Get a (Nutrient) Load of Lake Trafford!

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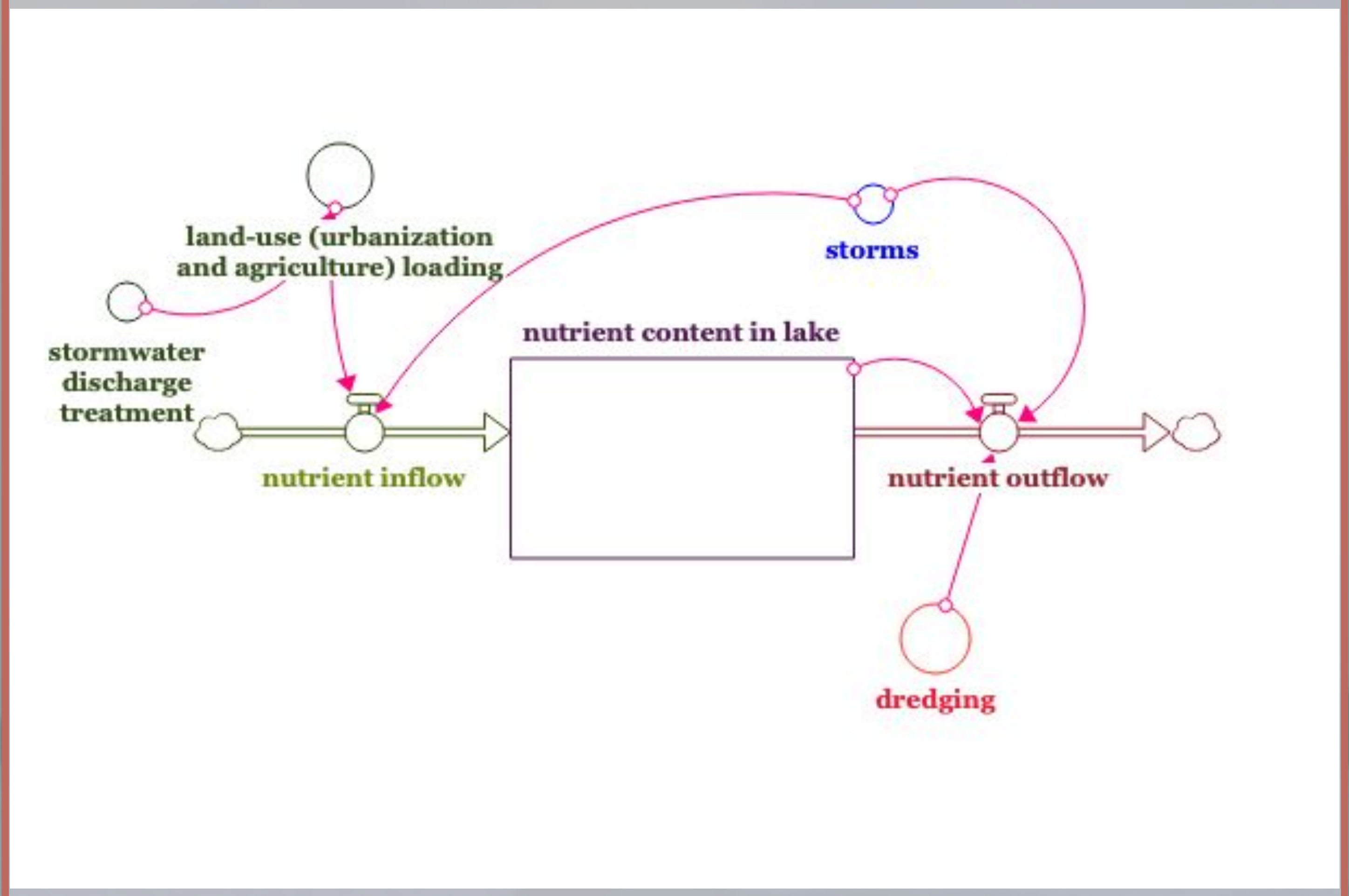
Simulation and Modeling Fall 2021

CONCEPTUAL MODEL



RESEARCH OBJECTIVE

The purpose of this model was to explore how land-use change (urbanization and agriculture), stormwater management, and lake restoration (dredging) would affect the nutrient loading of Lake Trafford.

MODELING APPROACH

My model has stochastic elements (storm events, dredging events) which were manipulated to simulate different scenarios.

Storm events were set at a probability of 10%, 25%, and 50%. Dredging would take place either every 10 years or once on years 10, 25, or 45 for experimental purposes.

Nutrient inflow was set to be 10% of the initial nutrient value of 3000kg. Nutrient outflow removed 90% of the nutrient stock when dredging occurred and 10% if a storm occurred.

The duration of this experiment was 50 years. Each manipulated variable went through 20 trials and I used the average of all trials for the results.

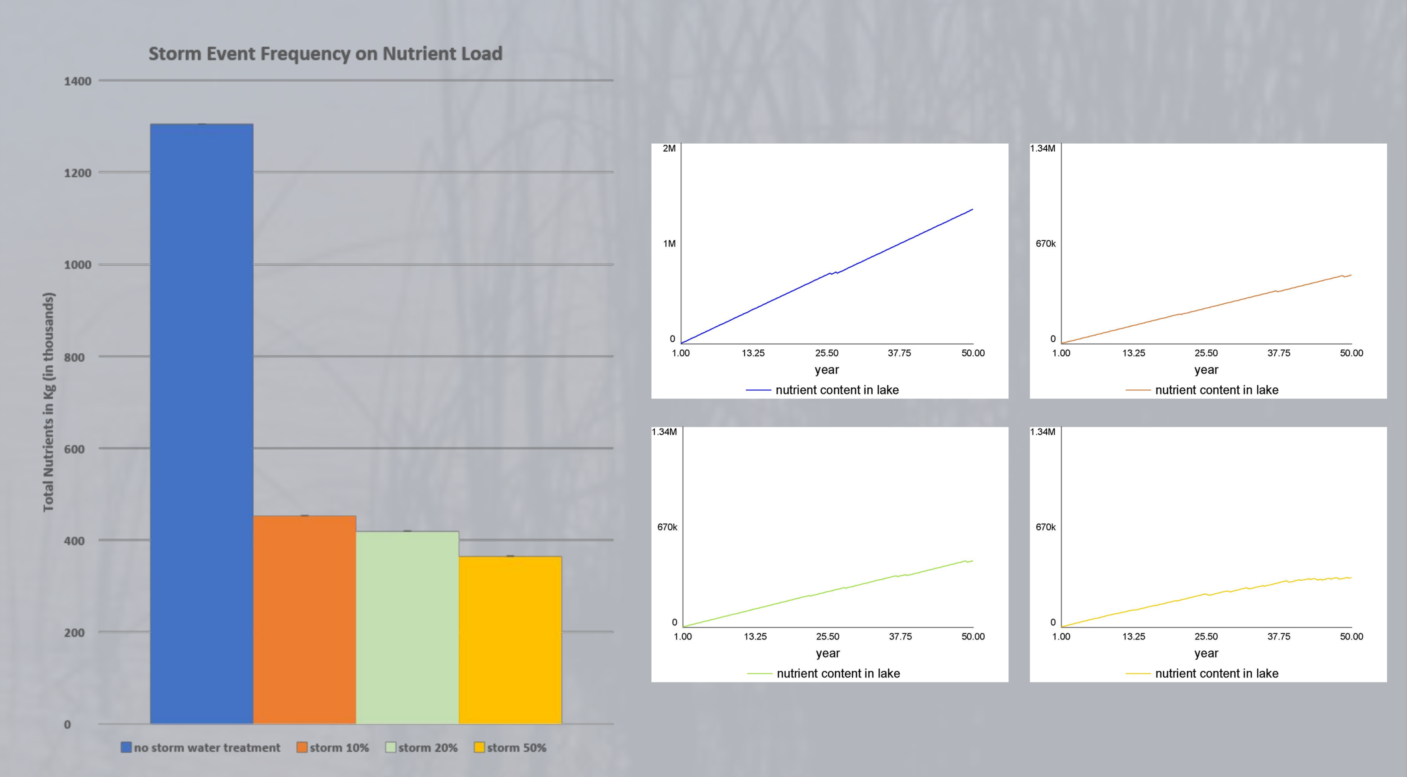
INTRODUCTION

Freshwater lakes and other bodies of water are formidable and self sustaining, but an overload of nutrients can throw these lake systems off balance. Surface runoff originates from nonpoint sources such as runoff from "urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition" (Kang & Gilbert, 2008).

Increasing demand for urbanization increases the number of impervious surfaces, which increases the amount of nutrients (i.e., nitrogen, phosphorus) that flows into watersheds and lakes. Land use surrounding Lake Trafford include commercial/industrial purposes and residential uses (Kang & Gilbert, 2008). Disturbances such as storms also impact runoff rates and can either decrease or increase nutrient loading, based on how stormwater is managed (Doyle & Miller, 1980).

All these factors create an excess of nutrient loading which affect algal populations and marine plant and animal life. Eutrophication is a concern which would not only affect the lake water quality and life in the lake but would also have an impact on society and our future.

SIMULATION RESULTS



ACKNOWLEDGEMENTS

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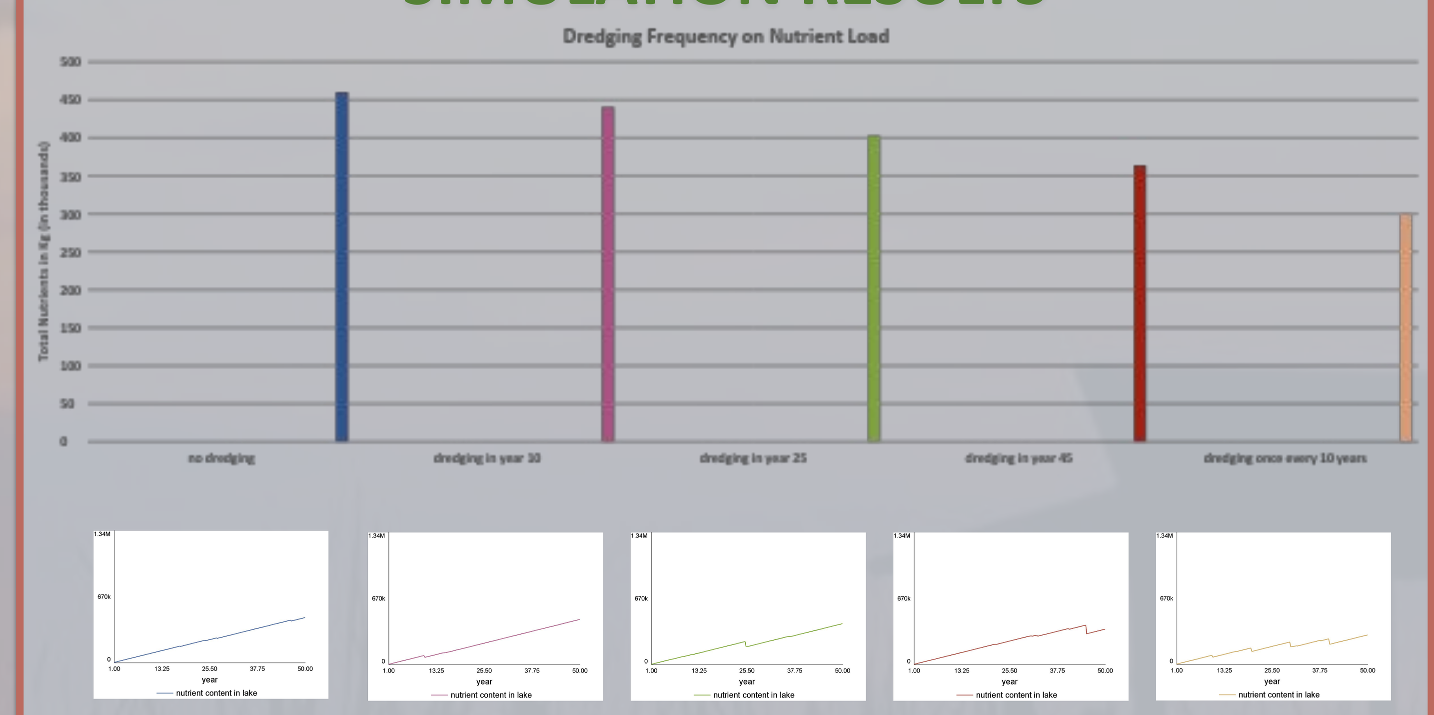
Background image: https://in.pinterest.com/pin/428404983279111427/

SIMULATION RESULTS



DISCUSSION

My results show that when the stochastic storm event frequency was manipulated, the higher the probability of storms, the less eutrophication would happen. When the storm probability=10% and no stormwater management was present (this management removes 65% of total nitrogen and phosphorus from land-use loading), the average final amount of nutrients was 1.34M kg. When the storm probability=10% with storm water treatment, the average final nutrients amount was 453k Kg; storm=20% was 419k Kg; storm=50% was 365k Kg after 50 years.

When there was no dredging event with regular stormwater management, the final average amount of nutrients was 460k Kg. When dredging occurred in Year 10, 440k Kg; Year 25=402k Kg; Year 45=364k Kg. When dredging occurred once every 10 years, the final average amount of nutrients was 300k Kg.

I had expected the amount of nutrients to be much higher If no dredging event occurred. However, the results did imply that the lack of stormwater management and lake restoration practices resulted in an exponential growth of nutrients. The best result occurred when dredging happened every 10 years.

This simulation could have been improved with the use of more accurate data and more trials.

LITERATURE CITED

Doyle, W. H., & Miller, J. (1980). Calibration of a distributed routing rainfall-runoff model at four urban sites near Miami, Florida. *Water-Resources Investigations Report, 80–1*. https://doi.org/10.3133/wri801

Kang, W.J., & Gilbert, D. (2008). TMDL Report Nutrient, Un-ionized Ammonia, and DO TMDLs for Lake Trafford. [Report]. Florida Department Of Environmental Protection. https://floridadep.gov/dear/water-quality-evaluation-tmdl/documents/lake-trafford-wbid-3259w-nutrients-dissolved-oxygen-and