

# Evaluation of RDM for Chesapeake Bay Water Quality Decision-making Under Uncertainty

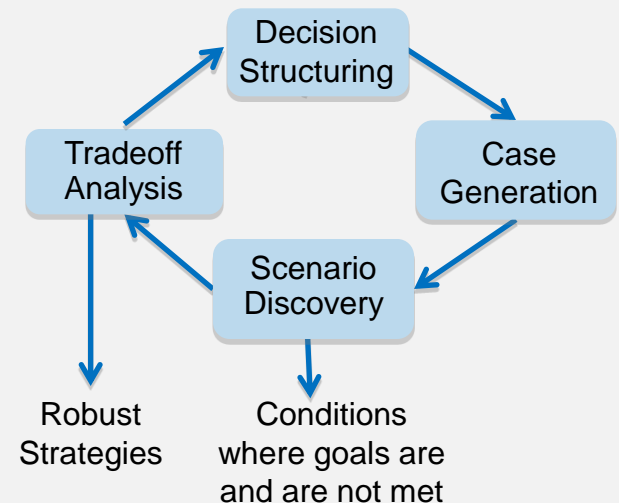
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# Brief Review of RDM

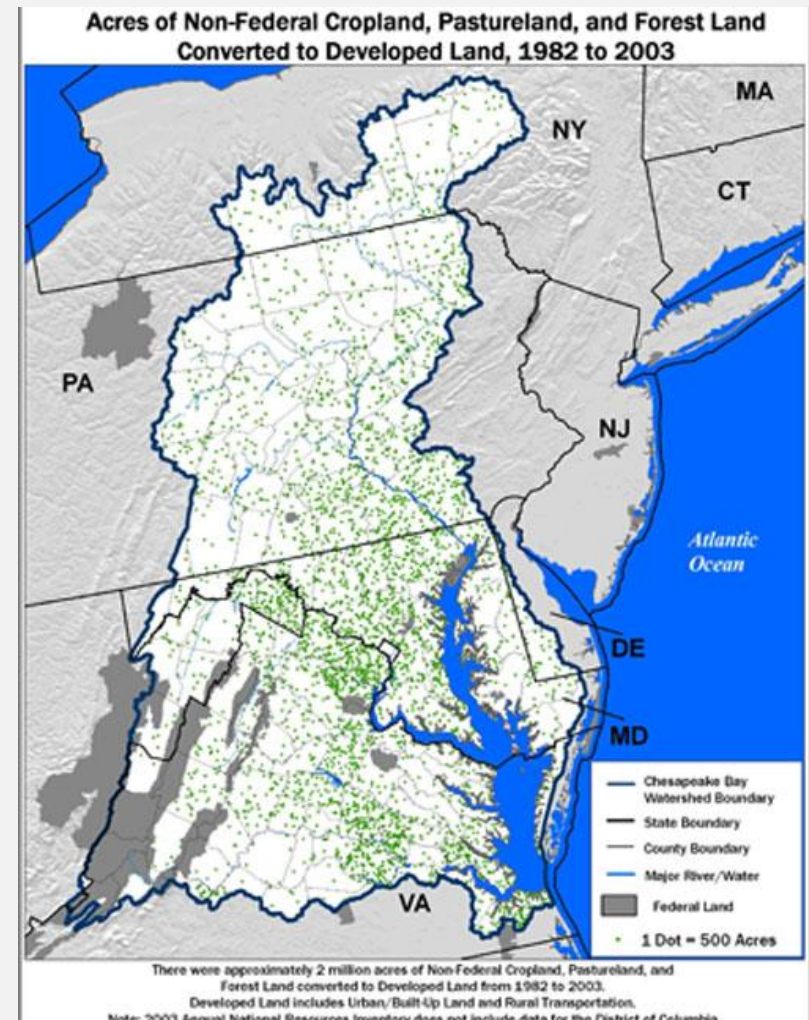
- RDM Is a Quantitative Decision Framework Useful for Conditions of “Deep” Uncertainty
- Basic steps include:
  - Define key objectives, uncertainties, strategies, and relationships
  - Model each of many sets of assumptions to explore performance of strategies
  - Identify conditions under which goals are / are not met
  - Analyze tradeoffs among strategies and make potential modifications



Source: Lempert, et al. 2004. Characterizing climate-change uncertainties for decision-makers. *Climate Change*, 65:1-9.

# Application of RDM to Patuxent

- Focus is urban stormwater
- Consider phosphorous, nitrogen, sediment loads
- Use Chesapeake Bay Phase V Watershed Model
- Scenarios include changes in climate, land use, implementation of MD's WIP2



# Scope the Case Study (XLRM)

Uncertain Factors (X)	Policy Levers (L)
<p><b>Land use</b></p> <ul style="list-style-type: none"> <li>• Population trends</li> <li>• [Infill/development patterns]</li> </ul> <p><b>Climate change effects</b></p> <p><b>BMP implementation uncertainty (not yet implemented)</b></p> <ul style="list-style-type: none"> <li>• BMP effectiveness (flashy storms)</li> <li>• BMP cost uncertainty</li> </ul>	<p><b>Maryland Department of Environment (MDE) Phase II Watershed Implementation Plan</b>; BMPs may include</p> <ul style="list-style-type: none"> <li>• Stormwater management-filtering practices</li> <li>• Stormwater management-infiltration practices</li> <li>• Urban stream restoration</li> <li>• Riparian forest buffers-urban</li> </ul>
System Model Relationships (R)	Performance Metrics (M)
<p><b>Phase 5.3 Chesapeake Bay Watershed Model</b></p> <p><b>Chesapeake Bay Water Quality and Sediment Transport Model</b></p> <p><b>Scenario Builder</b></p>	<p><b>Nitrogen loads</b></p> <p><b>Phosphorous loads</b></p> <p><b>Sediment loads</b></p> <p><b>Implementation costs</b></p>

# Uncertainties to Explore

- Policy levers:
  - No additional action (current investments only, with O&M)
  - Maryland's Phase II Watershed Implementation Plan
- Uncertain factors:
  - Land use uncertainty
    - 3 different population projections (“Current trends” extrapolated to 2050; ICLUS A2 and ICLUS B1)
    - Trend scenario reflecting greatest dispersion or sprawl, based on 1986-2000s historic trendline
  - Climate change uncertainty
    - 6 general circulation models
    - 3 emissions scenarios
    - several time periods (2035-2045; *2055-2065*)
    - *evapotranspiration CO<sub>2</sub> adjustment*

# Uncertainties to Explore (Con't)

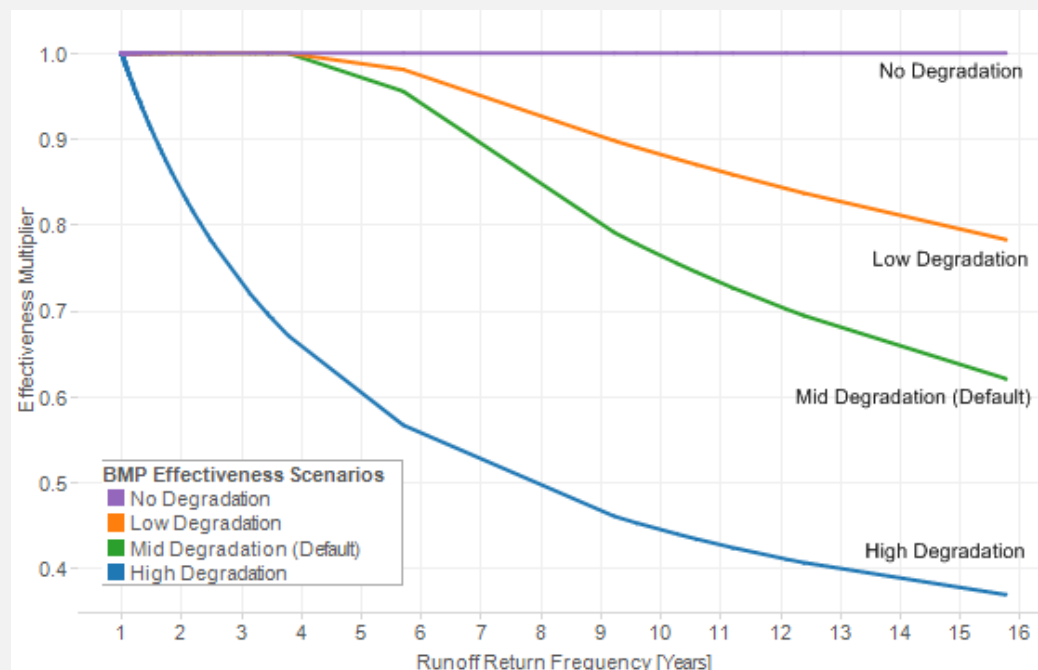
## – BMP Effectiveness

- No degradation: Michaelis-Menton curve turned off
- Low degradation
- Default assumptions (mid)
- Rapid Degradation

<i>Summary</i>	<b>MinFreq</b>	<b>HalfSat</b>	<b>Asymptot</b>
<b>No degradation: M-M curve turned off</b>	NA	NA	NA
<b>Low degradation</b>	5	34	0.2
<b>Default assumptions (mid)</b>	5	17	0.2
<b>Rapid degradation</b>	1	5	0.2

## – Model Uncertainties

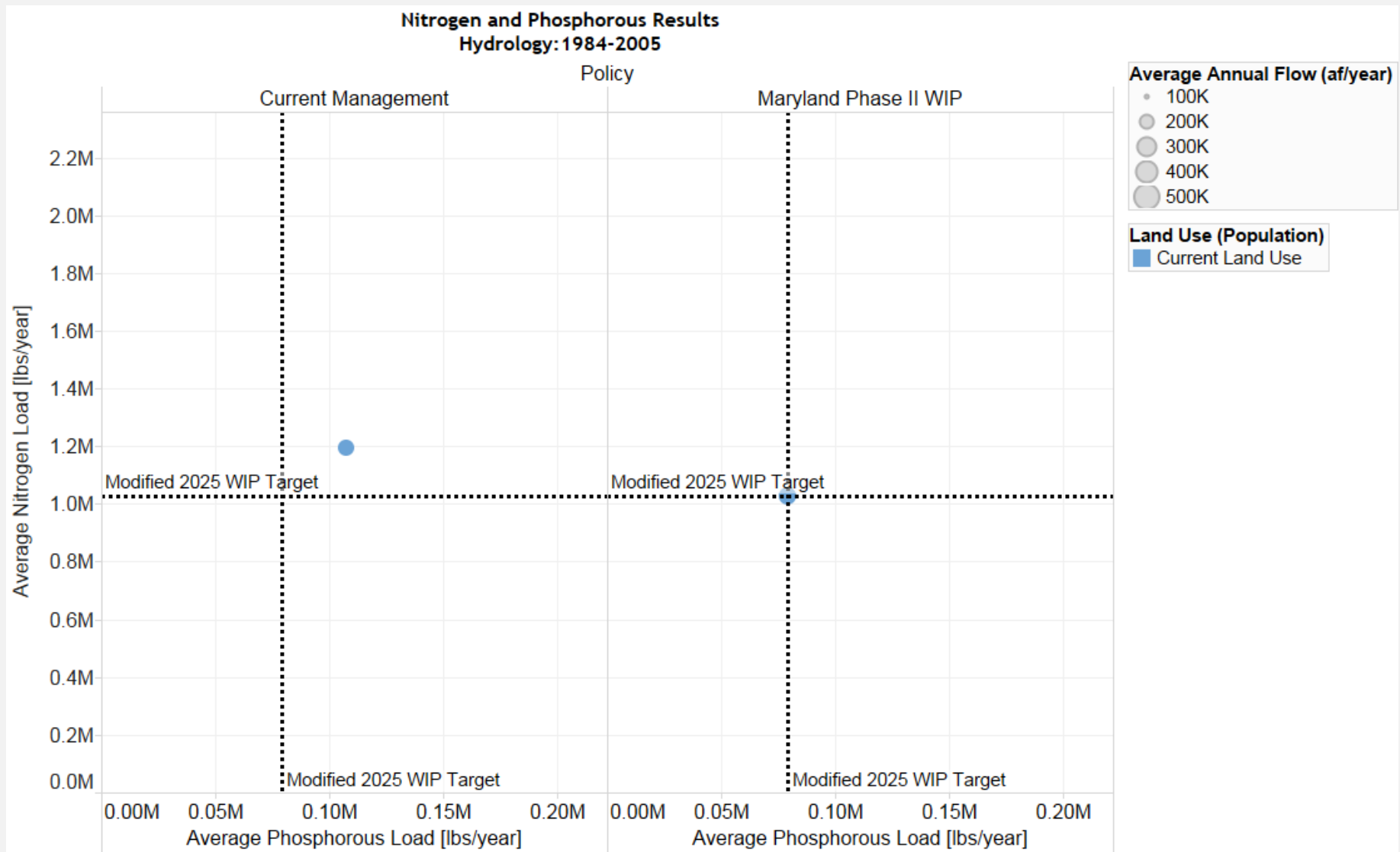
- Phase V model without CO2 and evapotranspiration
- Phase V model with CO2 effects only



# Preliminary Results (runs in progress)

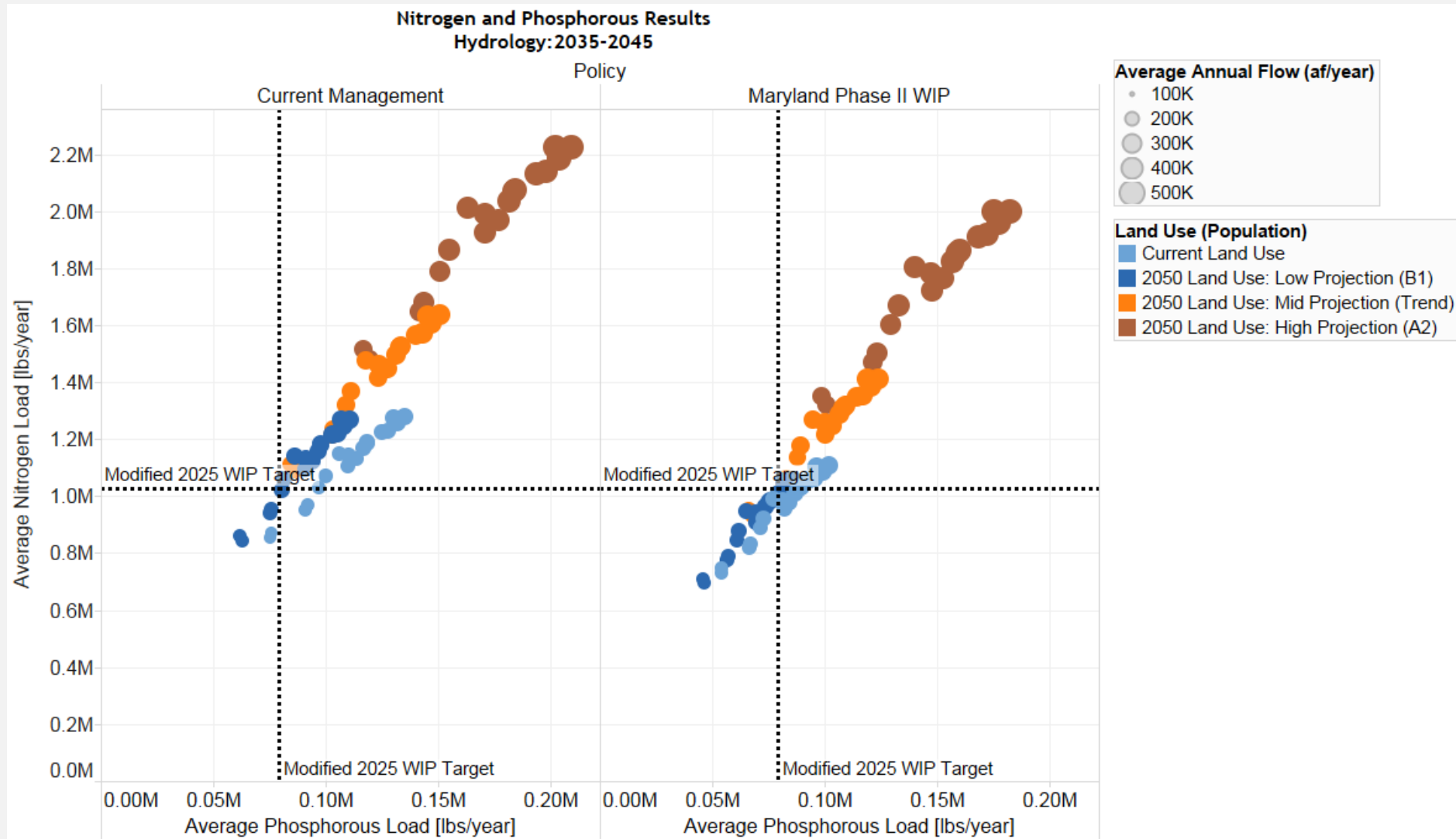
- BMP effectiveness: Mid Degradation only
- No evapotranspiration CO<sub>2</sub> correction
- Results not yet reviewed, subject to change

# Historical Results Align With Phase II WIP Modeling

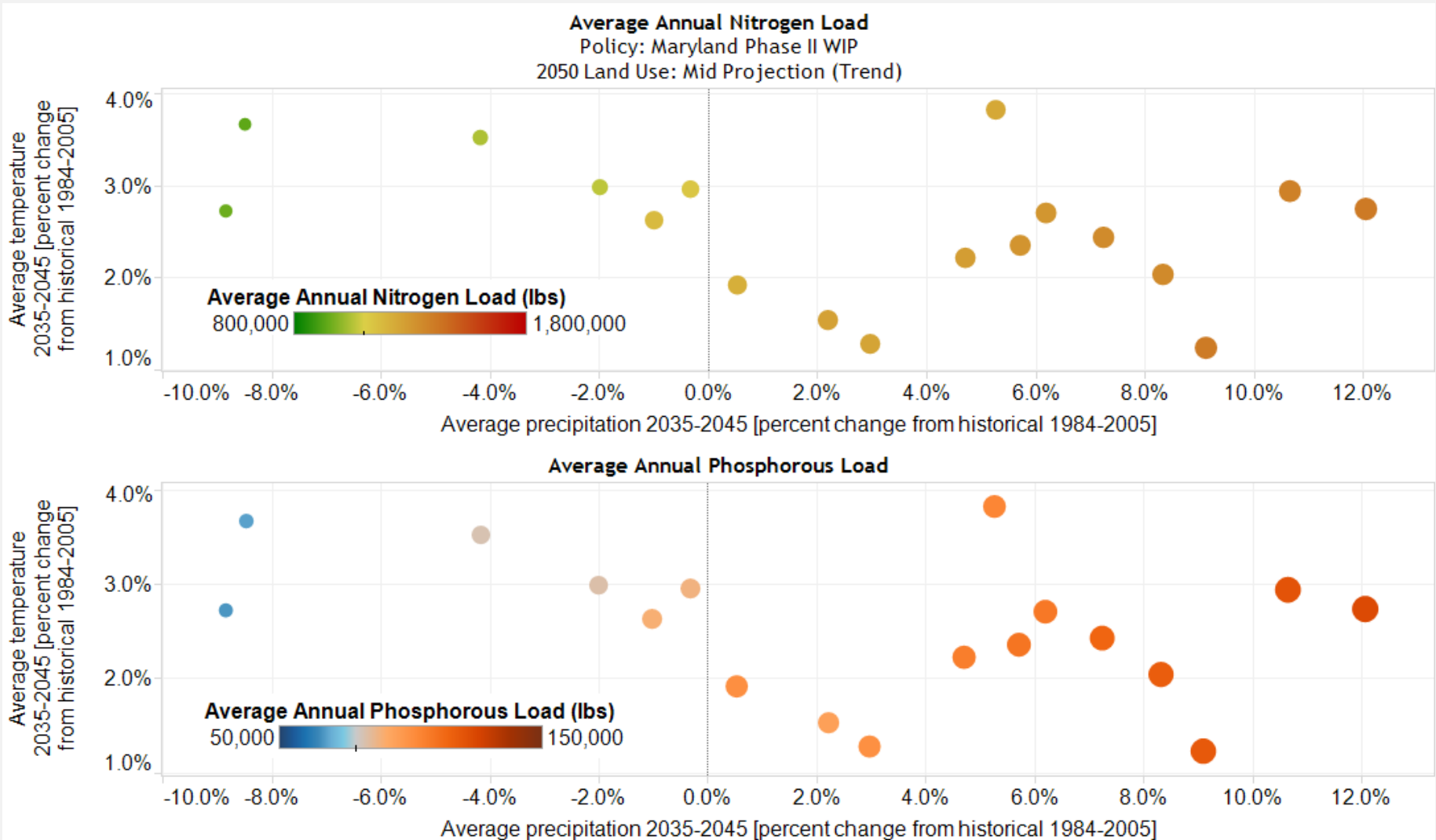




# Climate and Land Use Together Lead to Many Stressing Futures



# Climate Scenarios With Precipitation Increase Correlated With Larger Contaminant Loads



# Timeline and Products

- Complete analysis – August 2013
- Disseminate results
  - Give presentations to CBP, EPA OW and R3, Maryland? Others? -- Ongoing
  - Prepare journal articles – September 2013
  - Prepare RAND report to EPA – September 2013
  - CBP/EPA report focused on policy implications? – Beyond September 2013