MacroGas Project

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Introduction

- Objective: to develop two **R Shiny Apps** for data analysis by stream ecologists.
- Enable researchers to more efficiently **clean, visualize, perform quality control**, and carry out **calculations** to better understand the chemistry of New Hope Creek.
- In conjunction, the apps allow for the evaluation of different channel characteristics and overall **limnology** that affect **riverine greenhouse gas (GHG) emissions.**

Deliverables

Salt Slug App:

- Designed for the study of NaCl conservative tracer injections (also known as salt slugs)
- Users can upload their data, perform quality assurance/quality control (QA/QC) functions, then calculate and download:
  - Stream discharge (Q)
  - Groundwater exchange (Q_n - Q_1)
  - Time to half height ($t_{1/2}$)

HydroGas App:

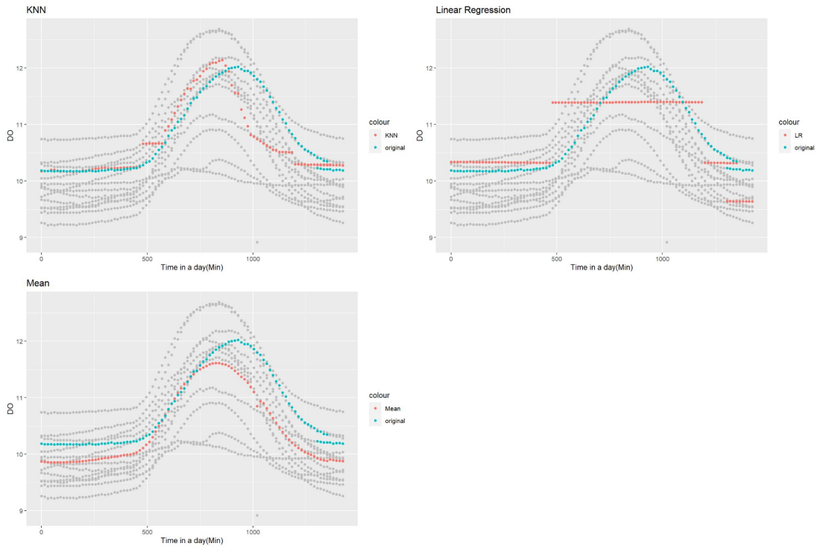
- The app uses modules to display as many variables as the user uploads, such as dissolved oxygen (DO), CO2, CH4, water temperature, conductivity, pressure, and salinity.
- Users can perform QA/QC, download melted data, and view DO and hypoxia metrics and visualizations.
- The app combines the latest, cleaned data with the existing dataset from the same location within Google Drive.

Imputation:

- Test different models to fill missing periods of data from equipment or other issues.

Imputation

We tested different models to predict the values of missing sensor data. Since the provided data from sensors was inadequate by itself for good predictions, we supplemented that data with weather data pulled from the Open Meteo API. Using K-Nearest Neighbors, Regression, and mean imputation, we showed that time of day and seasonality were the most significant predictors of dissolved oxygen. Additionally, we were able to create adequate estimates of missing data as shown below.



HydroGas App

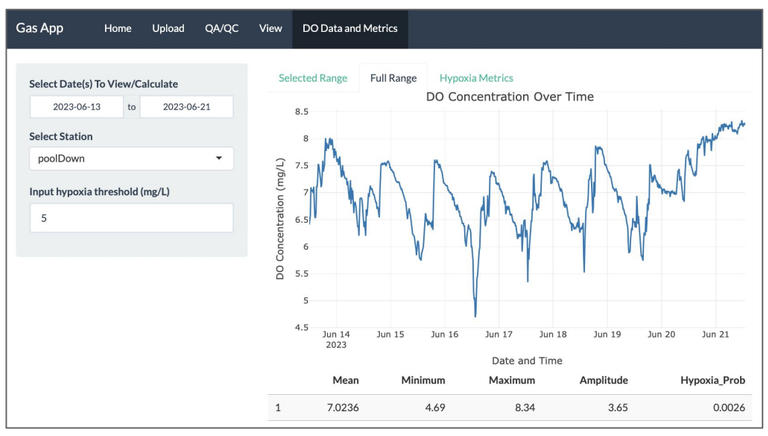
Background:

- **Hypoxia:** Hypoxia is a period of low oxygen in rivers, which endangers organisms and can increase riverine methane emissions.
- **Greenhouse Gas Emissions:** Streams emit GHGs, and this app can assist researchers' ability to understand fluxes between different dissolved GHGs such as CH4, CO2, and NO2 that vary across stream reaches and contribute to riverine emissions.

App Objectives:

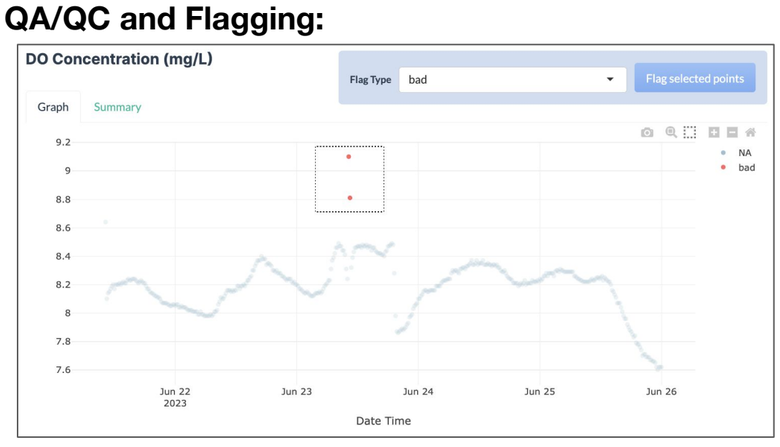
- To help stream ecologists easily view and analyze raw data collected from sensors for different variables, including DO and different GHGs.
- To calculate various DO and hypoxia metrics.

DO Metrics:

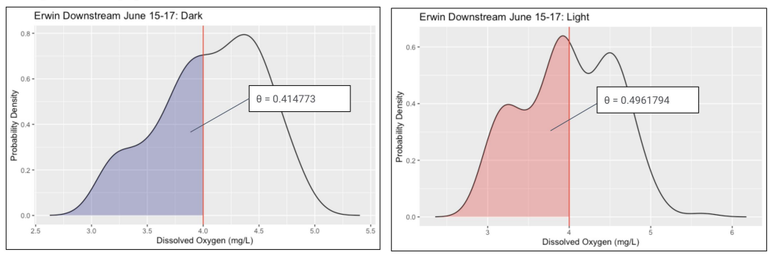


Displays mean, minimum, maximum, amplitude, and probability of hypoxia across selected range of data.

QA/QC and Flagging:



Night Hypoxia Ratio:



Displays probability estimates of different DO levels, as well as the probability of hypoxia at nighttime and daytime, and the ratio of the two.

QR Codes

HYDROGAS APP

http://bit.ly/3QaECcd

SALT SLUG APP

http://bit.ly/3O7TAwZ

Salt Slug App

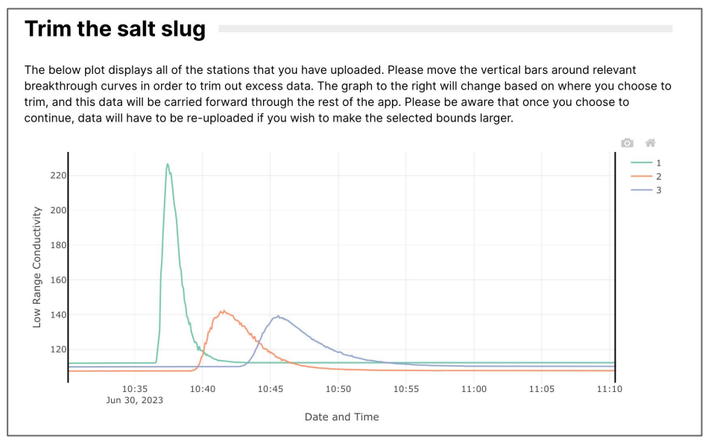
Background:

- A salt slug experiment is a method used to calculate the volume of water flowing through a stream.
  - Differences in discharge between upstream and downstream sensors in a salt slug are representative of gains and losses from groundwater interactions.
- These experiments improve researchers' understanding of hydrology and flow dynamics at different locations.

App Objectives:

- To help stream ecologists easily upload and analyze their salt slug data.
- To quickly and automatically calculates the discharge at each station and the overall groundwater exchange within one experiment.
- To calculate the time to half height, which can be used to find the flow rate.

Visualize/Trim Breakthrough Curves:



Calculate Page:

Conclusion

These apps serve as useful tools that streamline and enhance the data analysis process, including data visualization, trimming, interpretation, and even missing data imputation. With their user-friendly interface and powerful functions, they boost data analysis efficiency, contributing to the advancement of stream ecology research and environmental understanding.

References

Carter, A. M., Blaszczak, J. R., Heffernan, J. B., & Bernhardt, E. S. (2021). Hypoxia dynamics and spatial distribution in a low Gradient River. *Limnology and Oceanography*, *66*(6), 2251–2265. https://doi.org/10.1002/lno.11751

Covino, T., McGlynn, B., & Mallard, J. (2011). Stream-groundwater exchange and hydrologic turnover at the network scale. *Water Resources Research*, *47*(12). https://doi.org/10.1029/2011wr010942