Maximal and Minimal Temperatures of Swiss Watercourses

Degree programme : MAS | Specialisation : MAS Data Science

The aim of the study is to model the development of new yearly maximal or minimal temperatures in Swiss watercourses over the past few years. Particularly, the hypotheses whether there is a time shift in temperatures over the years or an increasing fluctuation of water temperatures shall be checked.

Introduction

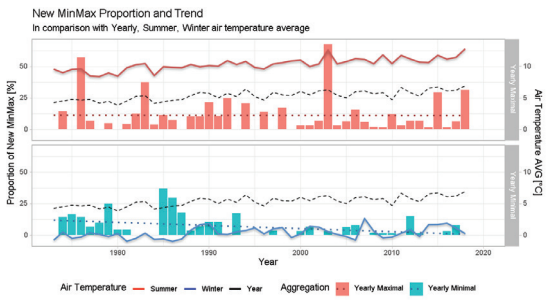
Within the BFH, the institute for optimization and data analysis (Institut für Optimierung und Datenanalyse, IODA) has a collaboration with the Swiss Federal Office for the Environment (FOEN, BAFU). The FOEN monitors the main hydrological parameters over whole Switzerland. The water temperature of rivers in Switzerland is one of the most important parameters for the habitat quality of water bodies. The Federal Monitoring Network for Watercourse Temperatures, with about 70 stations, provides a nationwide representative picture. Among other indicators, monthly and yearly maximal and minimal temperatures are logged.

Objectives are:

- To describe the evolution of these new MinMax and more particularly assess, if new occurrences are resulting from a global increase of the water temperature variability.
- To define which available and intrinsic explanatory variables can best describe this evolution.
- To develop a graphical visualization, ideally showing the time-based progression.

Cluster analyses

As a first step, it was analyzed whether the available stations can be grouped within meaningful clusters and consequently can further be used as explanatory variables. With the help of a k-mean algorithm, four clusters were defined based on the following characteristics: temperature mean, temperature standard-deviation, drainage area size, average altitude of drainage area, glacial stage, flow regime and station altitude.



Evolution of new minimal and maximal water temperatures proportion

Variability assessment

Secondly, the variability of water temperature was evaluated essentially by scrutinizing the yearly standard deviation of available stations. It seems that a slight increase of the global variability can be confirmed with a linear regression by time and cluster previously defined. Several other factors could increase the global variability like the season of the age of a station. Stations implemented before and after 2002 show different variability patterns.

Evolution of New Minimal & Maximal occurrences

Specific data analyses were carried out to define new yearly minimal and maximal water temperatures for every station, from their implementation up until 2018. Then a yearly percentage of newMin and newMax against the total of potential events was aggregated. These proportions fluctuate between 3% to 68% (figure). As expected, air temperature seems to be a strong explanatory variable. Afterward, relationship between the explained variable, occurrences of new MinMax and potential exogen variables were modelled mainly with binomial regressions. Even if the accuracy is around 0.88, all models performed poorly with respect to finding true new occurrences. The excess of zero, no new MinMax, must be computed separately.

To continue

The scope of this study remained within the available data provided by the FOEN and did not include much external explanatory variables such as sun exposition, seasonal solar warming or the watercourse network hierarchy. These parameters could help to model the evolution of new minimal and maximal water temperatures even more accurately.

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