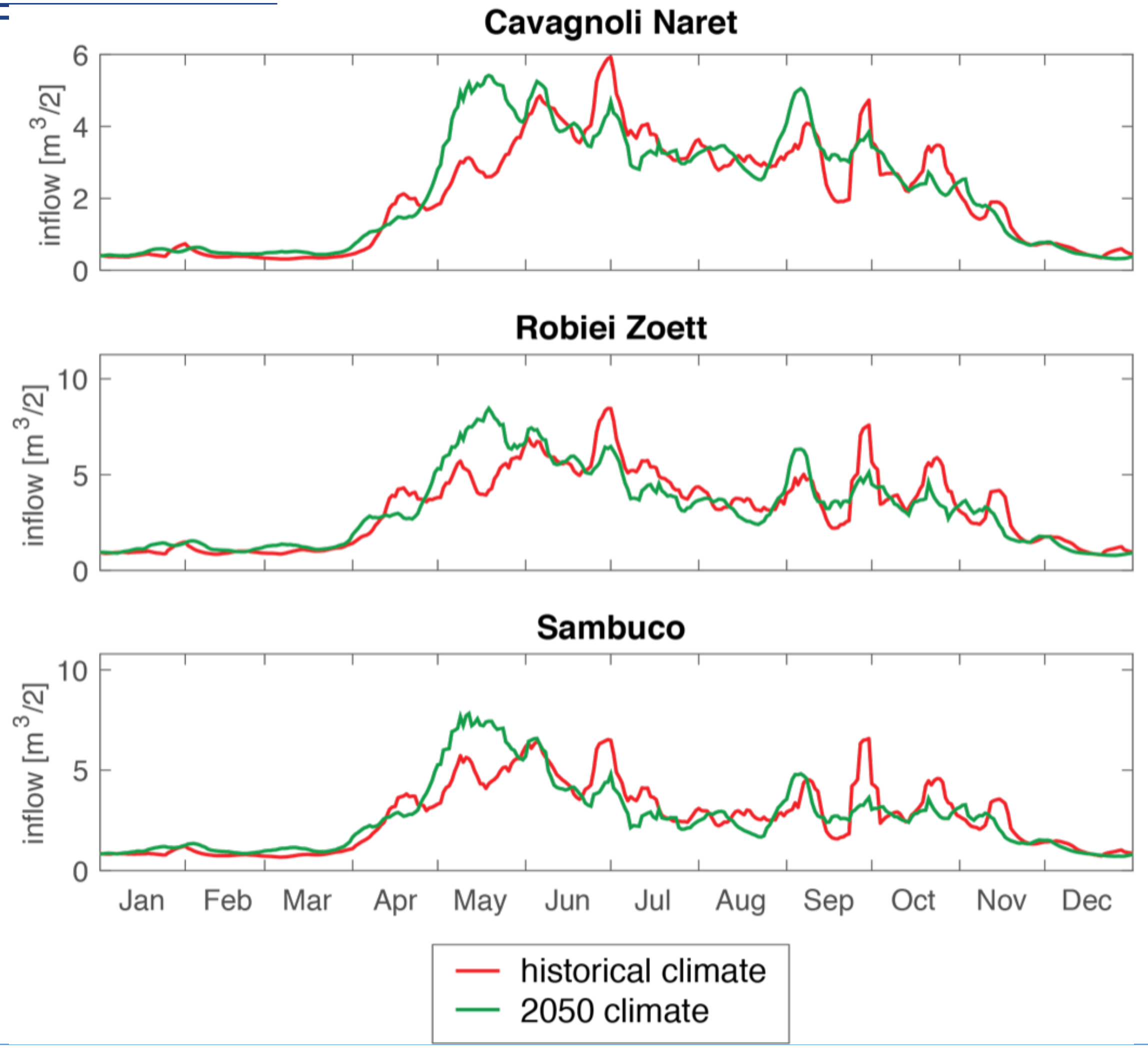
- Increase during April-May (reduction in SWE, but increase of rainfall → total precipitation increases)
- Decrease between June and October (reduction in both SWE and rainfall).

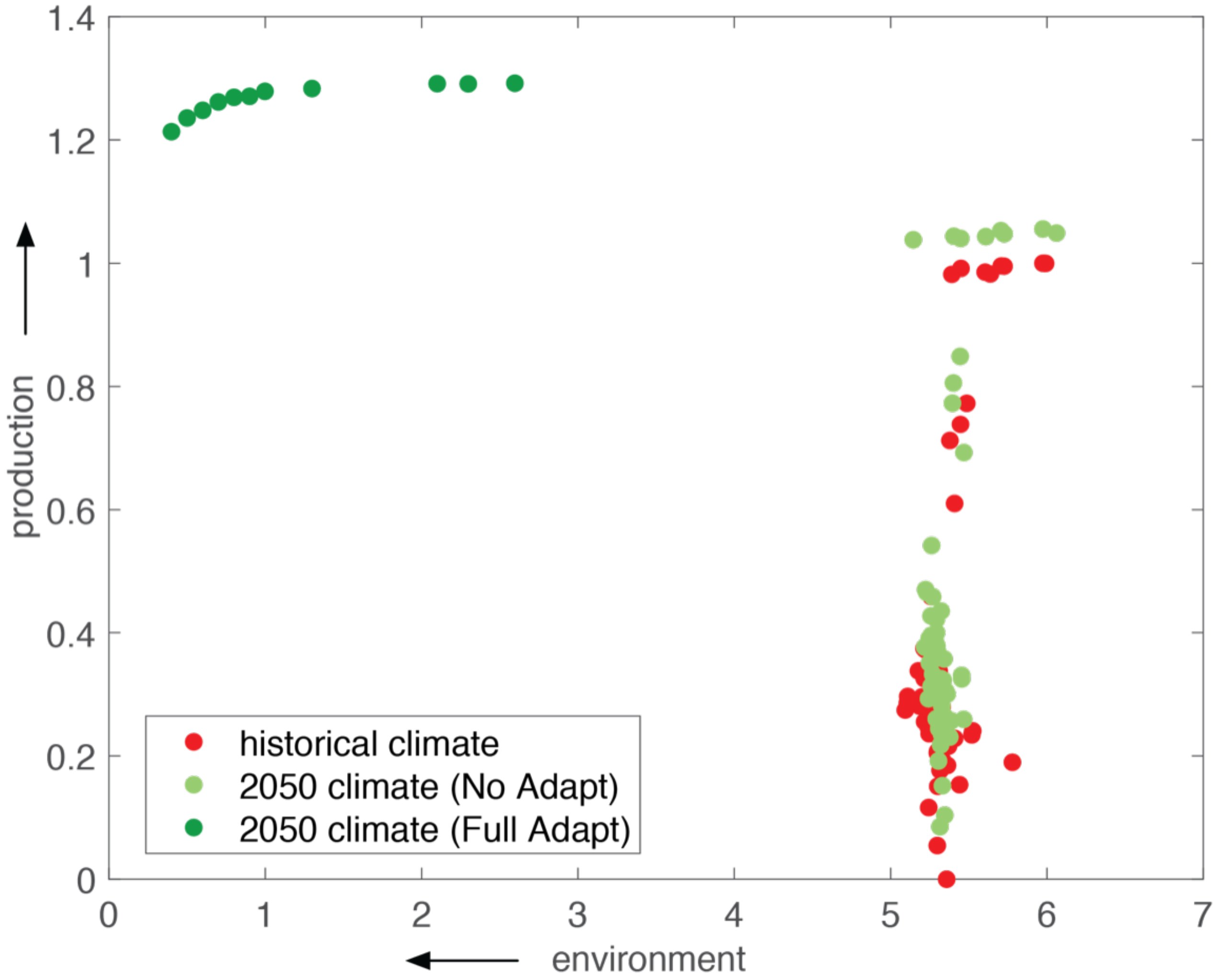


Future work

- Finalizing the setup of the model – adding the missing contributions (e.g. Gries reservoir and Altstafel tunnel and Sfundau reservoir).
- Switching from daily simulations to hourly, in order to simulate sub-daily hydrological processes (e.g. radiation variability) and flow dynamics including sediment production and transport.
- Increasing the spatial resolution to 100 m to match the resolution of the climate.
- Update the model parameterization to improve the model performance and to account for future hydropower operation policies (see next slides presented by Castelletti).

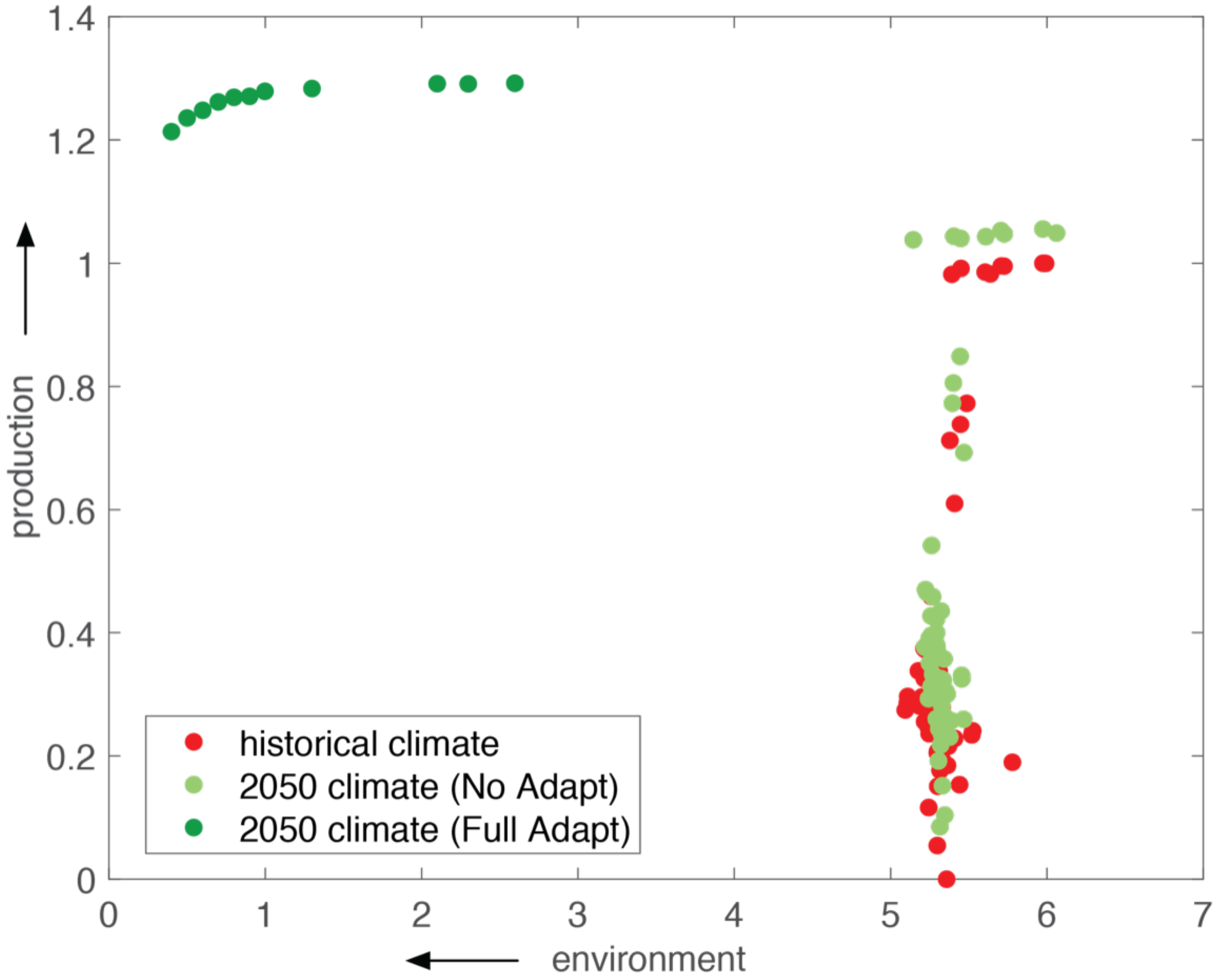
Impact on the operations (preliminary)



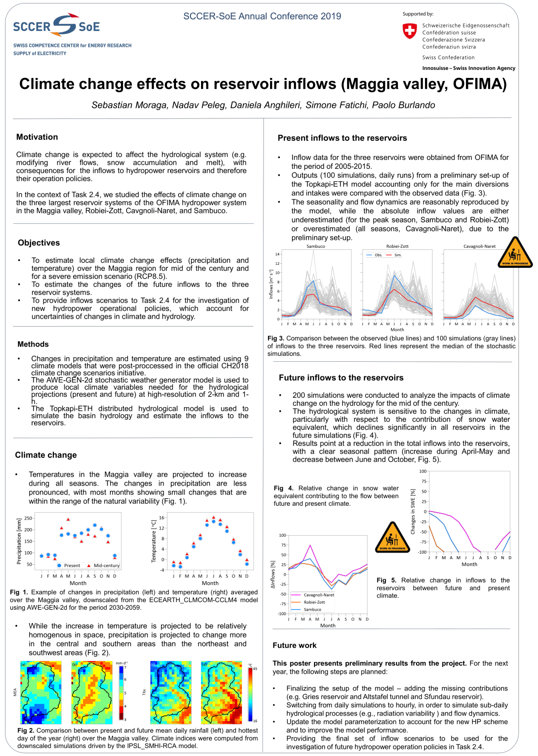


Impact on the operations (preliminary)

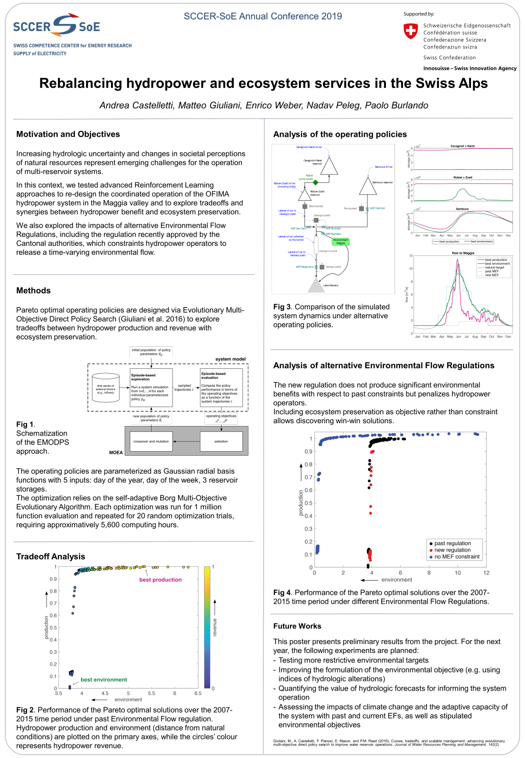
- Increasing spring inflow will have no impact with NO ADAPTATION
- With ADAPTATION production will increase
- And the conflict between HP and environment will be reduced



Thank you for your attention!



Climate change effects on reservoir inflows (Maggia valley, OFIMA)
(Moraga et al.)



Rebalancing hydropower and ecosystem services in the Swiss Alps
(Castelletti et al.)