IOWA STATE UNIVERSITY
Civil, Construction and Environmental Engineering

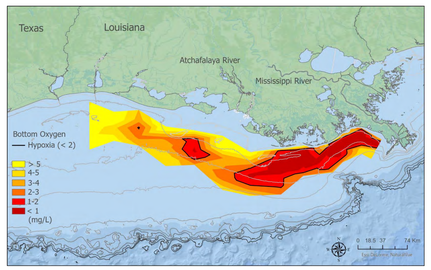
Revanth Mamidala[1], Lu Liu[1*].

1. Dept. of Civil, Construction and Environmental Engineering, Iowa State University.

Eco-Hydrological Modeling for Sustainable Drinking Water Protection in the Des Moines River Basin

Introduction

- Excessive nitrate concentrations in surface waters are threatening public water supplies.
- The United States Environmental Protection Agency (EPA) limits NO_3 - 10 mg/l, NO_2-1 mg/l and NH_3 - 0 mg/l.
- The Des Moines Water Works (DMWW) uses surface waters from Des Moines and Raccoon Rivers to supply more than 600,000 people in central Iowa with three treatment plants.
- The daily water samples at Van Meter on Raccoon River show that the Nitrates plus Nitrites concentrations exceed the EPA standards in 21% of the samples.



Gulf of Mexico - NOAA 2017

- Hypoxia in the Gulf of Mexico continues to expand, with the 2017 dead zone being the largest recorded (NOAA, 2017).
- In response to these, the states in the Mississippi basin are undertaking ambitious efforts to achieve a 40-45% reduction in nutrients.
- These water quality goals can be met by combining in-field management practices with downstream nutrient removal practices such as bioreactors and filter strips at the edges of fields.

Objectives

The objectives of the study are to:

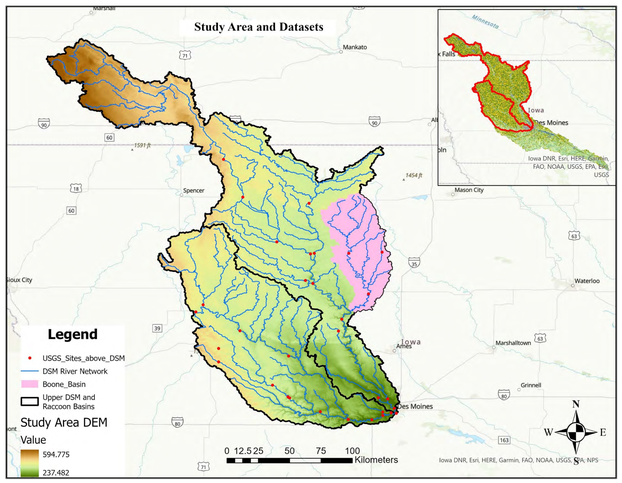
i. Construct an Eco-Hydrological model of the Des Moines River basin beyond the confluence of Raccoon River and simulate the model at daily timesteps from 1990 to 2023.

ii. Simulate the model for various land use and management practices with forecasted climate variables from CMIP6 for various RCP and SSP scenarios.

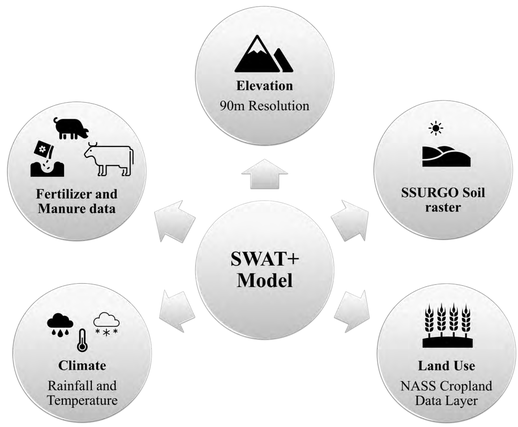
iii. Identify the nutrient hotspots and propose better management practices in these zones.

iv. Perform economic analysis for various scenarios in water treatment and supply.

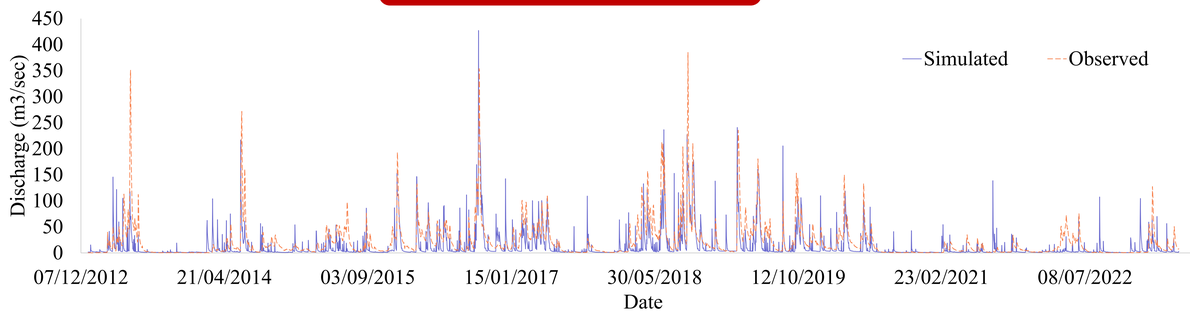
Study Area



Methods

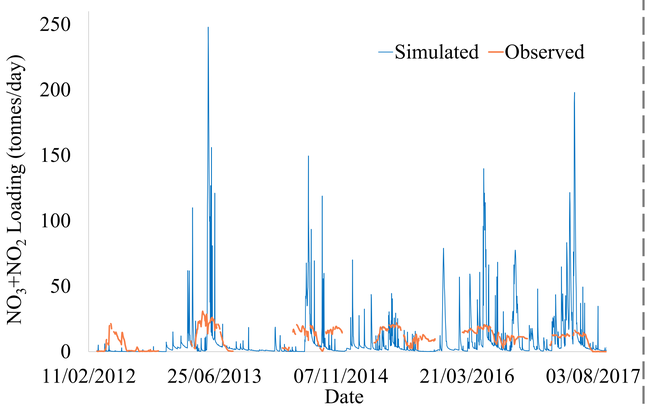


Preliminary Results

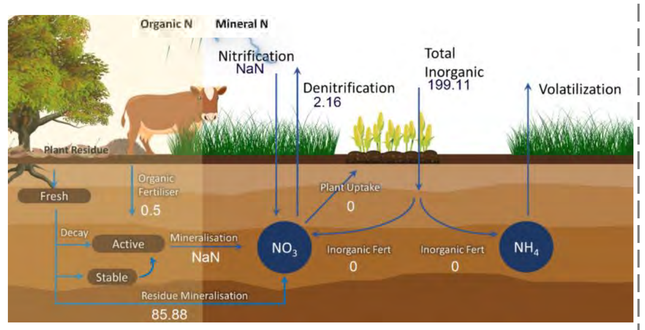


Daily flow Validation for Boone River Basin at USGS 5481000 observation site

Statistical Metric	Calibration	Validation
NSE	0.516	0.444
MSE	783.329	617.769
RMSE	27.988	24.855
Pbias	58.231	40.075
Time Period	1999-2012	2013-2023



NO_3+NO_2 Daily Loads at USGS 5481000



Nitrogen Cycle for Calibration Period 1999 - 2012

Discussions

- Surq_lag (2.8 days) and ESCO (0.3) parameters are sensitive parameters besides CN2.
- The current model overestimates the discharge values during low flows and underestimates the peak flows.
- The model is not simulating the plant uptake value for nutrients, which may cause heavy loading in the streams.
- USLE and AWC values are also not reflected in the output.

Future Steps

- The model is to be refined by introducing lakes and reservoirs.
- Crop rotation and management schedules are to be implemented along with fertilizer and manure application.
- Using the calibrated model, the Eco-Hydrology of the basin shall be forecasted for various land use and climate scenarios.
- Best management practices and treatment processes for different scenarios will be analyzed based on economic analysis.

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