

Title: Bridging Science and Society: An Integrated Framework for Water Quality Management through Training, Research, and Professionalisation

Abstract

Water quality is a major environmental and societal concern, increasingly challenged by pollution, climate change, and evolving management demands. This paper reports on a collaborative initiative between the Community of Municipalities of Sumène-Artense (CCSA) and the University of Clermont Auvergne aimed at developing transparent and accessible methodologies for helping manage water resources. Two complementary approaches were explored: biological tools for assessing quality through biomarkers, and explainable artificial intelligence. Together, these tools provide ecologically grounded indicators of water quality and predictive models that are interpretable by technicians, decision-makers, and citizens. At the heart of the project, and elaborated throughout this paper, is the triptych of Training, Research, and Professionalisation, which served as the guiding framework for linking scientific innovation with societal relevance. Students of different degrees were embedded in field and laboratory work, acquiring technical and transversal skills, while associations, GEMAPI technicians, and local actors participated in data collection and interpretation. This integration strengthens scientific mediation and ensures that research remains both academically rigorous and socially relevant. This study demonstrates how modular, adaptable and explainable methodologies can foster dialogue between science and society while supporting sustainable water governance.

1 Introduction

The quality of water resources represents a critical environmental and societal challenge, shaped by human activities, climate change, and ineffective management strategies. In response to these pressures, a collaborative study between the Sumène-Artense Federation of Municipalities (CCSA) and the University of Clermont Auvergne (UCA) represented by its University Institute of Technology (IUT) investigated innovative approaches related to water quality assessment that integrate biological analyses and artificial intelligence (AI). The primary objective of this partnership was to gather a pluridisciplinary team to develop transparent and accessible methodologies to enhance the assessment and management of water quality. Two main questions were explored: 1. What other biological analysis processes can be implemented to assess water quality in a way that is understandable to the public? and 2. How can artificial intelligence be leveraged to “make data speak”?

Concerning biological analyses, the laboratories IMoST (*UMR 1240, INSERM, UCA*) and UMRF (*UMR 0545, UCA*) were selected on identified needs and the scientific expertise to develop environmental biomarkers. This method involves analysing a stress-response protein, called Permeability Glycoprotein (P-gp) belonging to the class of Multidrug Resistance proteins. Highly ubiquitous, it is expressed in the cells of all organisms (Valton et al 2013; 2015; 2017). Such biomarkers provide a direct biological assessment of water quality through a higher aquatic organism.

Concerning the need to make environmental data accessible and understandable to the public, another team of the laboratory LIMOS (*UMR 6158, UCA*) drew on large datasets provided by the Adour-Garonne Water Agency and local associations and applied A.I. techniques to develop data predictions. The main purposes were to assess water quality across spatial and temporal dimensions, while proposing water analytical techniques that are simple, explainable, and reusable.

Exchanges between researchers, citizens, elected officials, and students underscored the need to adopt the triptych approach, “Training, Research, and Professionalisation”, as a strategic framework for addressing water management challenges (Healey et al., 2009). This model advocates for the intentional and interconnected integration of academic training, scientific research, and practical, field-based expertise to ensure that water management is not only scientifically sound but also socially relevant and professionally robust. Effective and sustainable water governance also demands professionals who are not only technically skilled but also equipped to translate research into action and engage meaningfully with diverse stakeholders. Moreover, collaborative initiatives that bridge academic and non-academic actors foster a culture of shared responsibility and innovation, both of which are essential in responding

to the growing pressures on water resources caused by climate change, pollution, and increased demand (Brown et al., 2009; OECD, 2020; Karasani et al., 2023).

This paper outlines both the actions already undertaken and potential future directions related to our project, focusing on two key dimensions. First, it discusses the adaptation of biological analysis and A.I. methods to meet emerging needs, highlighting innovation at the intersection of environmental science and societal relevance. Second, it illustrates the practical implementation of the “Training, Research, Professionalization” triptych, particularly through the integration of students into a pluridisciplinary study. We finally propose establishing a participatory model that brings together research, students, elected officials, and citizens. The central question is: who should be involved, and how, in order to co-construct a shared water observatory? This initiative aims at creating a collaborative space where scientific knowledge, local expertise, and civic engagement converge to monitor, evaluate, and respond to water-related challenges.

The paper is organised as follows. Section 2 presents the technical innovations developed in the project, focusing first on the use of biomarkers and on the use of explainable AI. Section 3 examines how these innovations were embedded within the triptych of “Training, Research, and Professionalisation”, highlighting student involvement in research-informed training. Section 4 introduces the participatory model, describing how local stakeholders, students, and citizens were engaged as partners in water quality research. Finally, Section 5 concludes the paper and outlines future perspectives.

2 Adapting Technical Aspects for Diverse Needs

2.1 Adapting Biological Technical Methodologies to Make Them Interpretable for non-specialists

Biomarkers refer to a biological characteristic measured in organisms. They enable us to determine the effects of contamination on the health of organisms. Biomarkers make possible the integration of the cocktail effect of contaminants, which is very useful when dealing with complex mixtures of pollutants. It complements or surpasses chemical analysis. Indeed, a molecule in low concentration can be very toxic. The "Resistance" research group at INSERM UCA 1240 Molecular Imaging and Theranostic Strategies (IMOST) has extensive expertise in developing environmental biomarkers based on the expression of the major multidrug resistance (MDR) protein, permeability glycoprotein (P-gp). The latter is a membrane efflux protein involved in defense mechanisms at the cellular level. The expression of P-gp (at the gene and protein level) can be induced (increased) in the presence of xenobiotics (drugs and pollutants) in the environment. This induction property of P-gp can be exploited for the development of a global, predictive biomarker of water pollution. The proof of concept for the Sentinel biomarker has been demonstrated in the laboratory and also in the field in various rivers in the Auvergne Rhône Alpes region of France [Bamdad et al., 2011; Valton et al., 2013; 2015; 2017]. However, the methodologies used for this development were cumbersome and costly. More recently, the Resistance group has developed two new classes of fluorescent intracellular tracers called “Guardian” and “Saphir” that can detect and quantify P-gp in a specific and direct manner [Bamdad et al., 2024 patent N° FR2414029, Daumar et al., 2023].

In this context, the IMoST Resistance group initiated the development of a Sentinel biomarker for P-gp in red blood cells from trout in the CCSA's lakes and rivers, but using the new methodology with these innovative tracers. For this development, several methodologies for preservation of trout red blood cells were carried out. Subsequently, the methodology for labelling with the two fluorescent tracers was developed and standardised in the laboratory. Indeed, preliminary tests were carried out with farmed trouts, and the results were used to determine the optimal experimental conditions. Comparative studies were then carried out in the field using blood from trouts from river waters in collaboration with the Federation for Fishing and Protection of Aquatic Environments of Cantal and Puy de Dôme, in France.

In this study, red blood cells were taken from trout living in the following waterways: “Le Bédât,” “La Jordanne,” “Le Mars,” and “Ruisseau d'Icon.” In the laboratory, the P-gp in these red blood cells was quantified using each of the two tracers, Guardian and Saphir. Measurement protocols have been simplified and adapted so that they can be implemented by students, promoting hands-on learning and broader engagement in environmental monitoring.

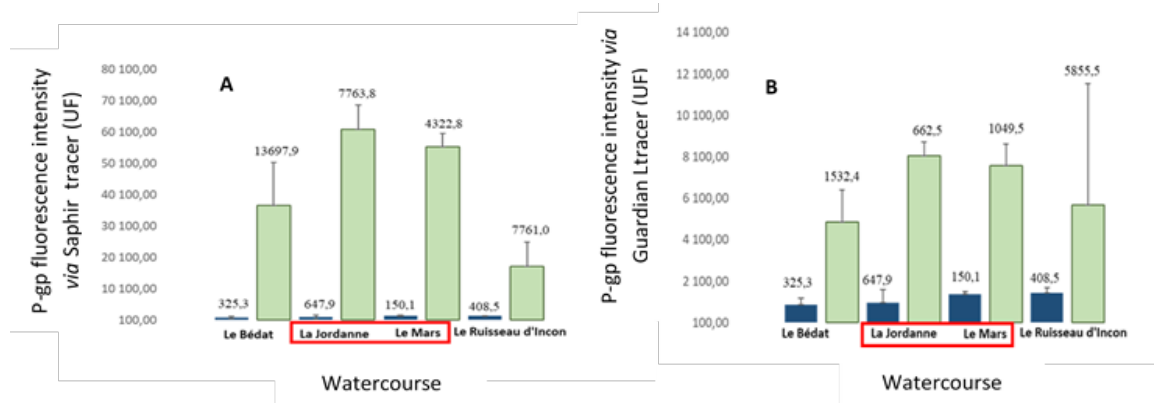


Figure 1: P-gp quantification on trout red blood cells in various watercourse using Saphir fluorescent tracer (A: green fluorescence = P-gp indicated by yellow arrow) and Guardian fluorescent tracer. Fluorescence intensity can be quantified using fluorescence imaging and/or flow cytometry methodologies. Blue bar = non-fluorescent control cells. Green bar: cells labelled with tracers (UF: Fluorescence Units).

After that the optimal conditions for storing blood samples had been established, the first field tests were carried out. For this work, we collaborated with the Fishing and Aquatic Environment Protection Federation of Cantal (45) and Puy de Dôme (63) (Figure 1 A, B). The results obtained from samples labelled with the two fluorescent tracers Saphir and Guardian showed that P-gp expression is highest in “La Jordanne” and “Le Mars”, followed by “Le Bédât” and finally “Le ruisseau d’Icon”. The high level of P-gp expression at Le Mars and La Jordanne could be also explained by the disappearance of 50% of the trouts at these sites. At “Le Bédât”, located in an urban area, the level of P-gp is lower than at the two previous streams. This could be explained by chronic pollution of this river, to which the trouts have adapted. For the Icon stream, we can see that the P-gp expression rate is the lowest, which is consistent with existing physicochemical data.

P-gp is an excellent biomarker for assessing organisms' responses to stress in environmental conditions, serving as a bioindicator of water quality. Unlike traditional chemical assessments, which often require complex interpretation of multiple pollutants, biomarker-based approaches offer a single, integrative biological measure of water toxicity. This approach directly reflects the physiological response of living organisms to contamination. As a result, it makes the results potentially easier to interpret and communicate, particularly to non-specialists and local stakeholders. This is because the response is translated into clear signals such as “healthy” or “stressed” states, rather than long lists of chemical concentrations. This biological framework is more intuitive for non-specialists, who can more easily relate to the health of fish or other organisms than to abstract numerical thresholds. This, in turn, facilitates dialogue with local stakeholders and promotes participatory decision-making in water quality management.

2.2 Explainable AI Approaches as a Cornerstone of Participation

Water agencies generate large volumes of data under the form of numerical datasets that are large, complex and require expert knowledge to interpret, particularly due to the use of specialised scales and units for each parameter. Making these ‘data speak’ is a crucial step toward democratising access to environmental information. It enables non-experts, such as students, elected officials, and citizens, to understand the state of water quality and participate meaningfully in discussions and decisions related

to water management. Developing tools and visualizations that translate raw data into clear, accessible insights is therefore essential for fostering transparency, awareness, and collective responsibility.

While advanced models such as generative adversarial networks a.k.a. GANs (Silva et al., 2021) can produce powerful insights about water quality management, they often function as “black boxes”, delivering results that lack transparency. This becomes problematic in contexts that directly affect people, such as sudden changes in water quality or the influence of agricultural practices on pollution levels. In such cases, stakeholders, especially citizens, students, and local decision-makers, seek understandable explanations, particularly when results are surprising or impactful.

To address this, it is essential to prioritise explainable AI approaches, even if they sacrifice some predictive accuracy (Doshi-Velez et al., 2017). In this study, we employed our approaches related to data quality (Jouseau et al., 2024) to estimate the relevance of the data, then we used algorithms like K-means for grouping water stations having similar characteristics, and applied approaches like decisions trees, random forests and regression techniques to predict short-term water quality (over several months). Such transparent methods make it easier to communicate findings, foster stakeholder trust, and support informed decision-making at the local level. However, long-term forecasting remains challenging due to uncertainties in meteorological forecasts, particularly concerning extreme events such as droughts.

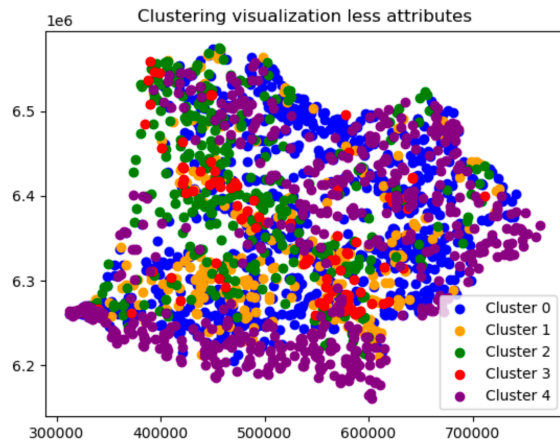


Figure 2: Clustering of water stations according to water quality in the Adour-Garonne area

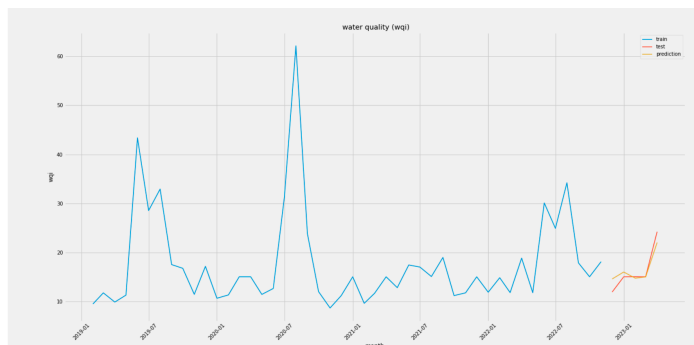


Figure 3: Water quality prediction of one station. The data used to train the AI approach are depicted in blue. The generated predictions are in orange. And the testing data used to evaluate the effectiveness of the prediction are in red.

To effectively communicate water quality results to diverse audiences, we proposed the development of dashboards featuring two distinct views tailored to different user needs. The public-facing interface would present a simplified overview using clear colour codes to indicate overall water health. This intuitive visual system, based on a universal Water Quality Index (WQI), categorises water quality into five easy-to-interpret levels and clusters monitoring stations within the Adour-Garonne region (Figure

2). This allows users to quickly compare stations across a medium geographic area and easily identify zones where water quality raises attention. In parallel, the expert view would provide technicians and researchers with access to predictive models (Figure 3). These models enable short-term forecasts of water quality (WQI) for each station over the coming months, helping to anticipate trends such as seasonal pollution spikes or drought impacts. By combining accessible public information with in-depth expert tools, this dashboard aims to enhance transparency, support informed decision-making, and foster collaborative water management across stakeholders.

3 The "Training-Research-Professionalisation" Triptych in Practice

3.1 Research-Informed Training:

Our approach emphasised the professionalisation of students by involving them directly in ongoing research projects, ensuring they develop both technical skills and practical expertise. This section introduces how students were embedded within our research framework, offering a unique opportunity to contribute meaningfully to water quality assessment and management.

Two master's interns and two professional bachelor's degree students were actively involved in data analysis and evaluation of P-gp-based protocols, contributing directly to the collection and processing of biological samples. These students participated in multiple stages of the project: those collecting samples coordinate with local fishing associations and GEMAPI technicians to identify optimal locations and times for sampling. They received specialised training to collect cells from fish and subsequently perform P-gp analyses in the laboratory. Continuous dialogue with GEMAPI technicians informed the selection of analytical techniques, monitoring stations, and the validation of result, distinguishing polluted streams from cleaner ones, for example.

Additionally, students specialising in water quality from the professional bachelor's degree in water management at Mauriac, conducted several chemical analyses of water samples. Researchers of UMRF engaged these students by presenting comparative insights between traditional chemical assessment methods and biomarker-based analyses. The results of their chemical measurements were compared with data on P-gp expression levels observed in living organisms, thereby enriching the students understanding of complementary approaches to water quality evaluation. Further, students from professional bachelor's degrees in data science assisted with data quality control, data repair, and the development of AI tools, working under the close supervision of researchers.

Beyond laboratory work, students collaborated with researchers to engage in scientific mediation activities, communicating project goals and tools to citizens and elected officials within CCSA. This immersive approach ensured that students not only gained technical skills but also developed the ability to translate scientific knowledge into accessible information, fostering professionalisation and community involvement.

3.2 Training for Professional Relevance

Our project is being integrated into academic curricula and student internships, thereby reinforcing the connection between academic learning and societal application. As part of this effort, master's students from the Biomedical Diagnostics program at Clermont Auvergne University contributed to the project, developing expertise in laboratory techniques and AI-based data analysis. This experience enabled students to develop technical skills (laboratory techniques, data analysis using AI tools) and interpersonal skills (scientific communication, stakeholder engagement, communication with GEMAPI, water agencies).

The master's degree in biomedical Diagnostics (DiaMed), unique in France, is based on skills in biotechnology and health. It provides both fundamental and technological training with a focus on bioanalysis and diagnostics applied to medical biology. The aim of this program is to train engineering-level professionals specialising in the field of bioanalysis and diagnostics in medical biology. The integration of an environmental theme into biomedical training opens students' minds to the "One

Health” approach. This concept consists of the existence of a strong interconnection between plant, animal, and human health, including environmental disturbances generated by human activity. The aim of taking this into account is to reduce potential emerging threats at the human/animal/environment interface, while protecting biodiversity.

AI can strengthen the One Health concept by linking human, animal, and environmental health. It enables early monitoring of diseases and pollution, as well as risk prediction for zoonoses, vector-borne threats, and climate impacts. AI also optimises research and bioassays by reducing reliance on animal testing and accelerating data analysis. This collaboration between biologists and computer scientists led to the development of new processes for predicting water quality. The initial results of the project were integrated into the academic program, ensuring that professionalisation is not treated as an abstract objective but as a lived experience. In line with the triptych of Training, Research, and Professionalisation, AI algorithms developed in the project are included as case studies in courses. Students are introduced to data quality control, and predictive modelling by working with actual datasets from the Adour-Garonne water agency. In this way, students become active actors to both scientific progress and societal needs.

3.3 From Formal Education to Continuous Professional Development

Learning about water quality should not only end with the completion of a university degree; rather, it must be viewed as a lifelong process that evolves in parallel with scientific discoveries, technological innovation, and environmental realities (Billett, 2010). As climate change, pollution sources, and regulatory frameworks continue to shift, the knowledge and skills required to monitor and manage water resources must also adapt. Professionals working in the field, municipal staff, educators, or elected officials, are increasingly confronted with new challenges such as emerging contaminants, ecological degradation, and complex data systems. To respond effectively, they must have ongoing access to updated scientific knowledge, new monitoring tools, and evolving best practices. Ensuring that learning remains continuous and accessible is essential not only for professional development but also for the long-term sustainability and resilience of water resource management.

To support this, we propose the development of short, certified training modules designed specifically for professionals already working in water management. These modules would include topics such as “Refresher Course on Emerging Contaminants” or “Introduction to Artificial Intelligence for Environmental Monitoring”. Delivered collaboratively by universities and local authorities, these courses would equip technicians, municipal staff, and educators with up-to-date knowledge and practical skills, such as sample collection techniques and the use of simplified AI dashboards. Additionally, we propose an AI-focused course tailored for elected officials whose objectives are to demystify AI and to teach them how to use AI tools for data management, note-taking, meeting summaries, and contract drafting, while addressing key topics such as AI safety, risk awareness, and ethics. The use of certification or micro-credentialing options would formally recognise the expertise gained through these trainings, motivating participation and validating skills within the professional community. To sustain ongoing engagement, digital learning platforms like Moodle, MOOCs, provide flexible access to educational resources and promote peer-to-peer exchange. This holistic approach ensures that all stakeholders involved in water management are continuously empowered to meet emerging environmental challenges with confidence and competence.

4 A Participatory Model: Associating Research with Students and the Community

4.1 Involving Local Stakeholders as Research Partners:

Engaging local stakeholders as active partners in water quality research is essential for ensuring that scientific efforts remain grounded in real-world concerns and community needs (Bonney et al., 2009). In our project, we initiated collaborations with a diverse group of local actors, including the CCSA, local high schools and vocational programs, (second- and third-years students of professional bachelor's degrees in water, biology and computer science, master's degree in biomedical Diagnostics), local

fishing clubs, and interested citizens. Introducing the project through open discussions and laboratory visits helped establish mutual trust and a shared understanding of the environmental and social challenges involved.

We then employed a variety of strategies to make this mutual trust a reality while ensuring public understanding and scientific mediation throughout the project. Second- and third-years students were involved over a two-year period, contributing to sample collection. GEMAPI technicians were involved in selecting the rivers and monitoring stations where water samples were collected. Field visits and workshops were held in local rural villages such as Hyde and Mauriac (Cantal region), as well as in urban centers like Aurillac (Cantal region) and Aubière (Puy de Dôme region). We organised dedicated feedback sessions to share progress and results with students, elected officials, and members of the local community. These interactive exchanges enabled stakeholders to gain a clearer understanding of the methodologies involving biomarkers and artificial intelligence, and to see how the findings relate directly to their local environment and practices. A key objective was to explain how biomarker-based approaches can be used to assess stress in aquatic organisms, drawing parallels to human health and environmental quality. We finally developed protocols in a collaborative manner with local stakeholders, students and their teachers to collect samples for analysis in our laboratories.

4.2 Designing the Participatory Approach

To integrate local knowledge and foster a sense of shared responsibility, a citizen science initiative should begin with a structured volunteer training program. We began to organise short workshops for interested citizens, local school groups or fishing federations. More sessions would provide practical skills in basic water monitoring techniques, such as observing water clarity, detecting algal blooms, identifying the presence of foam or odors, and noting changes in river flow. In addition, fishing federations could be specifically trained on how to collect trout samples safely, contributing to biomarker-based analyses carried out in collaboration with researchers. To reinforce participant engagement, these sessions could be accompanied by the delivery of micro-credentials in the form of certificates or Open Badges (see: [Université Clermont Auvergne Open Badges](#)). Open Badges make visible the competencies acquired during experiences, projects, or voluntary commitments, in parallel with formal academic training.

Another key element of the participatory approach lies in establishing a transparent and systematic feedback loop. Data collected by citizens should not only be processed and validated by researchers but also synthesised into clear and accessible outputs. These results must then be communicated back to participants through user-friendly formats, such as simplified reports or Web dashboards. To reinforce this exchange, specific public events could be hosted in local community centers or schools, where researchers present results in simplified form using metaphors (for instance, comparing stress in trout to a human immune response under pollution). In addition, these events would allow volunteers to ask questions, contribute local knowledge, and co-interpret the results alongside experts. By showing explicitly how citizen observations contribute to scientific analyses and influence decision-making, the initiative fosters trust, strengthens mutual understanding. This reciprocal process would also encourage participation, as volunteers can clearly perceive the impact of their contributions on real research outcomes and on the collective understanding of water quality.

To further strengthen the exchange process with local stakeholders and volunteers, we propose the creation of a ‘Water Observatory Committee’ composed of representatives from each stakeholder group. This committee would meet regularly to discuss ongoing research, co-analyse results, and collectively shape future investigations. Particular attention should be given to the inclusion of agricultural associations, whose members play a central role in practices directly influencing water quality. The primary purpose of the committee is not to assign blame or deliver prescriptive lessons, but rather to cultivate dialogue, shared responsibility, and the co-construction of solutions that are both equitable and sustainable. In this way, the committee would act as a cornerstone of local participatory governance, ensuring that scientific knowledge, professional expertise, and local experience are brought together in the service of water resource protection.

5 Conclusion

This paper illustrates how innovative technical methodologies, here biomarkers and explainable AI for evaluating and predicting water quality, can be mobilised not only for scientific advancement but also as tools for training, professionalisation, scientific mediation, and public engagement. By embedding students, associations, and GEMAPI technicians in real-world research, we have shown that the triptych of Training, Research, and Professionalisation is more than a theoretical model, it creates tangible synergies that strengthen both science and society.

Future directions should include the consolidation of a lifelong learning framework, where local technicians, elected officials, and citizens can continuously update their knowledge and skills in parallel with scientific progress. Modularising technical methodologies so they can be adapted to different user profiles, ranging from students to municipal water agencies, will be key to ensuring both accessibility and impact. The participatory model initiated in this study has shown that citizen science can provide a meaningful contribution to monitoring local rivers, whether through volunteer training workshops or collaborative interpretation sessions. The proposed Water Observatory Committee would institutionalise this exchange, ensuring that scientific, professional, and local knowledge are continuously brought together in the search for fair and sustainable solutions. In addition, we recommend expanding this concept to other federations of municipalities. Some actions have already been initiated with Brioude (<https://www.brioudesudauvergne.fr/>) and Ambert Livradois Forez (<https://www.ambertlivradoisforez.fr/>). Events such as the “Université Foraine” (<https://iut.uca.fr/universite-foraine/presentation-de-luniversite-foraine>), a mobile, place-based University model, have already shown promise in creating spaces for participatory science involving elected officials, territorial agents, and researchers. A standing committee and more frequent participatory workshops would further anchor research within the lived experience of local communities, making science more explainable, transparent, and ultimately actionable.

References:

- OECD, 2020, Organisation for Economic Co-operation and Development (OECD). (2020). Implementing the OECD principles on water governance: Indicator framework and evolving practices. Paris: OECD Publishing.
- Brown et al., 2009, Van de Meene, S. J., Brown, R. R., & Farrelly, M. (2009). Exploring sustainable urban water governance: A case study of institutional capacity. *Water Science and Technology*, 59(10), 1921–1928.
- Karasani et al. (2023), Karasani M., Latinopoulos, D., Ioannidou, N., Spiliotis, M., & Kagalou, I. Bridging the Gap between Science and Policy: A Prerequisite for Effective Water Governance. *Environmental Sciences Proceedings*, 25(1), 12. <https://doi.org/10.3390/ECWS-7-14241>
- Healey et al., 2009, Healey, M., & Jenkins, A. (2009). Developing undergraduate research and inquiry. York: Higher Education Academy.
- Etzkowitz et al. 2000, Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109–123, [https://doi.org/10.1016/S0048-7333\(99\)00055-4](https://doi.org/10.1016/S0048-7333(99)00055-4).
- Bonney, R., et al. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, 59(11), 977–984.
- Billett, S. (2010). Lifelong learning and self: work, subjectivity and learning. *Studies in Continuing Education*, 32(1), 1–16. <https://doi.org/10.1080/01580370903534223>
- Doshi-Velez et al., 2017, Doshi-Velez, F., & Kim, B. (2017). *Towards a rigorous science of interpretable machine learning*. arXiv:1702.08608.
- Silva, V. L. S., Heaney, C. E. & Pain, C. C. (2021). GAN for time series prediction, data assimilation and uncertainty quantification. *CoRR*, abs/2105.13859.
- Jouseau et al., 2024, Roxane Jouseau, Sébastien Salva, Chafik Samir, A Novel Metric for Measuring Data Quality in Classification Applications. *ICAART (3) 2024*: 141-148
- Bamdad M. ; Valton E. & Amblard C (09 décembre 2011) Biomarqueurs moléculaires sentinelles. Patent Sentinelle UCA n° FR2983871.

Bamdad M., Daumar P., Depresle M., Goisnard A. & Mounetou E. Guardian Patent Clermont Auvergne University/INSERM – N° FR2414029.

Daumar P.; Goisnard A, Dubois C, Roux M, Depresle M, Penault-Llorca F, Bamdad M, Mounetou E. Chemical biology fluorescent tools for in vitro investigation of the multidrug resistant P-glycoprotein (P-gp) expression in tumor cells RSC Adv. 2023 Sep 8;13(39):27016-27035. doi: 10.1039/d3ra05093a. eCollection 2023 Sep 8. PMID: 37693089.

Valton E.; Amblard, C.; Wawrzyniak I.; Penault-Llorca F. & Bamdad M. P-gp Expression in Brown Trout Erythrocytes: Evidence of a Detoxification Mechanism in Fish Erythrocytes. Sci Rep 2013, 3, 3422, doi:10.1038/srep03422.

Valton E., Amblard C., Desmolles F., Combourieu B., Penault-Llorca F. & Bamdad M. Mini-P-gp and P-gp Co-Expression in Brown Trout Erythrocytes : A Prospective Blood Biomarker of Aquatic Pollution. Diagnostics (Basel). 2015 Jan 12;5(1):10-26. doi: 10.3390/diagnostics5010010. PMID: 26854141.

Valton E.; Wawrzyniak I.; Amblard C.; Combourieu B.; Bayle M.-L.; Desmolles F.; Kwiatkowski F.; Penault-Llorca F. & Bamdad, M. P-gp Expression Levels in the Erythrocytes of Brown Trout: A New Tool for Aquatic Sentinel Biomarker Development. Biomarkers 2017, 22, 566–574, doi:10.1080/1354750X.2017.1338314.