Mass Balance of Nutrients (N &P) along St Johns River: Contributions of Urbanization and Agricultural Practices in the watershed

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Background

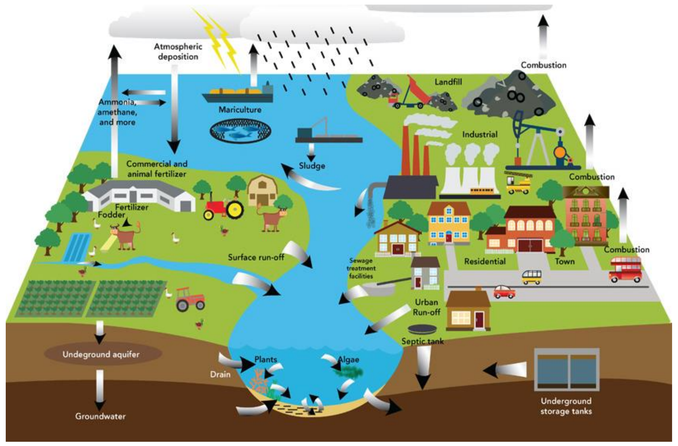


Figure 1: Sources of water pollutions and effects different practices have on water nutrient levels

- High levels of nutrients such as total nitrogen (N) and total phosphorus (P) in a watershed can lead to eutrophication, causing algal blooms that threaten the aquatic ecosystems and biodiversity of the St. Johns River.
- Nutrient polluted water can contaminate nearby bodies of water and affect activities. Typically, from urbanization and agricultural runoff, understanding the sources of nutrient input at various points along the St. Johns River is crucial in determining targeted policies and practices to conserve the watershed.
- This study investigates the temporal fluctuations of nitrogen and phosphorus in the St. Johns River watershed over 30 years to identify potential nutrient sources and driving factors.
- The St. Johns River is one of the longest rivers in Florida, stretching over 300 miles.
- It flows northward, providing crucial water resources for central and northeastern Florida.

Research Method

- Examined the United States Geological Survey (USGS) data monitoring locations along the St. Johns River. Selected six locations that contained data covering the entire needed date range and needed parameters for our study.
- Data from six U.S. Geological Survey (USGS) monitoring sites with comprehensive records were analysed, focusing on the key parameters: dissolved inorganic nitrogen (nitrate and nitrite as N), total Kjeldahl nitrogen, and total phosphate-phosphorus as P.
- Merged the USGS data with data gathered from similar locations from the Watershed information Network (WIN).
- At each site the data was separated by the given parameters; "Inorganic nitrogen (nitrate and nitrite) Dissolved", "Kjeldahl total nitrogen", “Total nitrogen” and "phosphate-phosphorus".
- Water quality change was analysed using Weighted Regression on Time, Discharge and Seasons (WRTDS; Eq. 1) to understand the gaps in the water quality time series and discharge variation.
  - Package: Exploration and Graphics for River Trends (EGRET) – a R package to facilitate the use of WRTDS method.

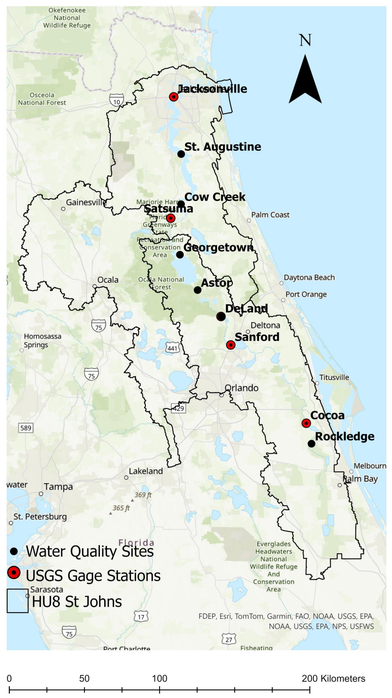
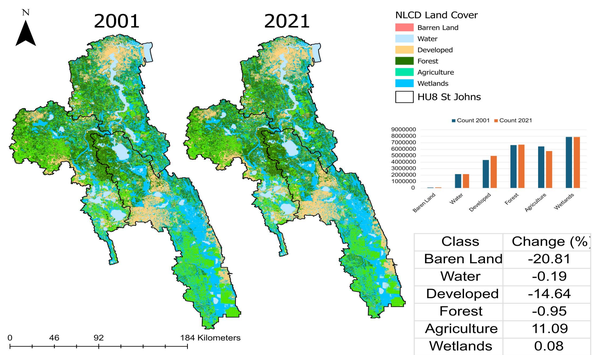


Figure 2: USGS Gauge Stations and Water Quality Data Extraction Sites



Class	Change (%
Baren Land	-20.81
Water	-0.19
Developed	-14.64
Forest	-0.95
Agriculture	11.09
Wetlands	0.08

Figure 3: Land Cover Changes in the watershed from 2001 and 2021

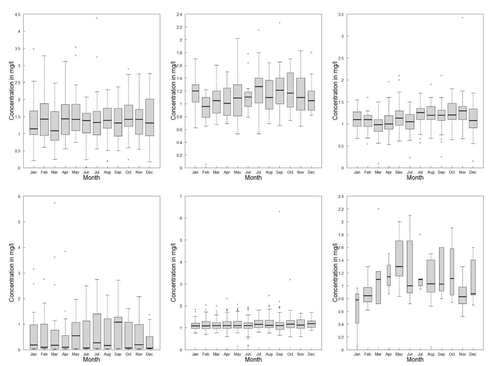


Figure 3: Monthly Total Kjeldahl nitrogen (TKN) concentration A. Rockledge, B. Sanford, C. Astor, D. Cow Creek, E. St. Augustine, F. Jacksonville.

Current Work and Next Steps

- Our results are in the middle stages of our research and ongoing as we have discovered a new obstacle recently.
- The St. Johns River is a unique waster shed. Unlike many other stream systems, its primary flow direction is from North to South, and it goes through periods of reverse flow, meaning the water flows backward from the Atlantic Ocean inwards. This can also create periods of stagnant discharge when the water flow in each direction equalizes.
- This phenomenon significantly alters our ability to measure the discharge and nutrient variance of the water near Jacksonville in the same way all other sites are analyzed.
- Monthly TKN Result shows Upstream has comparatively higher TKN than Downstream. Which indicates the dilution and tidal influences of the water quality in the St. Johns River.

Figure 5: Jacksonville Site Daily Stream Discharge and Rainfall from Jan 1998 and Nov 2024.

Future Research

- Investigating long-term trends in nutrient concentrations, load of contaminants, and other water quality parameters across different seasonal and hydrological conditions.
- Identify potential sources of pollutants (e.g., urban runoff, agricultural practices) using spatial and temporal analysis.
- Incorporating land use changes (agriculture, urbanization, etc.) and climate data into the model to predict how these factors contribute to nutrient contamination.
- Linking WRTDS output with ecological data to better understand how changes in water quality affect aquatic ecosystems and biodiversity in the St. Johns River basin.
- Inquire with policy agencies to gather insights and ensure the assessment is comprehensive and aligned with regulatory needs.
- Evaluate the WRTDS model and assess its validity using statistical metrics such as goodness of fit and residual analysis.
- Explore the mass balance of nutrients in similar watersheds using a similar approach.

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References