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MAKAHO : An interactive cartographic Tool for Trend Analysis of hydrological extremes in France

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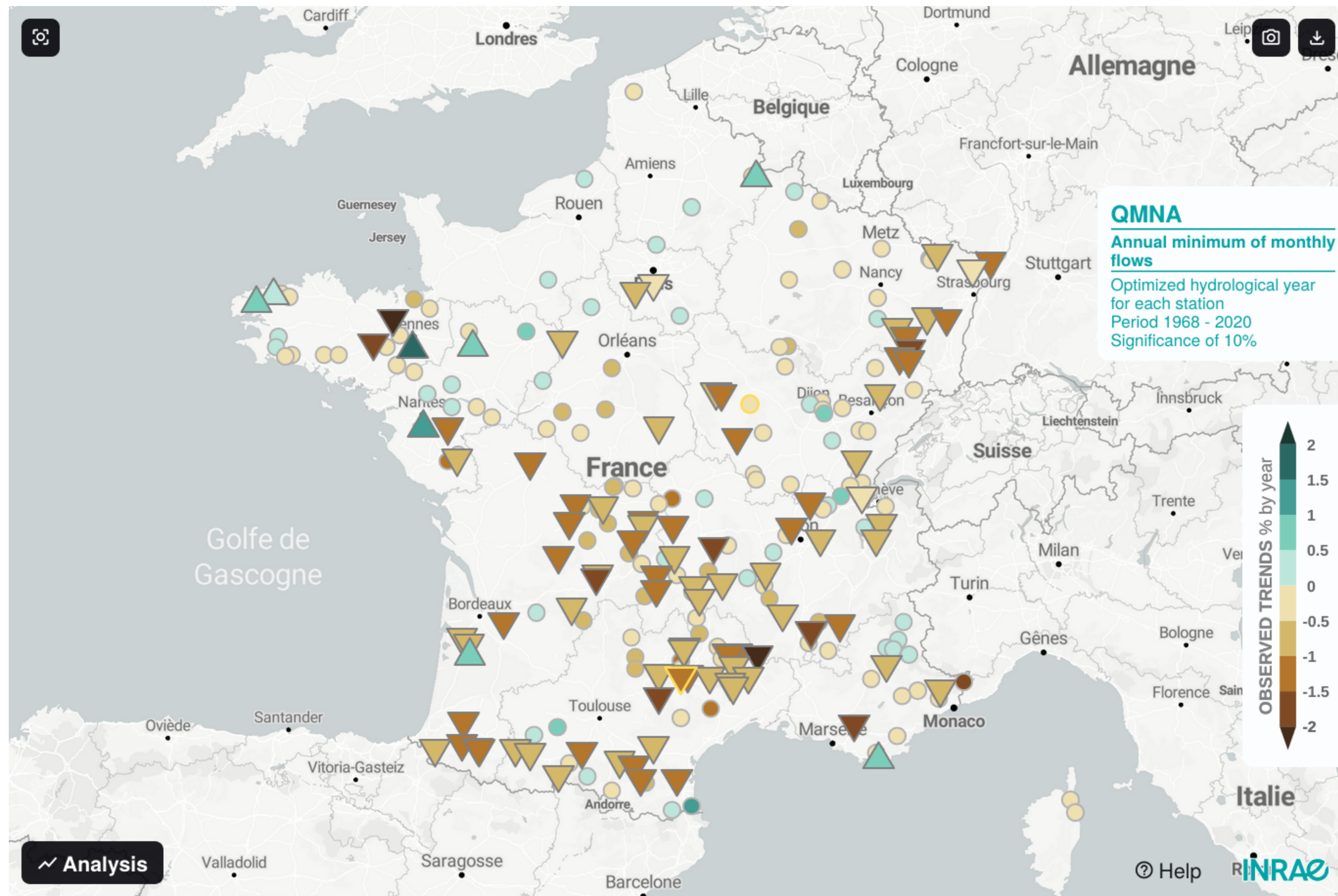
<https://makaho.sk8.inrae.fr>



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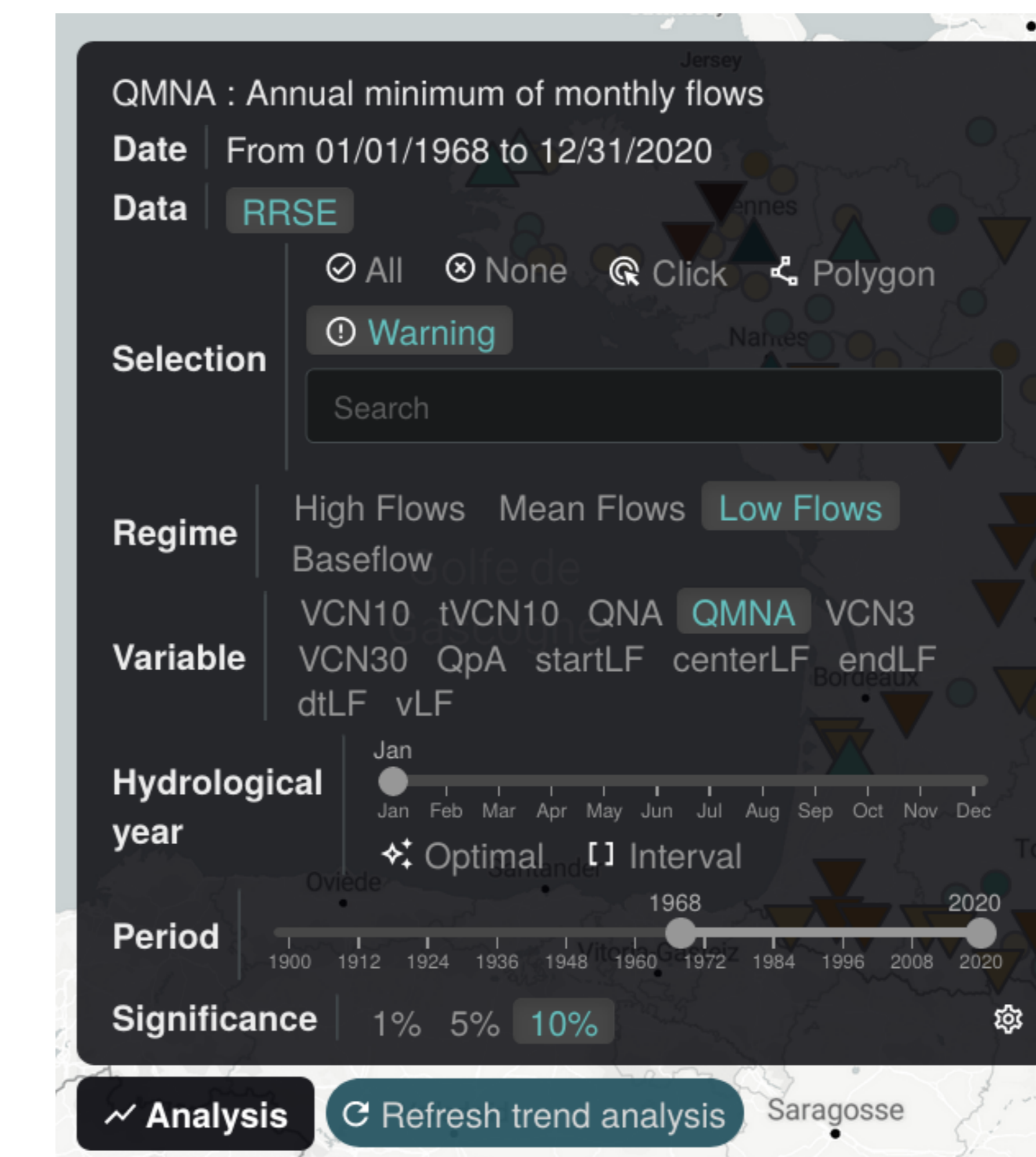
Liberté
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Fraternité

INRAE

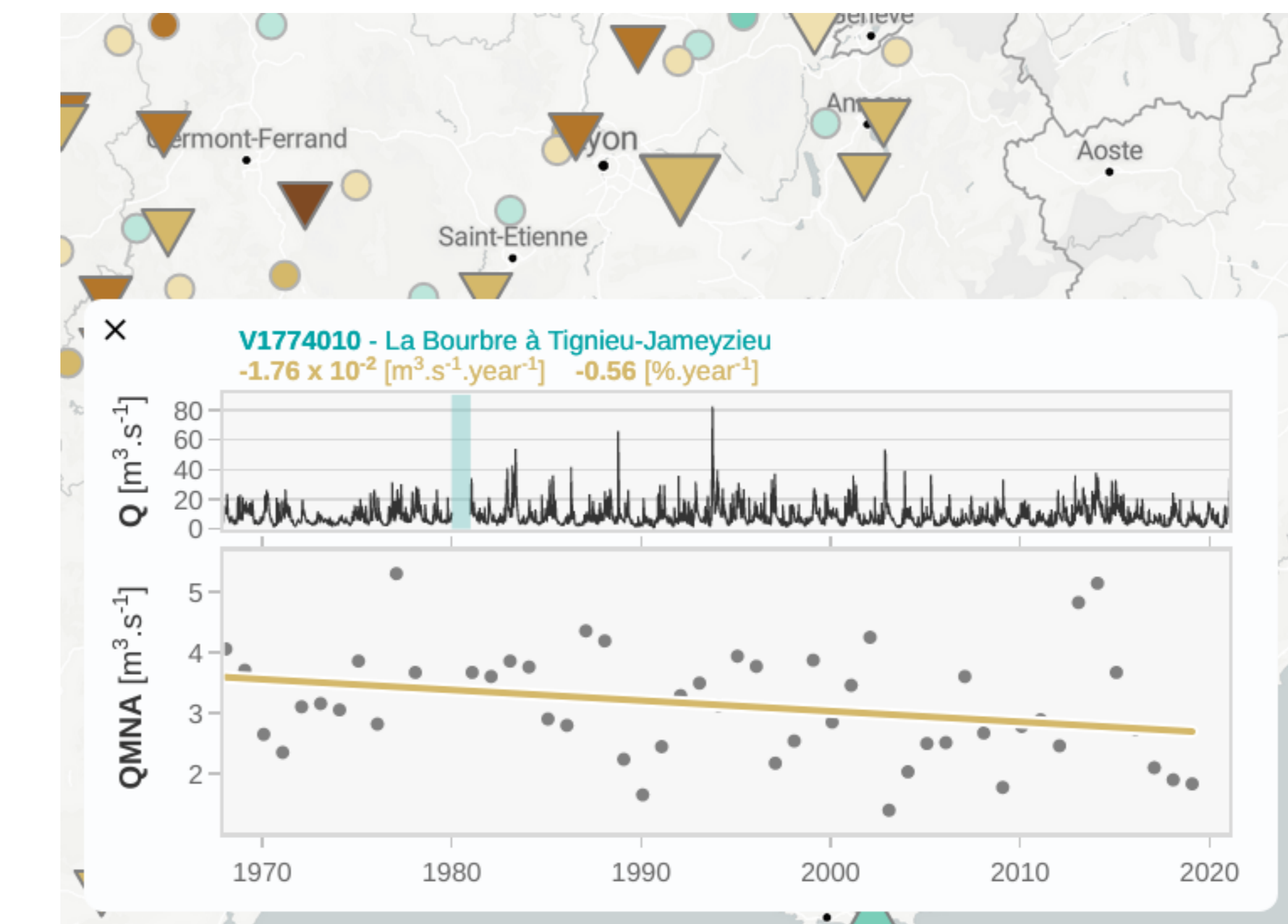


Interface

Calculations are performed **on the fly**, allowing greater customisation of analyses. Users can choose between nearly **50 variables** organized by hydrological topics.



The definition of the **hydrological year** is fully customizable and an optimal hydrological year is proposed based on hydrological considerations about the variable. The **analysis period** can be adjusted as well as the **significance level** of the Mann-Kendall test.



A click on a station displays the **time series** for the variable of interest.

Data processing



git@super-lou/EXstat

The daily discharge series are stored in the form of a table and are entirely processed by the **EXstat** R package. Initially, the aggregation of daily data into an annual variable is carried out following parameterization files standardized by the **CARD** project. Trend analysis is then performed on the resulting annual variable. MAKAHO thus is an interface with the EXstat package.

Tech stack



Web interface and data management



Interactive map



Aggregation process based on dplyr



Shiny web hosting by SK8 INRAE project

MAKAHO (MAnn-Kendall Analysis of Hydrological Observations) is an interactive cartographic visualization system designed to **examine trends in hydrometric observations** from the **232 stations** belonging to the French Reference Hydrometric Network (*Giuntoli et al., 2013*). These stations show a **high measurement quality**, time series with a historical depth of over 40 years, and they crucially gauge near-natural catchments. The statistical test used for trend detection is a variant of the **Mann-Kendall test** accounting for first-order autocorrelation. The trend slope is provided by the **Theil-Sen estimator**.

Giuntoli, I., Renard, B., Vidal, J.-P., and Bard, A. (2013). Low flows in France and their relationship to large-scale climate indices. *Journal of Hydrology*, 482:105–118. <https://doi.org/10.1016/j.jhydrol.2012.12.038>

Key results

- > Between 1968 and 2020, the hydrological situation in France exhibited a **marked contrast** between the **northern upward trends** and the **southern downward trends** in mean discharge.
- > Nearly **10 % of stations** show an **upward significant trend** in the **annual maximum daily streamflow** at the 90 % confidence level with an average increase of 13 % per decade. Almost all of these stations are located in the northern part of the country.
- > Mainly located in the south, around **40 % of stations** show a **decreasing trend** in the **annual minimum monthly discharge**, with an average intensity of about 11 % per decade.
- > The **duration of low flows** has **significantly increased in all the country** with an average of more than **10 days per decade**, reaching almost a month in extreme cases in the southwest.

Datasheets

Each hydrometric station has **technical sheets** summarizing all trend analysis results for a selection of variables. These datasheets are directly downloadable from the website.

