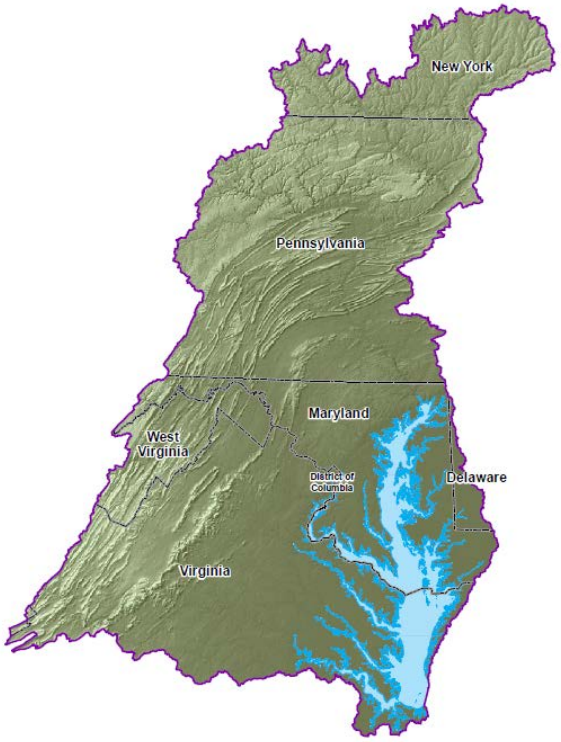
Simulating 64,000 Square Miles

A Brief Introduction to the Chesapeake Bay Program's Scenario Builder and Projections

The Chesapeake Bay Program has developed a number of modeling tools to better simulate and understand how anthropogenic and environmental changes to the 64,000 square mile Chesapeake Bay watershed impact water quality in the Chesapeake Bay. The Chesapeake Bay Program's Watershed Model estimates nutrient runoff and delivery of nutrients to the Chesapeake Bay from over 2,400 model segments. The results of the Watershed Model are then fed into the Chesapeake Bay Estuarine Model to determine water quality impacts to the Bay. Both of these models rely on information generated by the Chesapeake Bay Land Change Model and Scenario Builder. Together, these two tools provide the Watershed Model with a number of essential parameters that help describe the landscape and how nutrients move through that landscape into the rivers and streams.



The Landscape

Scenario Builder's first task is to create a "digital landscape," or map of the entire watershed. This map is only an estimation of the actual land uses across the watershed. The Chesapeake Bay Land Change Model provides Scenario Builder with land use data for urban and forested lands while the USDA's Census of Agriculture provides the agricultural acres for a variety of crops and even fallow lands. The Census of Agriculture data is provided only at the county scale. For this reason, Scenario Builder works at a county level to estimate nutrient generation and application. This means that the "digital landscape" is not a true reflection of each farm, operation, city or stream in the watershed. Instead, it represents an aggregated, county-level estimate of the land uses, animals, septics, BMPs and other conditions that impact nutrient generation, fate and transport.

The Crops

Scenario Builder's second responsibility is to mimic crop production within each county in order to estimate the amount of nutrients crops remove from the environment, as well as how crops interact with precipitation to reduce runoff of nutrients from fields. The USDA's Census of Agriculture provides Scenario Builder with yield data for 120 crops which are then used to inform nutrient uptake for crops in each county across the watershed. Scenario Builder also utilizes RUSLE2 percentages for leaf area and residue cover for each crop type to inform the amount of sediment that can be detached from the area under production for any given crop.

The Animals and Nutrients

Finally, Scenario Builder must determine how many nutrients are available for crops in any given county. Seven species of nutrients are represented in Scenario Builder (mineralized N, mineralized P, organic N, organic P, phosphate, nitrate and ammonia). These seven nutrient species are applied to the land through biosolids (sewage sludge), direct manure deposition, manure spreading (application), and inorganic fertilizer application. While jurisdictions supply Scenario Builder with exact biosolids information, the tool must estimate the amount of manure that is generated per animal type, and how much of that manure is stored, applied to crops or deposited directly in a pasture. Inorganic fertilizer application is not directly estimated from sales data, but instead represents all nutrients required to fulfill crop need after the organic sources are applied. These calculations are again done for each county across the watershed. Occasionally, more manure nutrients are generated in a county than the crops can uptake according to Scenario Builder calculations. When this happens, excess manure nutrients are spread across the landscape resulting in greater estimates of nutrient runoff into rivers.

Projecting the Unknown

The Chesapeake Bay Program does not have yearly data for every land use, animal, crop, farm, city, etc. to inform its simulations of nutrient fate and transport. While the Bay Program utilizes robust data sources as they are made available, including the Census of Agriculture, the National Land Cover Dataset (NLCD) and the United States Census, the Program must rely on projections for years that these and other datasets are not available. Animals and crops are projected forward from values provided in the 2007 Census of Agriculture, while the Land Use Change Model utilizes the most recent United States Census, NLCD and satellite imagery to inform future land use projections.

Underlying the Entire Process

The success of any model is directly dependent upon the quality of data fed into it as well as the assumptions the model uses to mimic real world processes. The purpose of this workshop is to peel back the layers of the Chesapeake Bay Program's projections and its Scenario Builder tool to better understand the data and assumptions being used. With this base of knowledge and their own expertise, workshop participants will identify additional datasets that could improve the Chesapeake Bay Program's projections and modeling tools for years to come.

More detailed information about Scenario Builder can be found at:
http://www.chesapeakebay.net/publications/title/documentation_for_scenario_builder

More detailed information about the Watershed Model can be found at:
http://www.chesapeakebay.net/about/programs/modeling/53/

All photos courtesy of the Chesapeake Bay Program.