Assessing Human Pressures and Environmental Impacts in the Sorgues Valley Under Climate Change

AUDREN Nathan[1,4,5], DUBOST Lilou[2], HERITIER Coline[4,7,8], PRED'HOMME Margaux[3,4,6]
Tutors : Raphaël SANTOS[1,5], Victoria CHIU[2], Frédéric PARAN[6,7], Anne HONNEGGER[6,9]
(1) Université Claude Bernard Lyon 1, (2) Université Jean Moulin Lyon 3, (3) Université Lumière Lyon 2, (4) EUR H2O' Lyon, (5) LEHNA UMR CNRS 5023, (6) EVS UMR CNRS 5600, (7) Mines Saint-Etienne, (8) EPF Engineering School, (9) ENS Lyon

In the context of climate change, the assessment of pressures and their impacts on the Sorgues and its watershed (220 km²) has been carried out to help local stakeholders reconcile environmental protection with human uses. This evaluation combines legal, socio-geographical, hydrological, and ecotoxicological approaches. The findings show that the Plaine des Sorgues is increasingly subject to anthropogenic pressures, particularly those related to tourism, highlighting the limitations of existing regulatory frameworks. These pressures, expected to intensify with global warming, threaten the balance of a fragile ecosystem, notably due to the close interactions between the accompanying aquifer and the river. Signs of degradation are already evident, especially among fish populations, underscoring the tangible impact of human activities.

To what extent do uses have an impact on the natural environment of the Sorgues valley? Elements of legal, hydrological, eco-toxicological and geo-sociological characterization

What are the Sorgues?

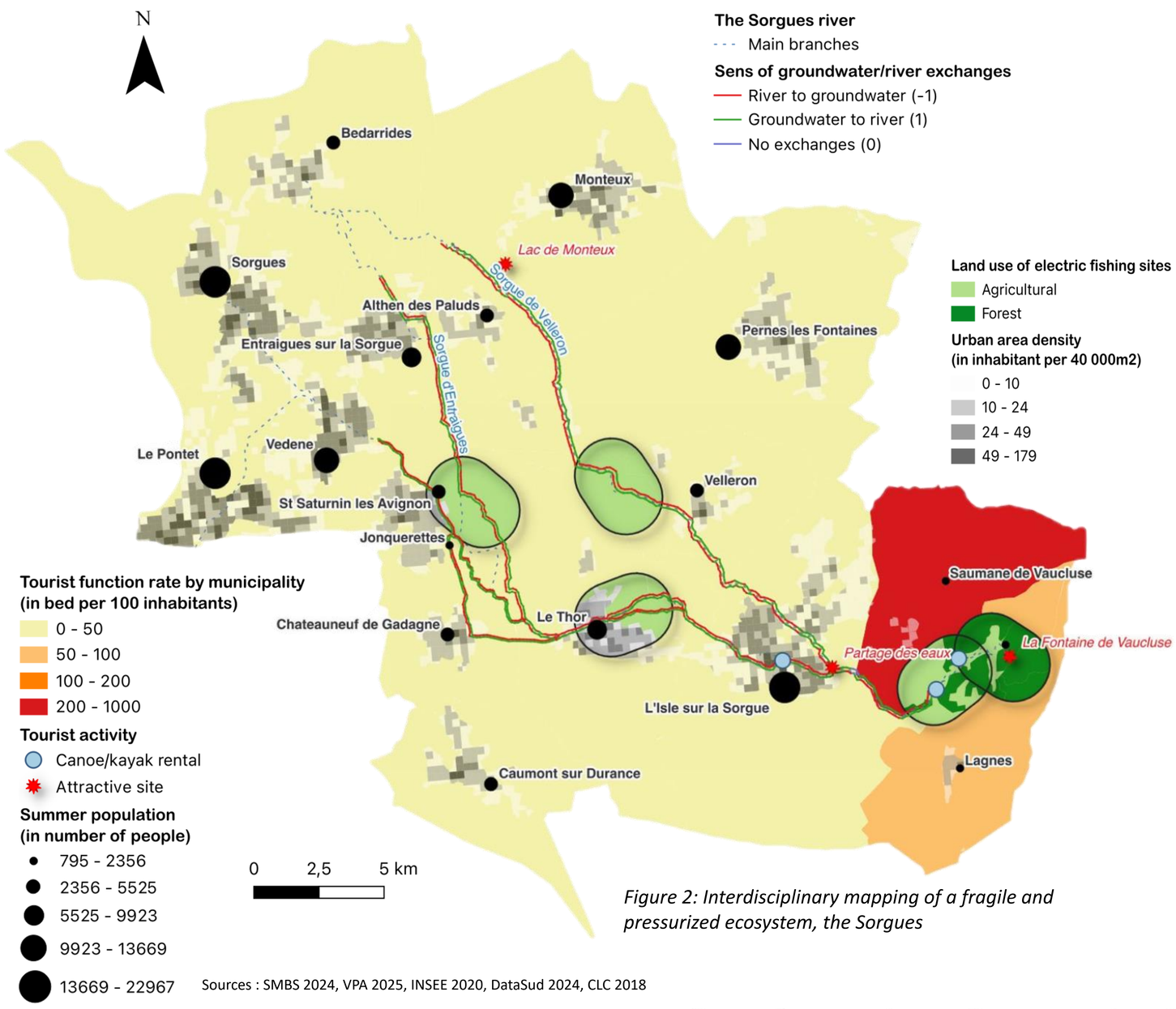
Located in the heart of the Vaucluse region, the Sorgues, or the Sorgue, originate from the karstic spring of the Fontaine de Vaucluse. Entirely shaped by human intervention, the river splits into several branches before flowing into the Rhône and the Ouvèze.

Figure 1: Location of the study site

MATERIAL AND METHODS

The pooling of contextualization and characterization work on projects aims to enrich **interdisciplinarity**:

- **Hydrology**: The analysis of groundwater–river exchanges helps to understand the hydrological functioning of the watershed by identifying recharge and discharge zones.
- **Ecotoxicology**: A land use map is used to identify potential pollutants, which are then measured and analyzed using molecular biomarkers.
- **Social geography**: Evaluation of tourism pressure, notably through the tourism function rate, and analysis of stakeholder perceptions via a sociological survey.
- **Law**: Analysis of current legislation and legal comparison using an analytical method



Sources : SMBS 2024, VPA 2025, INSEE 2020, DataSud 2024, CLC 2018

Figure 2: Interdisciplinary mapping of a fragile and pressurized ecosystem, the Sorgues

RESULTS

Fragile ecosystem

- The hydrological study shows **widespread groundwater-river interaction**.
- Groundwater levels vary about one meter seasonally without reversing flow direction.
- Local water gains or losses depend on rainfall and Fontaine flow.
- Strong connectivity makes the **system vulnerable** to river-borne pollution

Pressured ecosystem

- The Sorgues face strong, evolving, and spacially uneven **human pressures**, exacerbated by **climate change** supporting **the hydrosocial cycle concept.**
- **Tourism** highlights tensions, with heavy visitation upstream and growing activity downstream, along with activities like canoeing.
- **Regulatory changes** and compliance reflect tourism impacts. For exemple, swimming regulations exist but are poorly enforced due to limited resources and social concerns about water access.

Impacted ecosystem

- Anthropogenic pressures have direct impacts on ecosystem, evidenced by **genotoxicity** in fishes erythrocytes.
- Ecotoxicological impacts vary across sites, linked to **land use** and nearby human activities.

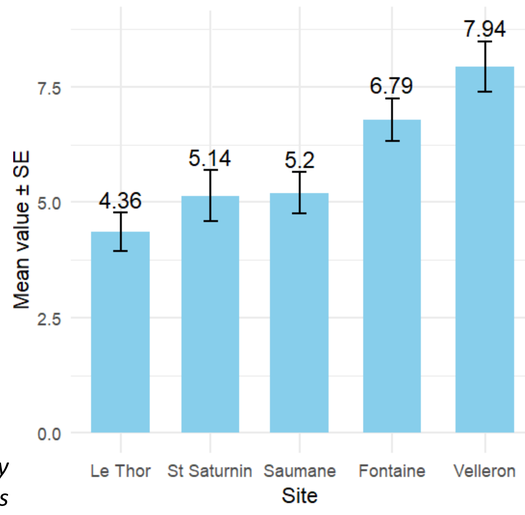


Figure 3: Variation in Genotoxicity (Comet Assay) Among Sampling Sites

Climate Change Adaptation

- **Water culture** is deeply rooted in the region.
- Climate change adaptation is accepted but remains a vague concept.

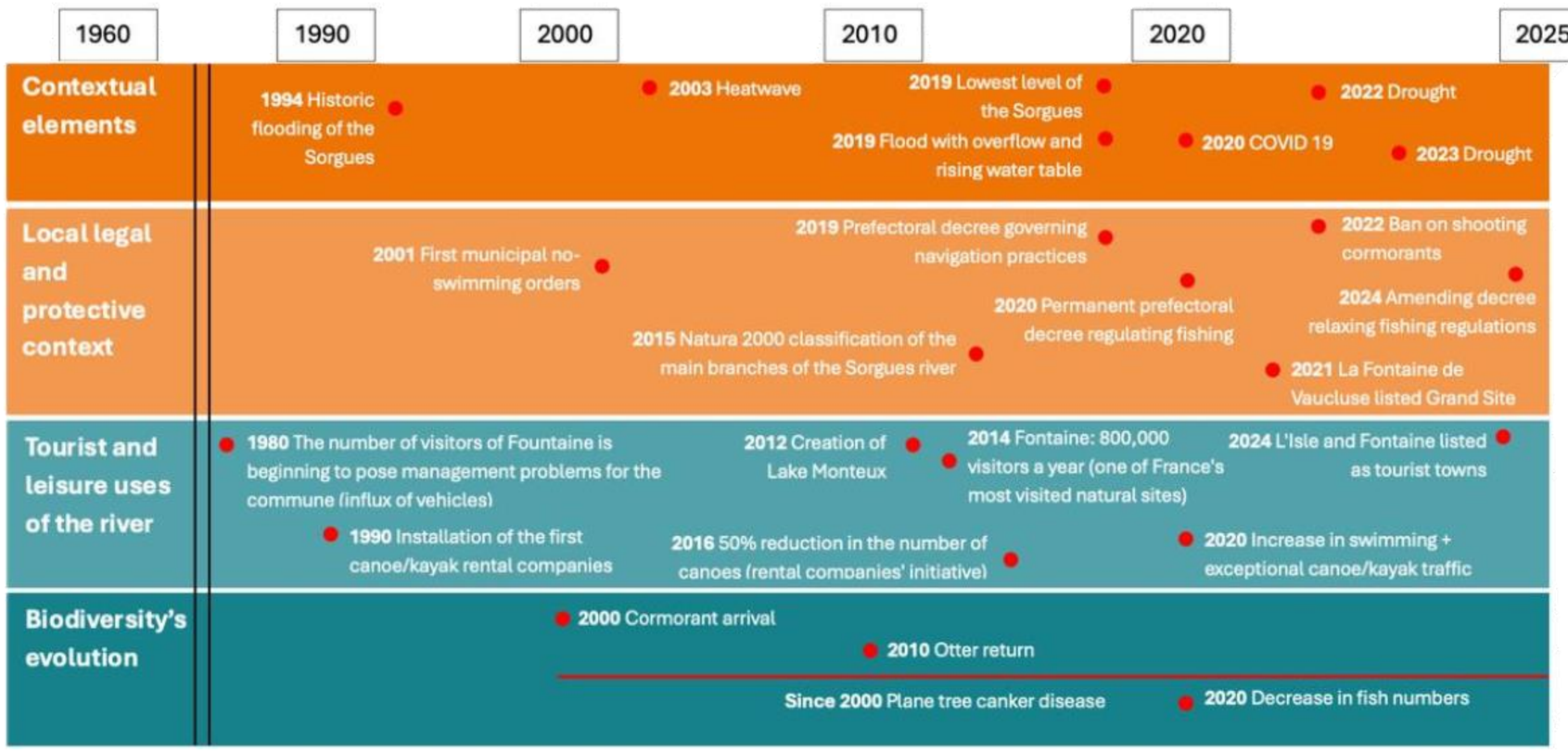


Figure 4: Chrono-systemic timeline of climate change adaptation on the Sorgues

CONCLUSION/PERSPECTIVES

The hydrological and regulatory context makes the Sorgues river network particularly vulnerable to human pressures, especially those related to tourism, which are expected to intensify with climate change. These pressures are already having visible impacts, notably on fish populations.

Environmental protection and climate change adaptation efforts have intensified in recent years. However, they are struggling to keep pace with the evolving pressures, as well as the sources and behavior of pollutants.

The study identified promising areas for further investigation, such as the integration of new biomarkers and the modeling of pollutant transfer dynamics, to better understand their origins, movements, and impacts.

Many tourist sites in France face similar pressures. It would be valuable to place these findings in a broader context by comparing them with other studies.

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