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Future Climate Impacts on CBW BMP Efficiencies

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Agenda

I. Project Overview
II. Watershed Settings
III. BMP Definitions
IV. Quantifying BMP Performance
V. Preliminary Results
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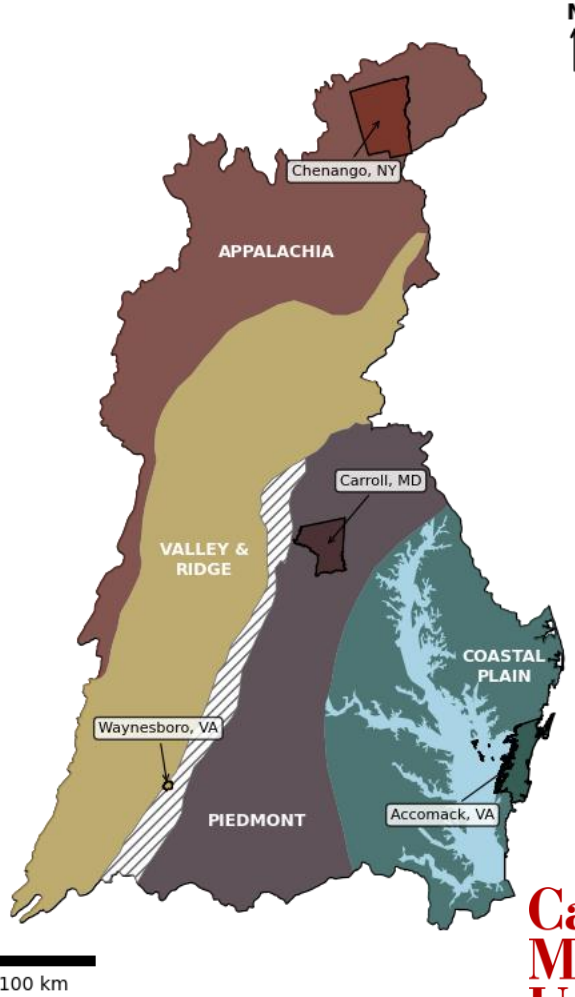
Project Overview

Goal: Quantify the performance of agricultural BMPs in the Chesapeake Bay watershed under current and future climate scenarios

Tools: APEX for agricultural, SWMM for urban

Output: N, P, and TSS removal efficiencies for BMPs under varying hydrologic scenarios



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Watershed Settings

4 regions × **4** crop types × **4-5** BMPs* × **2** RCPs × **7** decades

Hydrologic Regimes
- Reference: 1990-2000
- 2021-2090
  - RCP 4.5
  - RCP 8.5

Physiographic Region (PR)	Land Use (LU): Soybeans (Row Crops)	Corn (Row Crops)	Wheat (Row Crops)	Alfalfa (Hay Land)
Ridge & Valley	LU1 PR1	LU2 PR1	LU3 PR1	LU4 PR1
Appalachia	LU1 PR2	LU2 PR2	LU3 PR2	LU4 PR2
Coastal Plain	LU1 PR3	LU2 PR3	LU3 PR3	LU4 PR3
Piedmont	LU1 PR4	LU2 PR4	LU3 PR4	LU4 PR4

BMPs
- No till
- Manure Incorporation
- Nutrient Management
- Grass Buffers
- Cover crops*

**corn and soy only*

BMP Definitions (Informed by CAST and Expert Panels)

BMP	Definition	Variables in APEX
Baseline	• CAST operation schedule (plant, fertilizer, harvest, kill) • Conventional tillage	
Cover crops (soy and corn only)	• Winter wheat planted in off-season • No tillage	• Erosion control factor
No till	• No tillage operation	• Erosion control factor • Surface crop residue (t/ha)
Manure Incorporation	• Manure incorporated before tillage	• Erosion control factor • Manure amount
Nutrient Management	• N and P % reduction	• Erosion control factor
Grass Buffers	• 35-ft (10.67m) wide grass buffer on edge of field	• Erosion control factor • Buffer width • Buffer % of total field

Quantifying Performance

- Load Removal (kg/ha or t/ha)
- Removal Efficiency (%)
- Δ Efficiency (pp)

Load Removal

$$Load\ Removed = Load_{base} - Load_{future}$$

where:

$Load_{base}$ = Load removed (kg/ha or t/ha)

$Load_{BMP}$ = BMP efficiency in reference scenario

***Example**: Appalachia Alfalfa Grass Buffer 1990-2000*

Baseline (no BMP) TN load = 0.0129 t/ha

Grass Buffer TN load = 0.0079 t/ha

$$Load\ Removed = 0.0129 - 0.0079 = \mathbf{0.005\ t/ha}$$

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Removal Efficiency

$$Efficiency = \frac{Load_{base} - Load_{BMP}}{Load_{base}} \times 100\%$$

where:

Load = TN (kg/ha), TP (kg/ha), Sediment (t/ha) yield

Base = non-BMP scenario

***Example**: Appalachia Alfalfa Grass Buffer 1990-2000*

Baseline (no BMP) TN load = 0.0129 t/ha

Grass Buffer TN load = 0.0079 t/ha

$$Efficiency = \frac{0.0129\ t/ha - 0.0079 t/ha}{0.0129\ t/ha} \times 100\% = \mathbf{38.7\%\ removal}$$

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Δ Efficiency

$$\Delta Efficiency = Efficiency_{future} - Efficiency_{reference}$$

where:

Efficiency$_{future}$ = BMP efficiency in future scenario

Efficiency$_{reference}$ = BMP efficiency in reference scenario

***Example**: Appalachia Alfalfa Grass Buffer 1990-2000 vs 2061-2070 (RCP 8.5)*

Efficiency$_{1990\text{-}2000}$ = 38.7%

Efficiency$_{2061\text{-}2070}$ = 0.5%

$$\Delta Efficiency_{ref-2061-2070} = 0.5\% - 38.7\% = \mathbf{-38.2\ pp}$$

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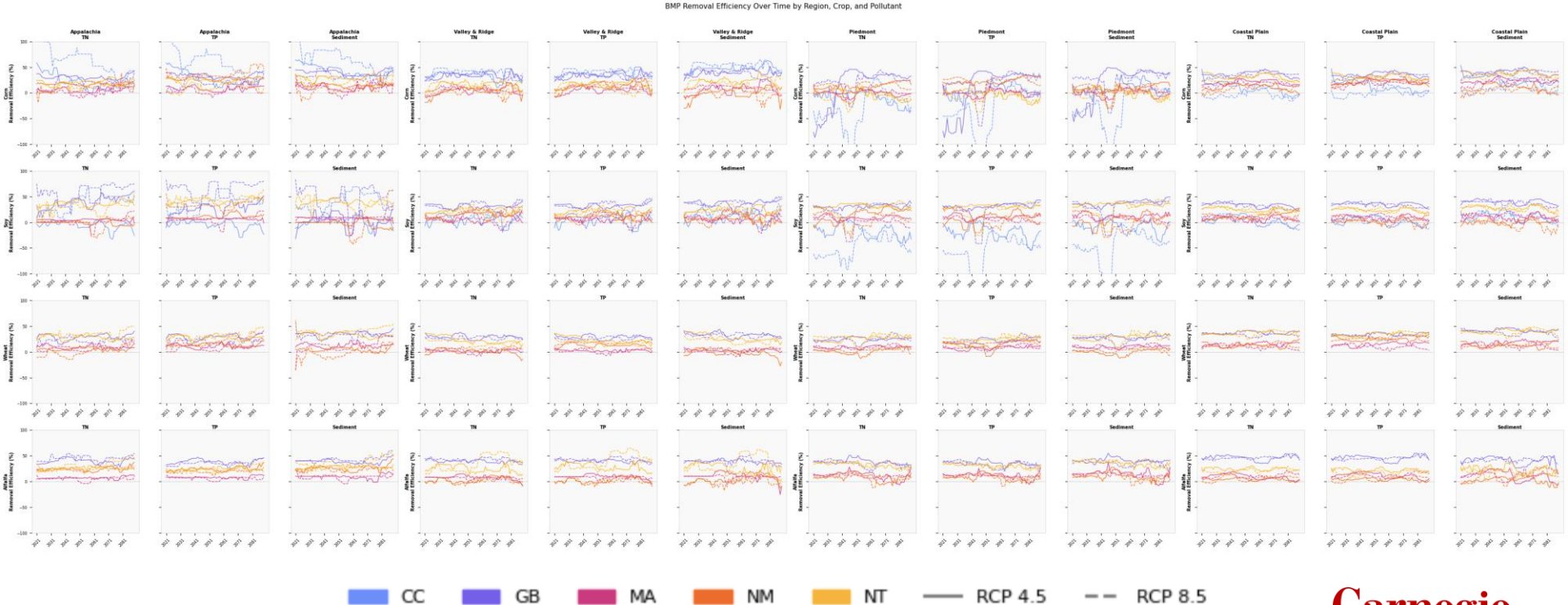
All Scenarios (BMP Removal Efficiency, %)



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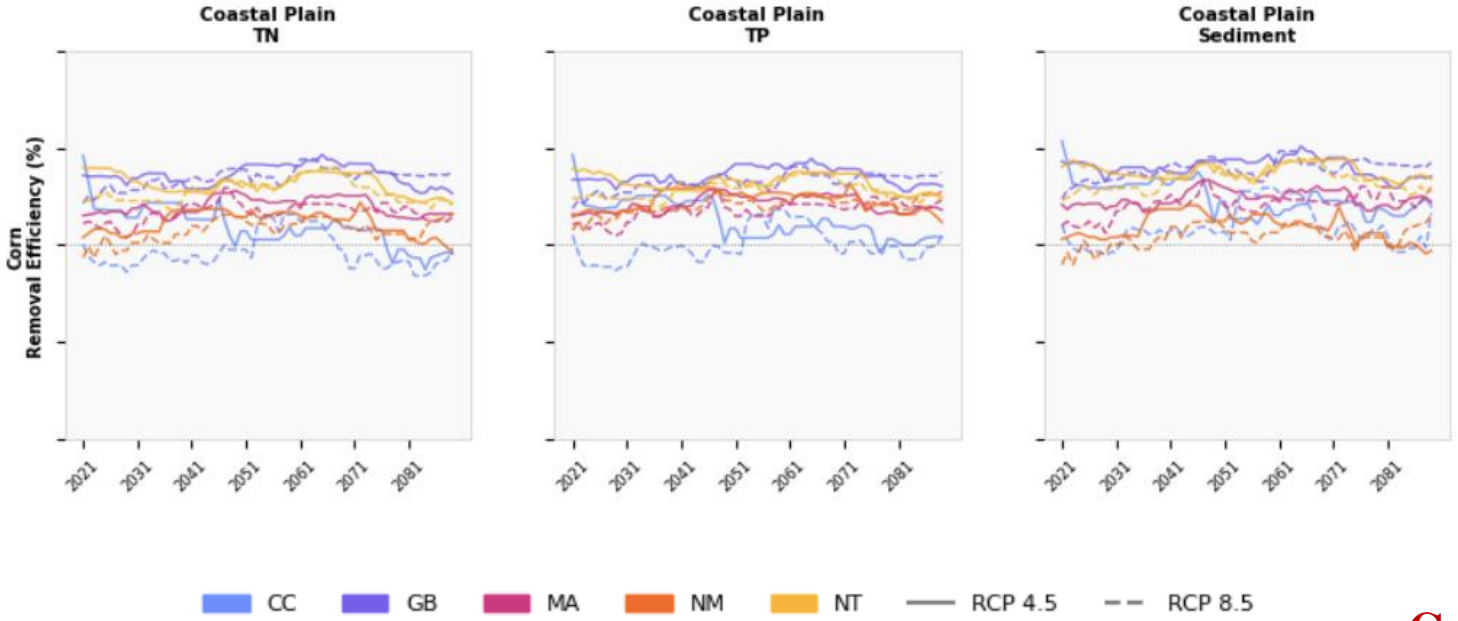
Example: Piedmont Corn



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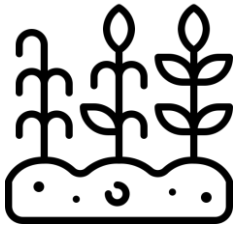
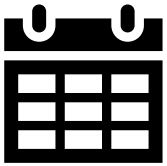
Anomalous Results (Removal < -50%)

affects ~4% of all 9,936 annual runs (RCP 4.5 & 8.5)



Crop Failure

- Baseline, BMP, or both crops fail
- 2.8%



BMP Failure

- $Load_{BMP} > Load_{base}$
- *under investigation*
- 1.5%

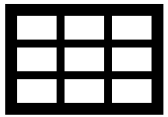
Enrichment Ratio Effect

- ↓total sediment load
- ↑sed-bound N&P
- 0.03%

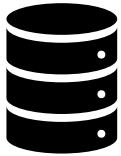
Deliverables

Technical Report

**template?*



Look-up Tables



APEX models

Peer-Reviewed Journal Article