Activity 4: BMP Climate Sensitivity Modeling

- Objectives:
  - Estimate impact of future hydrology on a range of widely used BMPs in Chesapeake Bay watershed.
  - Produce model simulations that provide pollutant removal efficiencies for different BMPs and uncertainties associated with future hydrological conditions.
- Research Steps:
  - Develop two types of rainfall-runoff hydrologic models to evaluate different urban and agricultural water quality BMPs.
  - Mechanistic models for urban and agricultural settings will be used to quantify nutrient and sediment removal efficiencies for range of BMPs on representative sites, under a broad set of climate futures.
  - Each individual BMP will be evaluated under an ensemble of downscaled climate projections using a subset of global climate models.
- Output:
  - One technical report that contains: literature review of existing urban and agricultural BMPs; synthesis of model simulations that provide pollutant removal efficiencies for BMPs; look up tables for pollutant removal efficiencies under a range of conditions
  - One to two peer reviewed journal articles

General Approach

1. Research design

a. Literature Review

- Understand past efforts
- Evaluate data availability
- Ensure consistency with larger modeling efforts

b. Stakeholder input

- Prioritize BMPs
- Identify representative sites

2. Implementation

a. Baseline scenario

- Model calibration
- Historic simulation (1991 – 2000)
- No BMPs or existing BMPs

b. Future climate scenarios

- Multiple climate projections
- BMP scenarios (one-at-a-time)

c. Output analysis

- Hydrologic changes (runoff timing, magnitude, frequency)
- Loading of TN, TP, TSS (exceedances, frequency, totals)
- Relative BMP removal efficiencies
- Uncertainty analysis

3. Synthesis of Outputs

a. Technical Report

- Literature review
- Detailed modeling procedure and outputs

b. BMP Curves/Tables

- Simplified relationships for BMP type, hydrologic condition, and removal efficiency

Proposed Modeling Approach

- **Model Selection:**
  - Urban: SWMM
  - Agricultural: HSPF
    - Provides hourly, continuous, mechanistic simulations
    - Can leverage Phase 5.3 to streamline model development
    - AgChem and potential to adapt prior RAND code to conduct ensemble runs
- **Model Development:**
  - Simplified representations of physiographic regions and land uses using prior calibrated parameters
  - Allows for more complex design of experiments
- **Design of Sensitivity Experiments**
  - Climate (1 base period, 2 future hydrologic regimes)
  - Physiographic regions (4 types)
  - Land use
    - Agriculture: 4 types (row crops, hay land, forest, pasture)
    - Urban: varying levels of development
  - BMPs (prioritize based on most implemented and most effective)

Proposed Modeling Approach

Hydrologic regimes

1. Base (e.g., 1991-2000)
2. Future 1 (e.g., 2035)
3. Future 2 (e.g., 2065)

Watershed Settings

Physiographic Region (PR)	Land Use (LU): Row crops	Hay land	Pasture	Forest
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

Test BMPs

1. Cover crops
2. Barnyard Runoff Control
3. Grass Buffers
4. Land Retirement
5. And more (in progress)