Trends in Swiss river discharge and temperatures under climate change: observations and simulations

Adrien Michel[1], Tristan Brauchli[1,2], Bettina Schaefli[2], Mathias Bavay[3], Hendrik Huwald[1], and Michael Lehning[1,3]

[1] CRYOS, School of Architecture, Civil and Environmental Engineering, EPFL. [2] Institut des dynamiques de la surface terrestre, University of Lausanne.

[3] WSL Institute for snow and avalanche research SLF, Davos.

introduction

In the framework of NCCS HYDRO-CH2018, we assess the past, current, and future evolution of river temperatures in Switzerland with focus on the natural river network.

Substantial work on discharge modelling exists, but much less on water temperature. There is no recent comprehensive description of observed trends of Swiss river temperature.

The strong linkage between river temperature and discharge requires studying discharge along with temperature.

observations

Time series of water temperature and dischrage (FOEN, Cantons), exitst for some sites since the 1960s or 70s.

These are long enough for a meaningful statistical analysis.

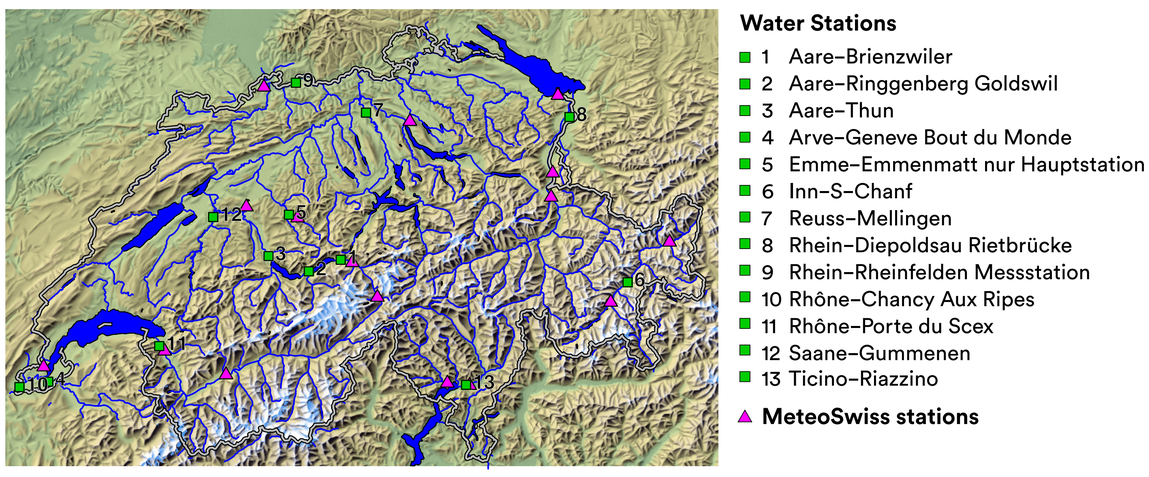

Figure 1 - First sub-set of stations used for the study

evolution of annual cycle

We study decadal averages (at daily resolution) of annual cycles for temperature and discharge.

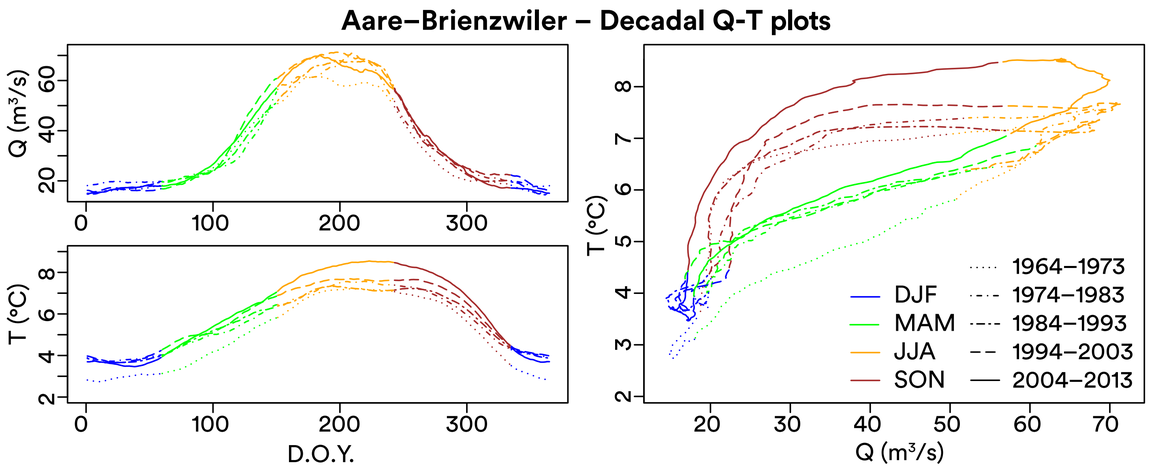

Figure 2 - Example of study of evolution of annual cycles for Aare-Brienzwiler

seasonal component removal and trend analysis

To assess the long-term evolution of water temperature (T) and discharge (Q) and their link with climatic conditions, seasonality is removed using the STL algorithm (Cleveland et al., 1990) in which parameters are adjusted for each station.

STL is applied to T and Q and to air temperature and recipitation measurments. Long-term trends are obtained from de-seasonalised time series.

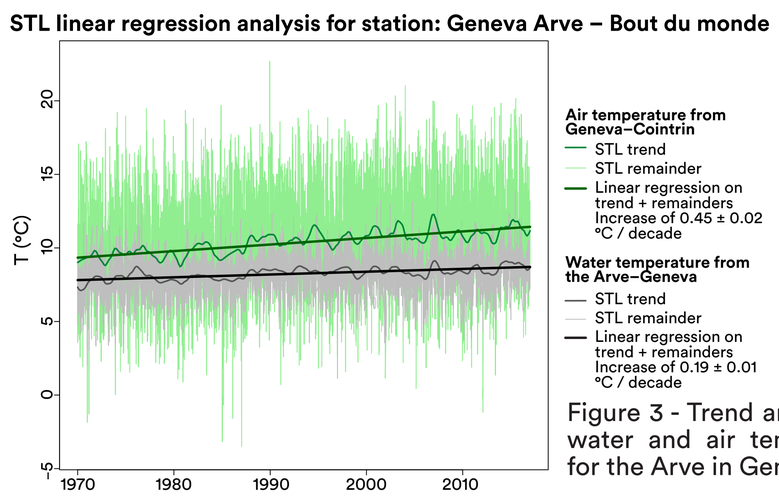

Figure 3 - Trend analysis for water and air temperature for the Arve in Geneva

next steps

- Add more stations.
- Data set of glacier melt will be used in the analysis.
- Do trend analysis by seasons.

simulation

The model chain Snowpack-Alpine3D-Streamflow (models.slf.ch) is used to assess the impact of climate change on river discharge and temperature.

The CH2018 climate change scenarios will be used as forcing.

Catchments and lakes for climate change study

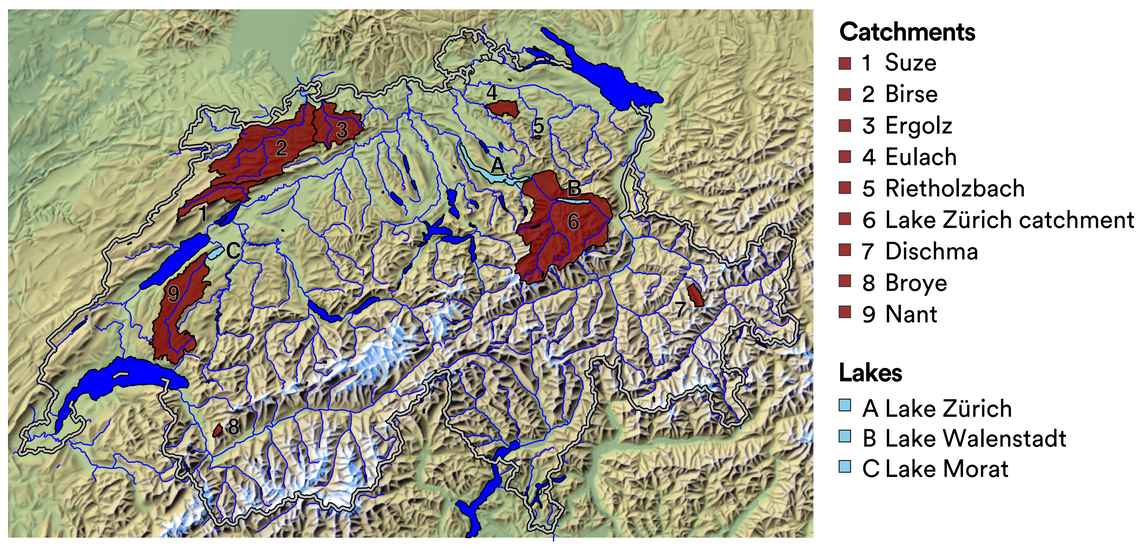

Figure 4 - First selection of catchments and lakes to be used with the CH2018 scenario

lake coupling

The model will be coupled with the EAWAG 3D lake model and simulations are planned for Lake Morat and Lake Zürich.

model development and validation

Models have been enhanced and optimized to run over large catchments.

The model chain has been tested and validated with historical data at various locations.

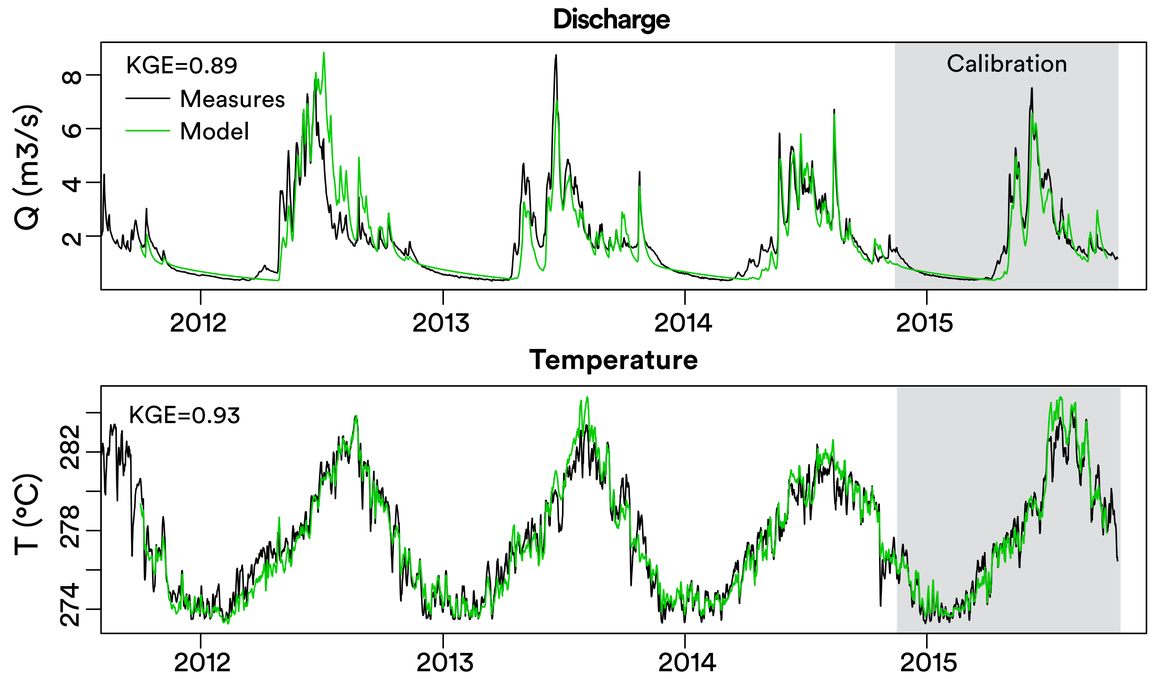

Figure 5 - Model validation for the Dischmabach catchment (Davos)

outlook

- Add a riparian vegetation module to asses the potential of riparian vegetation as mitigation strategy for stream temperature.
- Enhancement of some modules of the hydrological model (e.g. non linear reservoir in the soil).
- Enahncement of the glacier handling in Alpine3D for climate change impact on glaciers study.