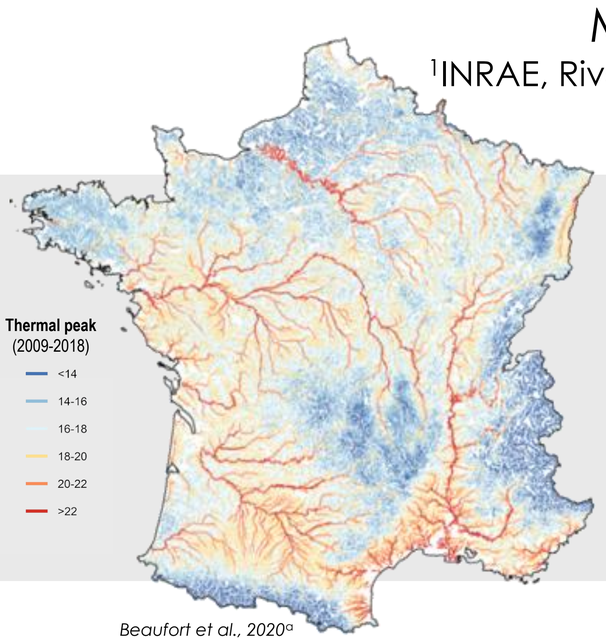
Prediction of river thermal regime metrics under climate change on a national scale

Marion Moussay[1], Florentina Moatar[1], André St-Hilaire[2]
[1]INRAE, RiverLy, 69100 Villeurbanne; [2]INRS, Centre Eau Terre Environnement, Québec G1K 9A9



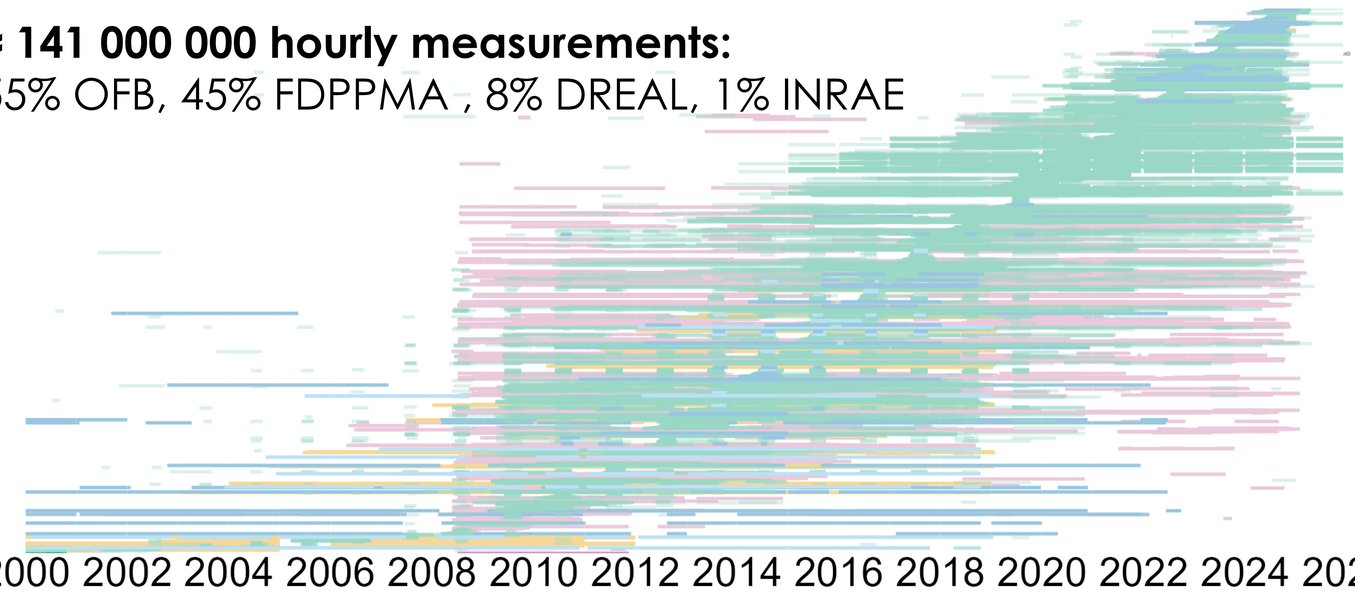
Beaufort et al., 2020[a]

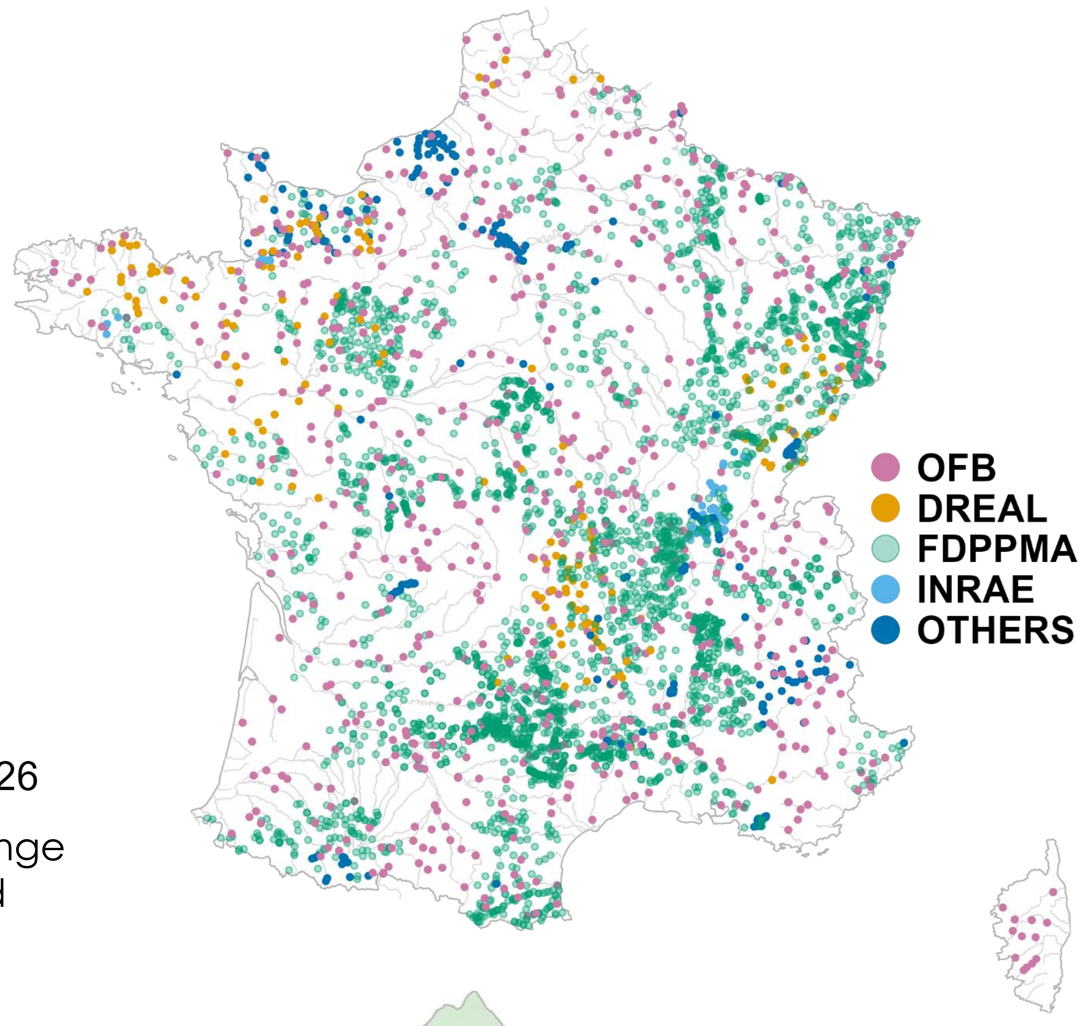
1. Modelling of current and future temporal variability
2. Spatial extrapolation of natural thermal regimes
3. Quantification of altered thermal regimes
4. Publication of thermal metrics: **thermie-rivieres.inrae.fr**

NATIONAL DATA COLLECTION

≈ 5000 sites: 23% OFB, 66% FDPPMA, 4% DREAL, 2% INRAE

≈ 141 000 000 hourly measurements:
55% OFB, 45% FDPPMA , 8% DREAL, 1% INRAE





DATA QUALITY ASSESSMENT : Comprehensive quality control - physical-range filters, rolling-window outlier detection based on short-term variability and manual validation - will secure reliable time series prior to analysis.

METHODOLOGY & ORGANISATION

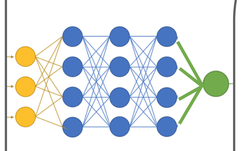
1 Modelling

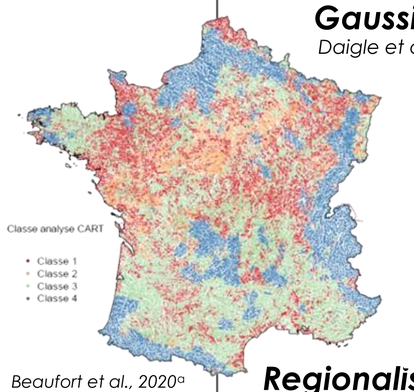
i. How can we reconstruct and forecast daily and extreme changes in river temperature?
Dataset : *heterogeneous data*

Long Short Time Memory
- Prediction performance
  Zhi et al., 2022, Feigl et al., 2023, Ikram et al., 2023
- Air temperature and additional predictor (discharge, groundwater proxy)

ii. How are water temperature extremes evolving under the influence of past climate, atmospheric forcings and future projections?
Dataset : 40-year series continues

Peak-Over-Threshold approach
Caissie et al.,2020





Beaufort et al., 2020[a]

2 Spatial extrapolation

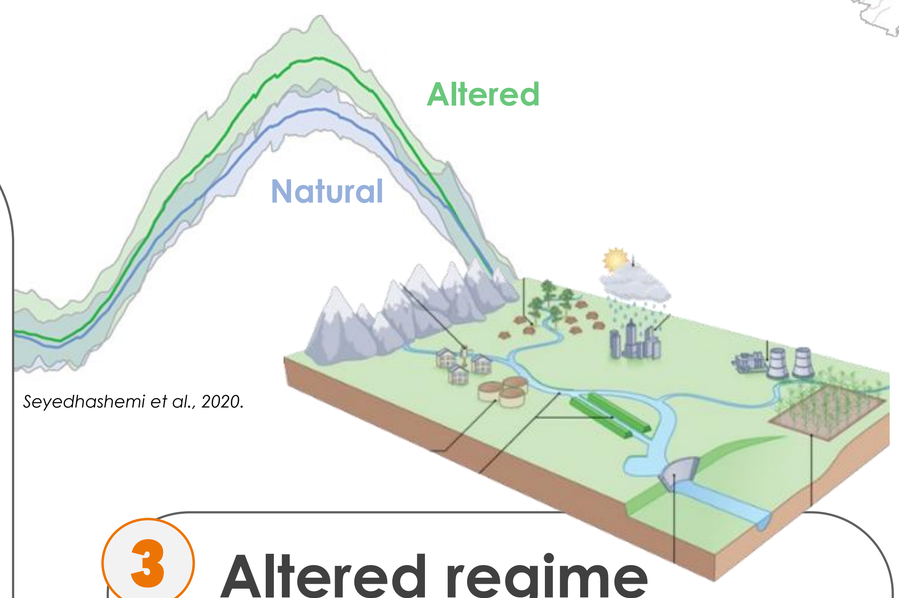
What factors explain the spatial variability of natural river thermal regimes?

Gaussian Thermal-Regime Model :
Daigle et al., 2020.

$$\widehat{T}(d) = Aexp\left(\frac{-(d-\mu)^2}{2\sigma^2}\right)$$

- A the annual maximum T_w
- σ the duration of the warm season
- μ the day-of-year on which A is reached

Regionalisation model
- Links A, σ, μ to basin physiography, flow-regime class[1] & GW–river exchange[2]
- Delivers France-wide maps of natural thermal regimes



Seyedhashemi et al., 2020.

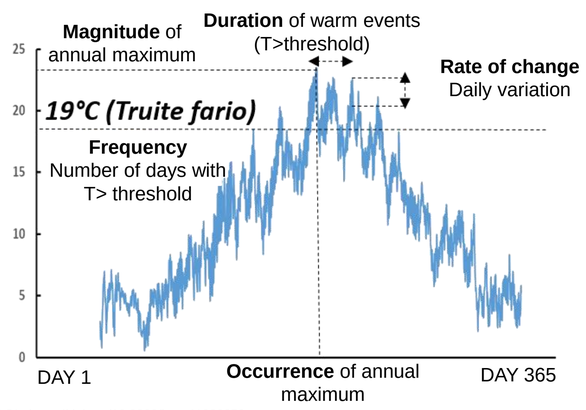
3 Altered regime

How do human activities modify river thermal regimes?

Influences described by fishing federations (FDPPMA): channelization, hyporheic clogging, urbanization, agriculture, weirs, reservoirs, water bodies, …

ECOLOGICAL RELEVANCE :
Translating past and future river-temperature dynamics into actionable indicators for temperature-sensitive fish

- Define biologically thermal metrics
- Map favourable vs. limiting habitat conditions under present and projected climates



Acknowledgements

The authors thank the **OFB** (Adeline BLARD-ZAKAR & Claire MAGAND), the many regional fishing organizations (**FDPPMA**), **DREAL**, and **EDF** for the temperature data.

Beaufort et al., 2020[a]. *[Rapport de recherche]* INRAE, https://hal.science/hal-03126527/
Beaufort et al.. 2020[b], *Hydrological Processes*, DOI : https://doi.org/10.1002/hyp.13608
Caissie et al., 2020, *Ecohydrology*, DOI : https://doi.org/10.1002/eco.2176
Daigle et al., 2019, *Journal of Hydrology*, DOI : https://doi.org/10.1016/j.jhydrol.2019.123963
Feigl et al., 2023, *Hydrology and Earth System Sciences*, DOI : https://doi.org/10.5194/hess-25-2951-2021
Ikram et al., 2023, *Journal of Marine Science and Engineering*, DOI : https://doi.org/10.3390/jmse11020259
Sauquet et al., 2000, *Hydrology and Earth System Sciences*, DOI : https://doi.org/10.5194/hess-4-79-2000
Seyedhashemi et al., 2020, *Science of The Total Environment*, DOI : https://doi.org/10.1016/j.scitotenv.2020.142667
Zhi et al., 2023, *Nature Climate Change*, DOI : https://doi.org/10.1038/s41558-023-01793-3