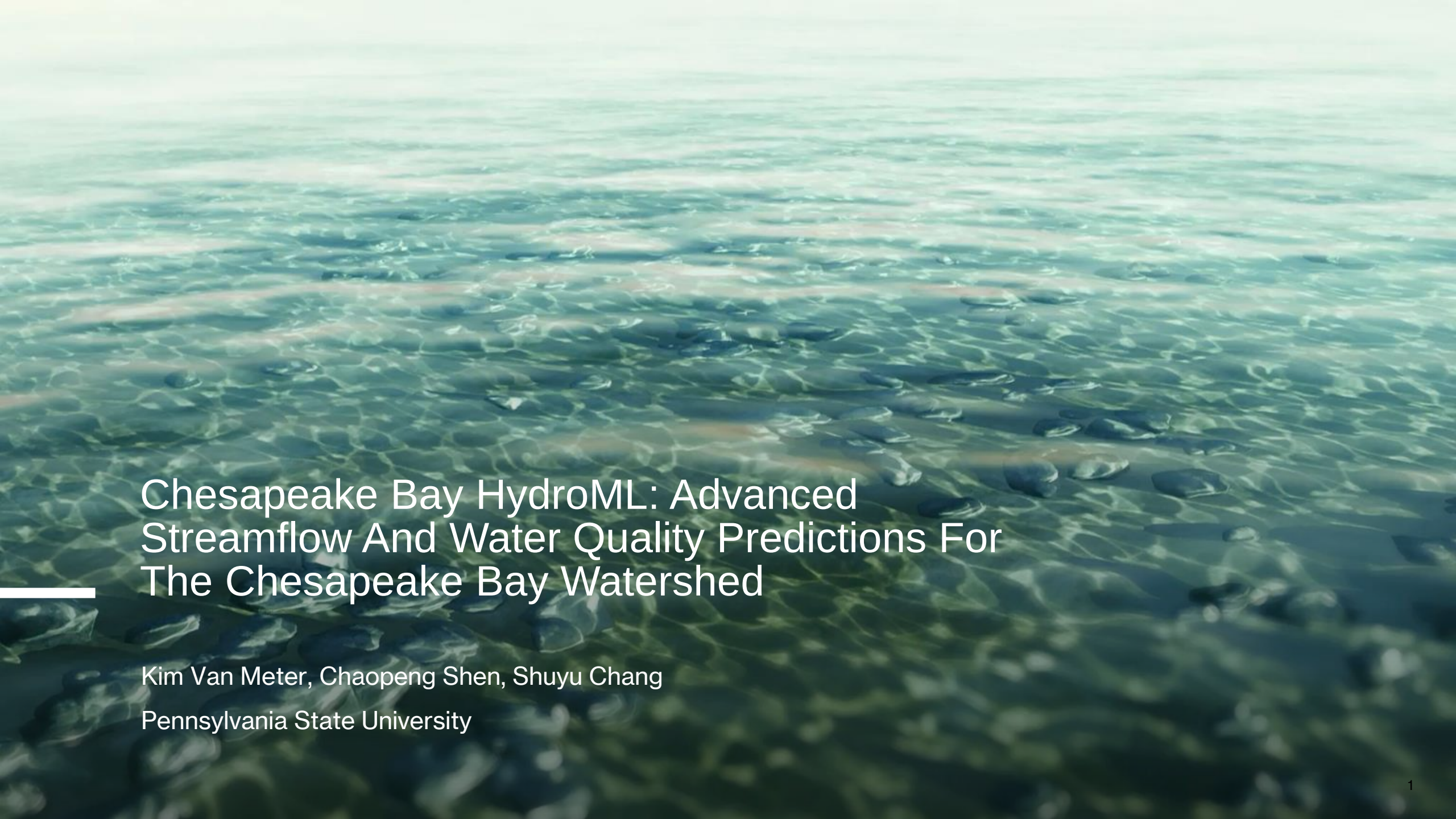


Chesapeake Bay HydroML: Advanced Streamflow And Water Quality Predictions For The Chesapeake Bay Watershed

Kim Van Meter, Chaopeng Shen, Shuyu Chang

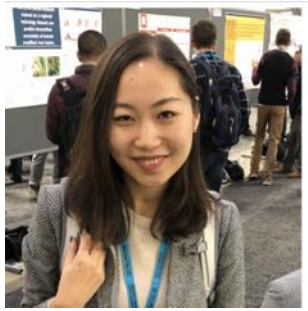
Pennsylvania State University

Introduction

Overall Objective

Explore and develop machine-learning approaches for eventual integration into the CBP modeling framework

Kim Van Meter
Department of Geography
Penn State University



Shuyu Chang
Department of Geography
Penn State University

Chaopeng Shen
Department of Civil &
Environmental Engineering
Penn State University

Elham Mahmod Por
Department of Civil &
Environmental Engineering
Penn State University
(starting summer 2024)

TEAM

Machine-Learning Solutions

Problems with Current Approaches

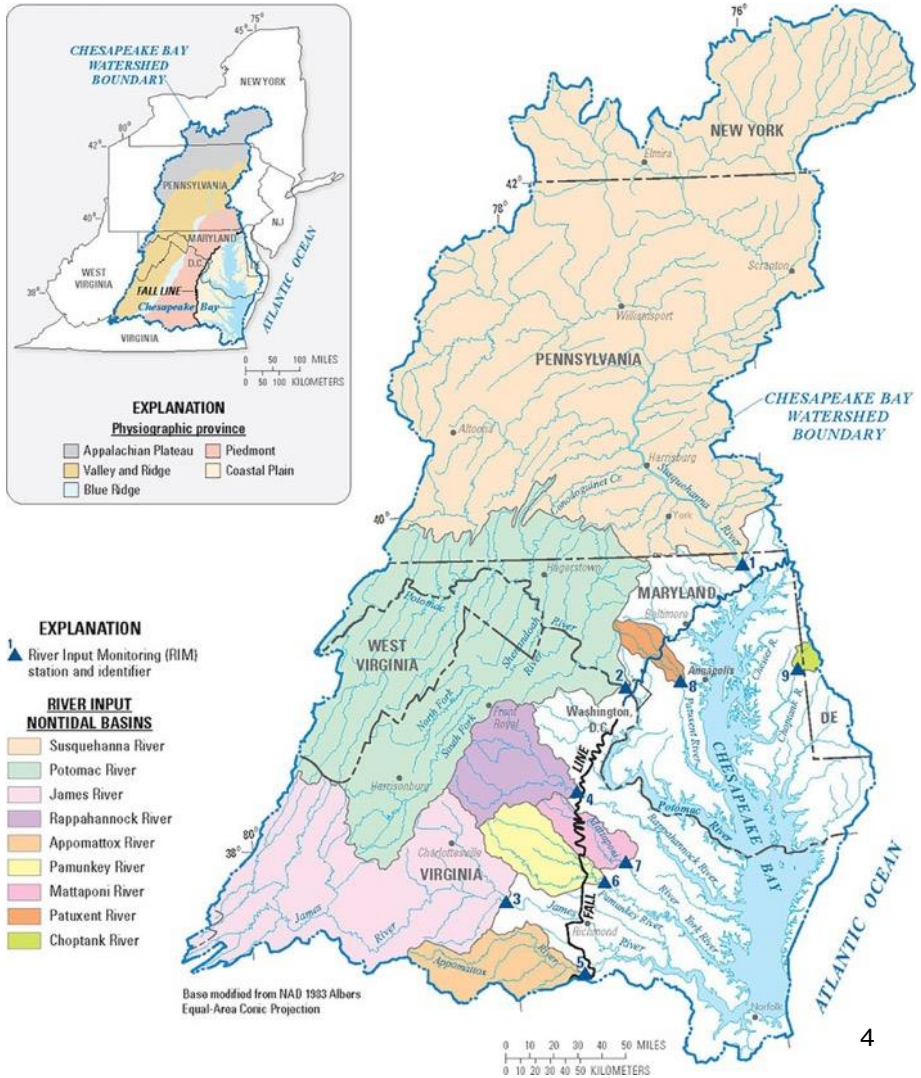
- Older versions of CPB watershed models were not designed to work at fine spatial scales
- Process-based models run at fine scale are slow and computationally expensive

Opportunities with Machine-Learning Approaches

- Data Integration - Can harness different data types, large amounts of input data
- Can handle fine-scale geospatial data
- Computational efficiency – less computationally intensive
- Provide data-driven insights that capture complex, nonlinear relationships, reducing need for detailed process understanding

Project Tasks Overview

1. Development of Machine-Learning Models to **assess the effects of fine-scale landforms and land use on nutrient and sediment delivery potential to the CBW** stream system at NHD100k scale *(Year 1)*
2. Use Machine Learning Methods to **temporally downscale long-term estimations to hourly estimates of flow, temperature and concentration** at the NHD100k scale. (*Years 1-3*)
3. **Develop approaches to integrate the methods or findings from Tasks 1 & 2 into the CBP Partnership Phase 7 watershed model** to predict the effects of management on temperature, nutrients, and sediment. (*Years 2-3*)



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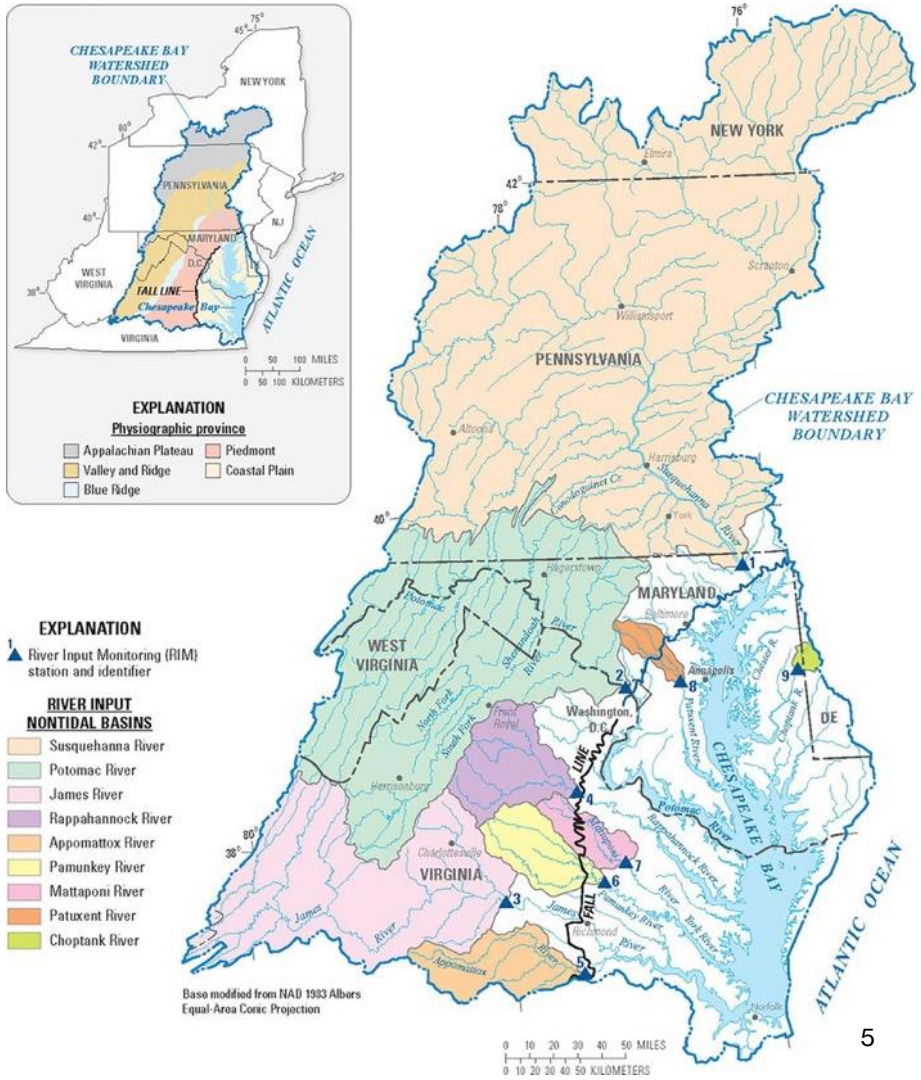


Task 1

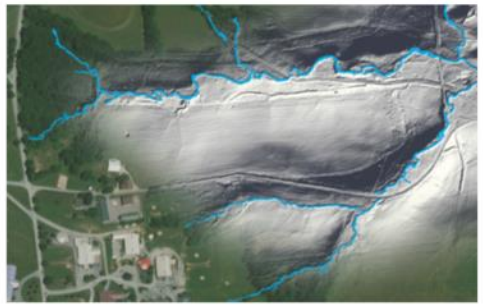
Development of Machine-Learning Models to **assess the effects of fine-scale landforms and land use on nutrient and sediment delivery potential to the CBW** stream system at NHD100k scale *(Year 1)*

Methods

- Develop Random Forest models to predict temperature, streamflow, and nutrient concentrations at annual & monthly time scales
- Utilize high-resolution datasets for CBP together with other publicly available input dataset
- Assess the value of high-resolution data

Cheapeake Bay Watershed Land cover

Land use



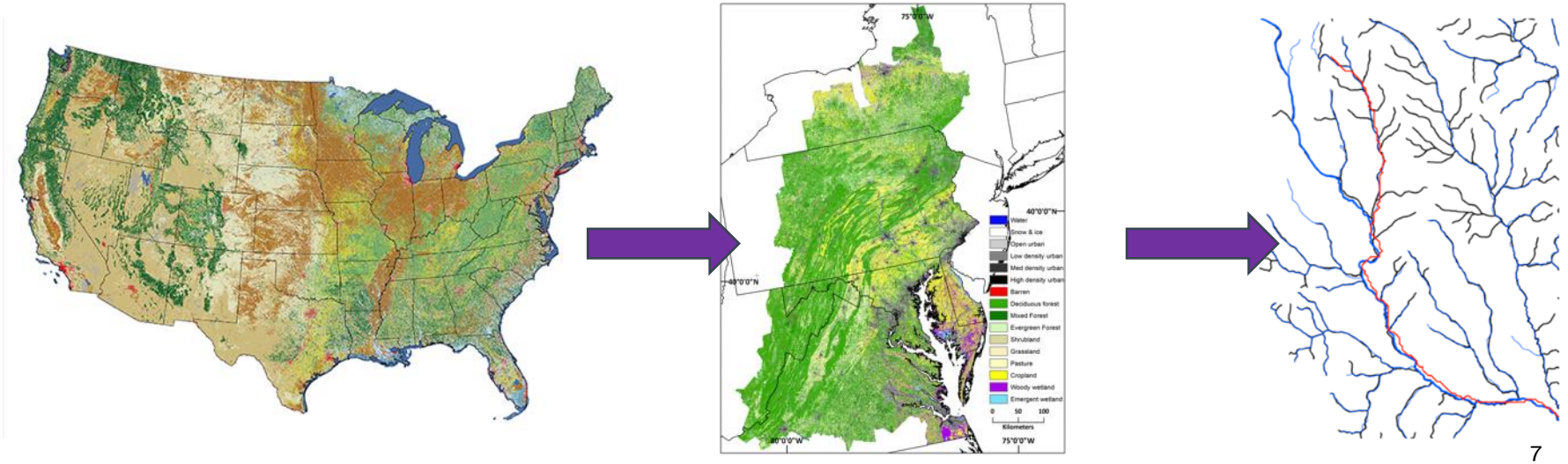
Enhanced flow paths

Task 2

Use Machine-Learning Methods to **temporally downscale long-term estimations to hourly estimates of flow, temperature and concentration** at the NHD100k scale. (*Years 1-3*)

Methods

- Develop long short-term memory (LSTM) network models to provide fine-scale (hourly, daily) estimates of flow, temperature, and concentration
- Here, we will build on work already in progress in the Van Meter and Shen labs (discuss Shen sediment model, Chang & Van Meter N and P models)

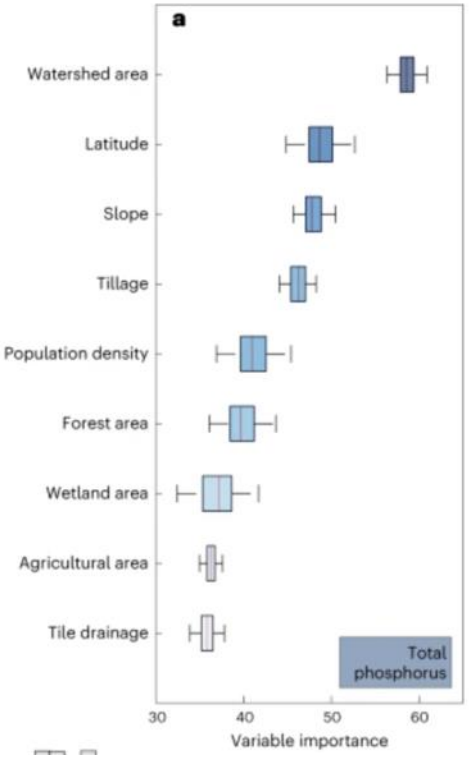


Task 3

Develop approaches to integrate the methods or findings from Tasks 1 & 2 into the CBP Partnership Phase 7 watershed model to predict the effects of management on temperature, nutrients, and sediment.

(*Years 2-3*)

Methods



- Ensure interpretability of the machine-learning models to provide insight into system dynamics (Variable Importance Plots, Shapley plots)
- Evaluate the ability of the models to simulate changes in climate, land use, and management (metamorphic testing)
- Develop simulation scenarios, run & evaluate models under selected simulations