

French Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes one of the PhD subjects proposed by the French Polytech network. The network is composed of engineering schools/universities. The document also provides information about the supervisor.

Supervisor information	
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Country	France

PhD information	
Title	Optimization, unification, and multifunctional enhancement of operational water resource management Decision Support Systems (DSS) AquAzur in Mediterranean-Alpine watersheds (FRANCE).
Main topics regards to CSC list (3 topics at maximum)	V- 9 Hydrology and continued use of resources of the ground and water V-15 Formation and forecast of serious natural disasters

Required skills in science and engineering	Advanced Hydrological and Hydraulic Modeling – experiencedeterministic numerical models for water resource management, flood risk assessment, and hydrogeological applications. IT and Software Development – Strong programming skills (Python, R, or similar)including interest with optimisation technics. Data Integration and Remote Sensing.
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Subject description (two pages maximum including biblio)

This PhD thesis focuses on Mediterranean-Alpine basins (the Var, the Cagne, and the Paillon) which are highly exposed to extreme hydrological events (flash-flood, drought) and highly antropized in their downstream area. In this research, building on existing models developed during previous Ph.D and operational since 2019 at the water utility Régie Eau d'Azur [1](namely Aquavar [2,3] , AquaCagne [4], AquaPaillon[5]) and capitalizing on two ongoing PhD research on non-conventional water reuse in the Var Valley, the thesis aims to optimize and unify modeling approaches within the AquaAzur project co-lead by the University Côte d'Azur, Eau d'Azur and the Metropolitan services of Nice city, France. On top of the different hydrological, hydraulic and hydrogeological models included in the AquaAzur DSS, a recent study, has developed an ontology (in OWL language) that catalogs (i) the water resource management issues, (ii) hydroinformatics models, and (iii) available open-source datasets. This ontology will serve as a first draft for the unification strategy roadmap, providing a structured foundation for the research. The first year of the thesis will focus on refining this strategy while ramping up with the numerical modelling tools in the water sector (IBER[6] , Mike SHE, SWAT, Mike +, etc.). The research will collaborate with IWHR (China Institute of Water Resources and Hydropower Research -Prof. Qiang Ma) to test the replicability of the unified approach on larger basins notably during the second year. Additionally, collaborations with Wuhan University (State Key Laboratory of Water Resources Engineering and Management – Prof. Dedi Liu) is planned to address energy and carbon footprint assessments related to water management operations during the third year of the Ph.D in line with the Franco-chinese research axis priority (<https://cnc-fr-cn.com/>).

Research Objectives

1. Optimization and unification of existing modeling approaches (year 1 and 2). The first objective is to optimize and unify the current modeling approaches within AquaAzur, integrating AquaVar, AquaCagne, AquaPaillon, and the two ongoing PhDs focusing on non-conventional water reuse in the Var Valley. This unification will involve: comparative testing with alternative modeling approaches developed by IWHR in China; or with IBER or other approaches. Adoption of modern computational tools to enhance performance and scalability. Research question: How can existing hydrological and hydraulic models be unified into a cohesive framework while preserving their individual strengths and ensuring scalability?
2. Integration of recently developed functionalities (year 1 and 2).The second objective is to capitalize on and integrate recently developed functionalities, such as: remote sensing data integration for

enhanced spatial and temporal resolution; modeling the impacts of non-conventional water use strategies, including treated wastewater reuse and de-impermeabilization; hydrogeomorphological evolution modeling, including the characterization of debris flow risks in the upper parts of the basins; coupling of IBER models with SWMM models, at least locally, using the recently developed IBER-SWIM coupling tool to enhance model integration and functionality.

Research question: How can newly developed functionalities (e.g., remote sensing data inclusion, non-conventional water reuse, hydrogeomorphology) be effectively integrated into a unified DSS to address multifaceted water management challenges?

3. Testing functionalities at multiple spatio-temporal scales (Year 2- 3)

The third objective is to : add, test, and catalog a range of functionalities across different spatial and temporal scales, with a primary focus on the Var basin lower valley which concentrate high stakes. These functionalities include: Flood risk prevention (including full valley or sub parts of the valley); Water resource management, integrating surface hydrology and groundwater (hydrogeology); Operational resource exploitation, with a focus on energy and carbon footprint assessments based on operational guidelines, in collaboration with Wuhan University.

For this multifunctional aspect, the thesis will propose nested modeling scales or, at minimum, catalog, list, and interrelate all modeling strategies to ensure coherence and scalability.

Research question: How can a unified DSS be tested and validated across multiple scales to ensure its applicability for flood risk prevention, water resource management, and operational efficiency, including energy and carbon footprint considerations?

This exciting research will contribute to a unified, adaptable, and multifunctional DSS, capable of addressing the complex water management challenges of Mediterranean-Alpine basins while providing actionable insights for operators and policymakers.

REFERENCES

- [1] Picoulat, F., Ler, L. G., Targosz, J., Game, P., Amaou Tallé, H., Abily, M., & Billaud, F. (2025). AquaVar decision support system for water resource management: Lessons learned from the first five years of operation. *River*, 4(1), 44-54.
- [2] Ma, Q., & Gourbesville, P. (2022). Integrated water resources management: A new strategy for DSS development and implementation. *River*, 1(2), 189-206.
- [3] Ma, Q. (2018). *Deterministic hydrological modelling for real time decision support systems: Application to the Var catchment, France* (Doctoral dissertation, COMUE Université Côte d'Azur (2015-2019)).
- [4] Wang, M. (2023). *Hydrological and hydraulic modelling of for Cagne catchment for a new decision support system within the AquaVar framework* (Doctoral dissertation, Université Côte d'Azur).
- [5] Game, P., Wang, M., Audra, P., & Gourbesville, P. (2023, January). Challenges & solutions for deterministic hydraulic modelling in Mediterranean coastal catchment. Application to the lower Paillons River, Nice, France. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1136, No. 1, p. 012026). IOP Publishing.
- [6] García-Feal, O., González-Cao, J., Gómez-Gesteira, M., Cea, L., Domínguez, J. M., & Formella, A. (2018). An accelerated tool for flood modelling based on Iber. *Water*, 10(10), 1459.