Research Update:

Modeling the Terrestrial Effects of Climate Change on Nutrient Loading to the Chesapeake Bay

Dano Wilusz, MPP
PhD Student, Advised by Dr. Bill Ball
Department of Geography and Environmental Engineering
Modeling Quarterly Meeting
July 23, 2013

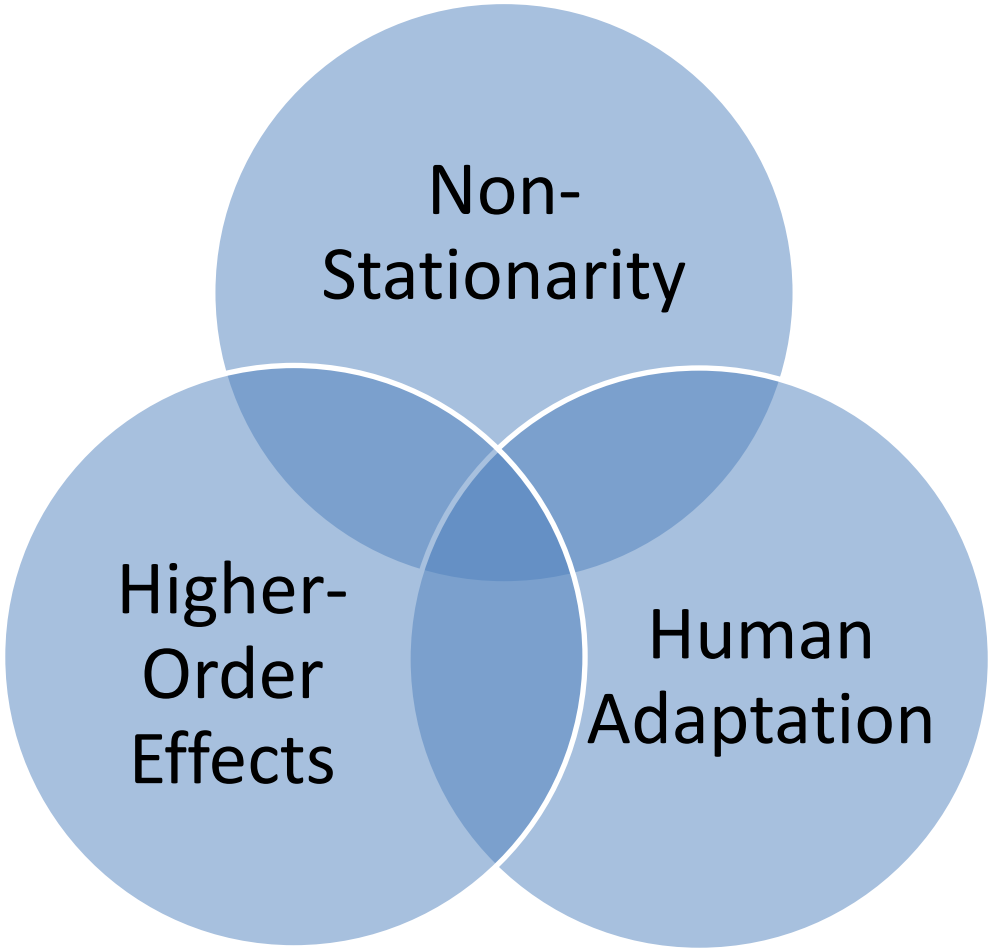
About me

- PhD Candidate, NSF IGERT Fellow, at DoGEE since 2012
- Foreign Affairs Officer at U.S. Department of State
- Masters of Public Policy at UC Berkeley
- Thermal Process Engineer at Applied Materials, Inc.
- Applied and Engineering Physics at Cornell University
- Hometown at Burlington, CT

Vision: On-going improvements to the WSM ensure that it adequately accounts for the terrestrial effects of climate change.

- Support Phase 6 model development
- Identify risks to TMDL and bay restoration.
- Generalize findings for other basins.

Three Challenges to Optimizing the WSM Under a Changing Climate



Two Complementary Tasks

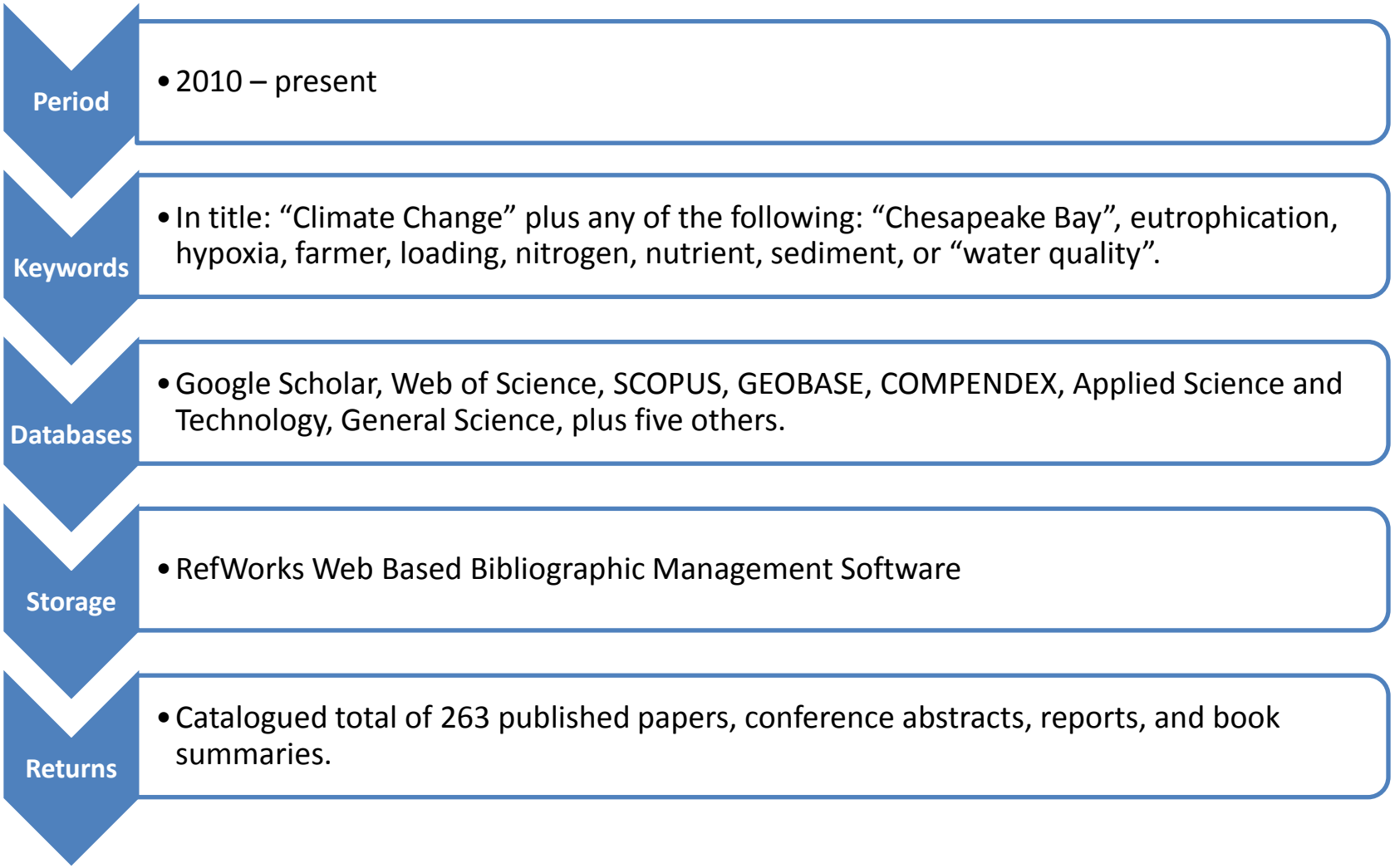
- Review recent literature on the terrestrial effects of climate change on nutrient loading.
- Identify model parameters and operations that may benefit from optimization due to climate change.

Literature Review

- Run scenarios to identify and characterize factors with the largest influence on model output.
- Test and verify model improvements by comparing with other model and field data.

WSM 5.3.2 Runs

Lit Review – Data Collection



Lit Review – Abstract Coding (ongoing)

Key findings:

- Estimates of effect on loading are significant but highly variable.

  Estimates among 24 modeling studies in different sites range from 100% increase in sediment load to 45% decrease in nitrogen loading by 2090s.

- Studies focus on changes in temperature and precipitation.

  Most modeling studies (13 of 24) focused on changes in temperature and precipitation. Other less commonly discussed parameters included sea level change (3), soil temperature (1), land use change (1), and soil response to changes in CO2 (1).

- Lack of reporting on sensitivity or uncertainty.

  Most modeling studies (20 of 24) used different climate change scenarios as proxy for sensitivity. Only 5 of 24 studies discussed sensitivities of key parameters. None suggested margins of error.

- Multiple models are rarely compared on the same watershed.

  Only 1 of 24 modeling studies compares results from multiple models.

WSM 5.3.2 Runs

Key Objectives:

- To focus on "2nd order effects" (beyond temperature and precipitation).

Model the effect of modifying ground temperature, increasing growing season, or accounting for plant response to higher CO2 levels.

- To shed light on the key factors found to affect trends, sensitivity, and uncertainty.

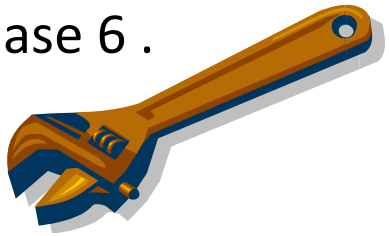
Analyze the sensitivity of results to small perturbations in the input parameters and determine the most significant contributions to observed trends.

- To compare multiple models.

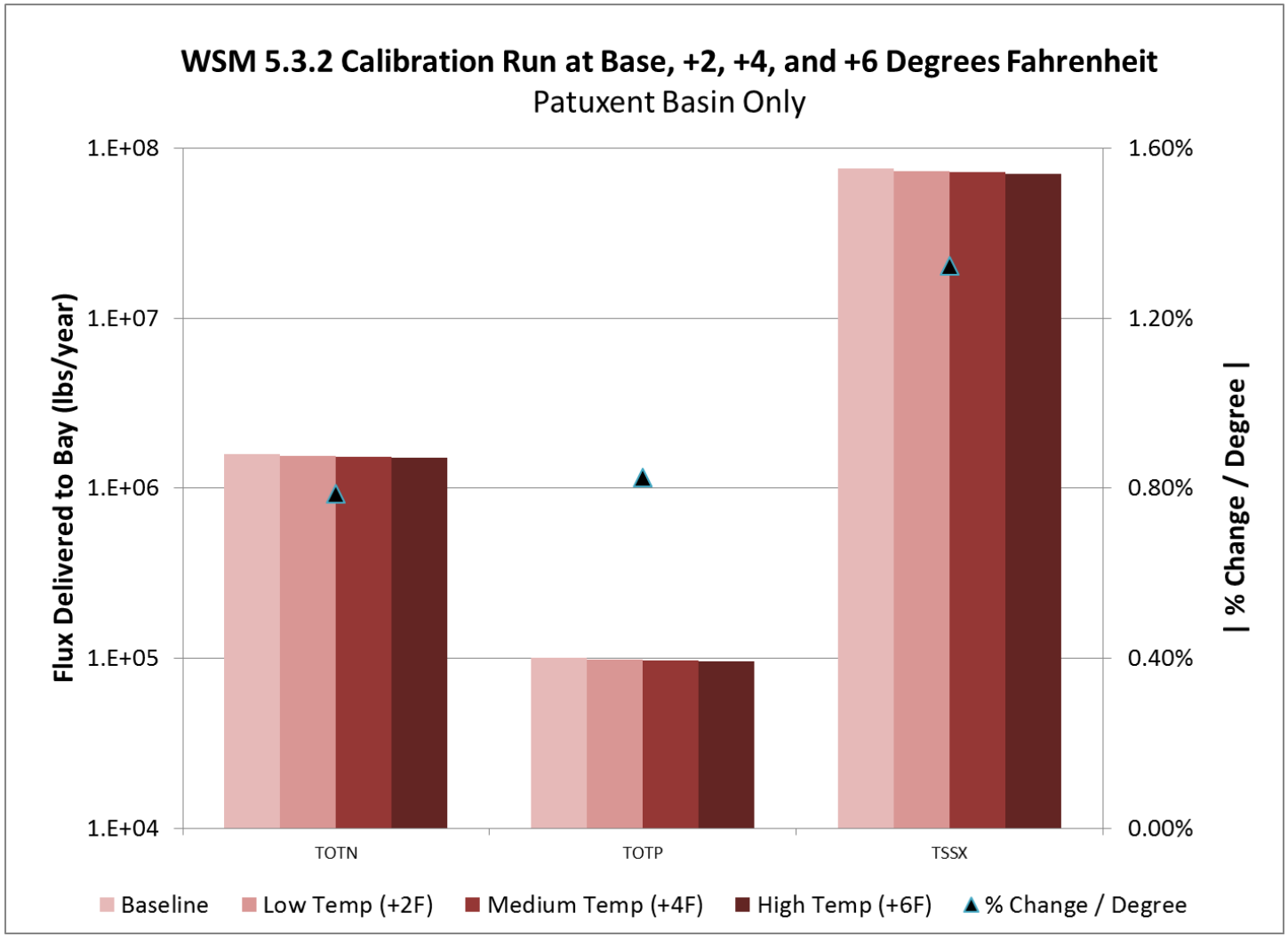
Other models could include SWAT or higher resolution models on smaller watersheds.

- Ultimately, to recommend improvements for Phase 6 .

Changes could be generalized to other basins as well.



WSM 5.3.2 Run Results (ongoing)



A uniform +1F increase resulted in a 0.8% to 1.3% decrease in TOTN, TOTP, and TSSX, and a 1.1% decrease in FLOW (not shown).

Next Steps – August and Beyond

- Literature Review:
  - Finish Coding Abstracts
  - Document key parameters for testing in the WSM 5.3.2 Runs.
- WSM 5.3.2 Runs
  - Continue developing expertise with model by running changes in temp and precip.
  - Adjust for other terrestrial effects and identify the most significant (e.g.,ground temp, growing season, crop mix)
  - Revisit literature review to develop and beta test model enhancements.

Longer Term: Feed results into Phase 6 development plan and Factors Affecting Trends Working Group. Develop PhD dissertation proposal.

Questions?

[Wordle of the literature review bibliography, including abstracts.]