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Open Source Development of Exploration and Graphics for RivEr Trends (EGRET): An R-package for the analysis of long-term changes in water quality and streamflow, including the water-quality method Weighted Regressions on Time, Discharge, and Season

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The development of an R package: Exploration and Graphics for River Trends (EGRET) is discussed. R is a free programming language developed for statistical computing and graphics. The development of this package was done using gitHub, allowing for easy collaboration between colleagues. The EGRET package includes 3 major features. The first is simplifying the methods for obtaining water quality, streamflow, and metadata. A large collection of United States river data is available through web services from the U.S. Geological Survey (USGS) National Water Information System (NWIS). Functions for importing data from the NWIS system were included in a supplement to the EGRET package: dataRetrieval. There are also functions for importing data encoded in WaterML, WaterML2 (an Open Geospatial Consortium standard), and WQX (a water quality standard developed by the USGS and United States Environmental Protection Agency (US EPA)). These functions can therefore be used to easily obtain data from outside the USGS system. The second major feature of EGRET is to perform model calculations to compute concentration, fluxes, and flow-normalized versions of those using weighted regressions on time, discharge, and season (WRTDS). The unique feature of WRTDS as compared to other regression models is that the coefficients of the explanatory variables can change over time. This is a more accurate representation of ever-changing environments, either due to land-use changes, climate changes, or any number of extenuating circumstances. Additionally, EGRET includes statistics and graphics to help evaluate whether the flux estimates may be biased, a known issue in some regression-based methods. Finally, EGRET includes many plotting functions to evaluate both measured data and model output. Used with default arguments, these functions create clean, informative graphics. They also allow users to customize the graphics for individual projects. Using EGRET and dataRetrieval, water quality trends can be studied. The open source development, and use of international standardized data formats, allows EGRET to be used on an international, cross-border scale.