inventWater

ESR Project 2
Machine learning methods integrating climate and water monitoring data to support modelling future water quality in lakes and reservoirs over decades

Host institution: Ruhr-Universitaet Bochum (RUB), Bochum, Germany.

Supervisor: Prof. Martina Floerke, Ruhr-Universitaet Bochum, Bochum, Germany

Co-Supervisor: Dr. Karsten Rinke, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany

The ESR will be enrolled in the 3-year PhD program of Ruhr-Universitaet Bochum, Bochum, Germany.

Project description

This project will integrate new machine learning tools to climate, water monitoring, and recent modelling results on both river and lake / reservoir water quality, vastly improving the confidence of modelling results and enabling to develop robust scenarios over decades. Future water quality in lakes and reservoirs faces multiple challenges: 1) developing countries are expecting increasing nutrient loads while lakes in developed countries that were supposedly recovering are seeing re-eutrophication (e.g., Lake Erie), 2) large scale models currently do not take into account the effects of extreme weather, seasonal changes or simplify across pluri-annual time scales, 3) future reservoir construction has the potential to impact even more severely downstream river loads. Machine Learning with emerging tools such as deep learning with convolutional neural networks are geared towards image recognition tasks and can extract features. Object recognition and automatic classification of water quality indicators result in vastly faster development of lake and reservoir water quality products, and pattern recognition can help to link eutrophication with weather events. The combination of techniques will greatly improve the robustness of modelling approaches, as the underlying database will be enhanced by several magnitudes. This in turn will reduce uncertainties when integrating and developing new scenarios.

Expected Results:

1. Integrate state-of-the-art river water quality modelling at large scales (World Water Quality Alliance and GlobeWQ projects) with specific lake or reservoir modelling approaches taking into account nutrient speciation and transformation processes

2. Develop lake and reservoir water quality products using new algorithms applied on existing satellite imagery and automated cluster recognition using machine learning techniques. In particular, convolutional neural networks that are geared towards image tasks.

3. Implement results and combine to climate scenarios (ISIMIP) as well as other scenario developments and assumptions as part of other ESRs.

Host laboratory

Ruhr-University Bochum (RUB) was founded in 1965 and is considered as one of the leading future universities in Europe, having 43,000 students and 5,700 scientific, technical and administrative staff members. Nearly all branches of study are offered. With two Excellence Clusters, the RUB is a highly renowned and internationally visible research institution. The Faculty of Civil and Environmental Engineering implements 20 professorships covering a broad spectrum of civil and environmental engineering. The main research focus of the institute Engineering Hydrology and Water Resources Management is on integrated large-scale/global-scale modelling of water resources quantity and quality and how to include small-scale processes and the analysis and evaluation of global change impacts by applying qualitative scenario development methodologies together with quantitative modelling and indicator development.

Old industrial facilities and green parks – Bochum is a city undergoing significant changes. If you keep an open mind, you'll recognise its charm and learn to appreciate the honesty of its inhabitants. Bochum is situated in the urbanised Ruhr region, a former industrial powerhouse and now one of Europe's capitals of culture.

Secondments

This project is carried out in strong collaboration with the following groups, and visits to their laboratories is expected during the project. A willingness to travel and spend time abroad is therefore essential:

- AU (Dennis Trolle), 2 months (Months 10-11) – screening of available water quality models;

- UFZ (Karsten Rinke), 3 months (Months 22-24) – connect lake / reservoir water quality process knowledge to newly available products from remote sensing and machine learning;

- WU (Maryna Strokal), 3 months (Months 29-31) – connection between future trends in pollutant flows, scenarios for lake water quality indicators and management / policy options

Specific requirements

- The candidate must hold a Master's degree from or equivalent to a Master degree awarded in the European Higher Education Area.

- Master's degree must be in Civil or Environmental Engineering, Environmental Sciences, Hydrology, Geography, Ecology, or similar.

- Technical Skills required: Good skills in typical scientific programming languages (e.g., Python, R, C++ etc.), database systems (MySQL) and Geographical Information Systems (GIS). Willingness to face complex modelling problems. Ability with models, mathematics and statistics are essential. Basic knowledge about ecological processes affecting water quality in lakes and rivers. Knowledge in Machine Learning and Artificial Intelligence methods is a strong plus.

- Proficiency in the English language is required, as well as good communication skills, both oral and written. Applicants from non-Anglophone countries or for those that have not completed their higher education with English as the language of instruction must include an English certificate in the application package (e.g. IELTS, TOEFL, Cambridge English). Basic knowledge in German is a plus.

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HOW TO APPLY

Download the application form from this link: http://u.pc.cd/LP8ctalK and fill it. The application form, together with an official copy of degree(s) (if applicable, an official English translation), course transcripts (if applicable, an official English translation), and English proficiency test results cited in the form, must be sent as a **SINGLE** pdf in a **SINGLE** email to *inventWater-jobs@icra.cat.*

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For additional information on this project, please contact Prof. Martina Floerke (martina.floerke@hydrology.ruhr-uni-bochum.de) or Dr. Hans Duerr (hans.duerr@hydrology.ruhr-uni-bochum.de)