



**Marburg  
University**

## RESEARCH SEMINAR

# *Distributional Regression for Improved Risk Assessment of Water Quality and Environmental Hazards*

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#### **Abstract:**


Environmental and public health risks are often driven not by average conditions, but by rare and extreme events — such as toxin peaks in drinking water, harmful algal blooms, or pollutant exceedances. Yet most statistical and machine learning approaches remain centered on modelling mean responses, treating variability and extremes as noise rather than as key signals. This mean-centric perspective limits our ability to quantify and predict high-impact events that are critical for water quality management and One Health (the health of people, animals, and ecosystems).

Focusing on aquatic systems, this talk demonstrates how distributional regression reveals hidden risk patterns in water quality data. Analyses of thousands of US lakes show that eutrophication and warming not only increase average concentrations of cyanobacterial toxins such as microcystin, but more strongly elevate the probability and severity of extreme toxin events, posing substantial risks to drinking water safety. In parallel, new remote sensing approaches for chlorophyll-a estimation illustrate how distributional modelling enables spatially explicit uncertainty quantification and probabilistic assessments of threshold exceedances, improving the monitoring of harmful algal blooms and water quality in coastal systems.

These examples highlight a broader shift in environmental modelling — from predicting average states to quantifying risks. By capturing how environmental drivers shape entire distributions, distributional regression provides a powerful framework for understanding variability, extremes, and their implications for One Health under global change.

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