May 7th, 2021

Dr. Damià Barceló, Dr. Jay Gan, Dr. Philip Hopke

Co-Editors-in-Chief

Science of the Total Environment

We are pleased to submit our manuscript, “Multi-scale trend analysis of water quality using error propagation of generalized additive models” to be considered as an original research paper in Science of the Total Environment.

Our manuscript presents a novel application of generalized additive models (GAMs) to describe seasonal and multi-decadal changes in monitoring data, using the USGS San Francisco Bay water quality data as a case study. Conclusions from trend analyses are often used to inform management decisions that can affect long-term quality of environmental resources. Many environmental monitoring programs collect temporally resolved but irregular time series data to quantify these trends. Mismatches between the scales of monitoring and analysis or management questions presents statistical challenge. Existing methods (e.g., non-parametric trend tests, time series decomposition) may not accurately describe these trends, particularly as it relates to the propagation of uncertainty from incomplete data and estimates from trend analysis models. Our proposed methods estimate seasonal averages in a response variable with GAMs and then use the uncertainty measures with mixed-effects meta-analysis regression to quantify inter-annual trends that account for full propagation of error across methods. By doing so, more accurate trend assessments are obtained.

Our approach has broad appeal because the problems it addresses are not unique to our examples and we provide a supplemental software package for others to apply our developed techniques. For example, the COVID19 pandemic created challenges for many monitoring agencies due to the logistics of sampling to ensure the safety of laboratory and field personnel. As a result, data gaps during 2020 due to missed sampling events as agencies adapted to new safety protocols are now common features of many long-term datasets. The analysis methods we provide in our manuscript can accommodate data gaps in trend assessment by providing an accurate estimate of uncertainty from missing data, while still allowing a comparison of inter-annual trends between years with complete data. This will have value by ensuring that trends can still be accurately assessed when comparing data at the height of the pandemic in 2020 with previous or future years.

We are confident that readers of Science of the Total Environment will find this manuscript informative and appreciate the opportunity to publish our work in this venue.

Sincerely,



Dr. Marcus W. Beck

Program Scientist

Tampa Bay Estuary Program