The Chesapeake Bay Program uses state-of-the-art science and monitoring data to replicate conditions of the Chesapeake Bay watershed. This information is then used by decision-makers at the federal, state and local levels to determine how best to restore and protect local waterways, and ultimately, the Chesapeake Bay. By combining sophisticated modeling data and real-world monitoring data, we gain a comprehensive view of the Chesapeake ecosystem—from the depths of the Bay to the upper reaches of the watershed.

The suite of computer modeling tools developed by the Chesapeake Bay Program divides the 64,000-square-mile watershed into thousands of smaller segments, and helps us understand the impact of pollution-reducing policies and practices at the regional and local level. The most significant value of the suite of modeling tools is the ability to predict how the Chesapeake Bay will respond to future conditions such as pollutant loads, land use changes and climate change.

What is included in the Chesapeake Bay Program's suite of modeling tools?

The Chesapeake Bay Program has a suite of four computer models that includes:
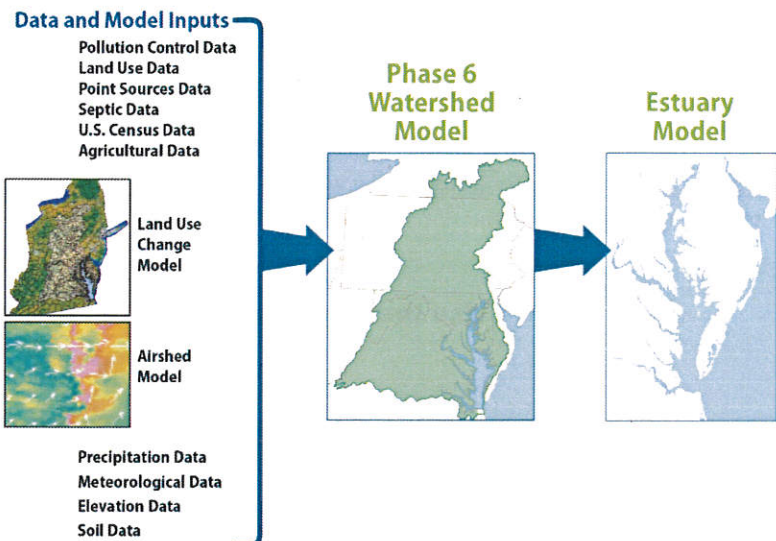
- **Airshed Model:** estimates the amount of nitrogen deposited onto the land and water by vehicles, power plants and other emission sources
- **Land Use Change Model:** predicts the impacts that urban population and development will have on sewer and septic systems
- **Phase 6 Watershed Model:** estimates the amount of nitrogen, phosphorus and sediment reaching the Chesapeake Bay
- **Estuary Model:** examines the effects that pollution loads have on water quality

State and local governments, planners, nonprofit organizations and others can use these models to test scenarios and simulations of possible actions in order to determine how much pollution is entering their local waterways, where it is coming from, how their actions will have an impact and much more before committing time and resources.

How do the models work together?

Step 1. Data from the Land Use Change Model, Airshed Model and other data such as human and farm animal populations, rainfall, septic systems and elevation are input in the Phase 6 Watershed Model.

Step 2. Results of Phase 6 Watershed Model are then input into the Estuary Model.

Data and Model Inputs
Pollution Control Data
Land Use Data
Point Sources Data
Septic Data
U.S. Census Data
Agricultural Data

Land Use Change Model

Airshed Model

Precipitation Data
Meteorological Data
Elevation Data
Soil Data

Phase 6 Watershed Model

Estuary Model

How has the Chesapeake Bay Suite of Modeling Tools improved over time?

The development and ongoing improvement of the suite of modeling tools is a highly collaborative process involving many partners, stakeholders and experts. Since its inception, the suite of modeling tools has undergone extensive peer review by federal, state and academic modeling experts and scientists.

The newest version of the suite is known as Phase 6. Its simplified structure makes it easier to use. The Phase 6 Suite of Modeling Tools includes expanded and improved data about:

- The sources and amount of nutrients entering the water;
- The latest, cutting-edge high-resolution land cover data from satellites; and
- New and updated information about the efficiencies of pollution-reducing best management practices.

Aerial imagery of Denton, Maryland, is overlaid with data from the Chespeake Bay High Resolution Land Cover Project. The data, newly included in the Watershed Model, delivers 900 times more information than existing data, showing land cover such as tree canopy (represented in dark green), buildings (represented in red) and roads (represented in black). (Image courtesy of the Chesapeake Conservancy)

The Phase 6 Suite of Modeling Tools can also simulate the environmental impacts of population growth, climate change and sediment build-up behind the Conowingo Dam (on the Susquehanna River in Maryland), which helps decision makers explore options for addressing these factors.

How can I use the Chesapeake Bay Suite of Modeling Tools?

The suite of modeling tools can be accessed online for free through the Chesapeake Assessment Scenario Tool (CAST). CAST allows local communities to run model simulations for various situations (or scenarios) that are relevant to their locality. The modeling results can help states, local governments and others identify which pollution prevention strategies and conservation practices make the most sense, given their available resources.

CAST helps local planners better understand which pollution control practices can provide the greatest reduction in nitrogen, phosphorus and sediment loads—and how much various implementation options might cost. Plus, CAST can indicate which practices would be most successful in different geographic areas, and how water quality and land use patterns might change as a result. Based on scenario outputs, planners can refine their choices.

Learn more about using CAST by viewing the Watershed Academy webinar at https://www.epa.gov/watershedacademy/using-cast-develop-implementation-plans-meet-loading-targets-chesapeake-bay.

Use the Chesapeake Assessment Scenario Tool at

cast.chesapeakebay.net

Phase 6 is the newest version of the Chesapeake Bay Watershed Model, now called the Chesapeake Bay Suite of Modeling Tools. Its simplified structure makes it easy to use and its data and information have been expanded and improved. But how is it different from the previous version?

What's New in the Phase 6 Watershed Model?

The Phase 6 Watershed Model brings more scientific and partnership input into the model than ever before. It includes new science, new data and new inputs, including those from industries not previously involved. Thanks to its new features, the model has further improved the ability to answer questions about how different land use types or land management decisions can affect nutrient and sediment pollution levels.

Highlights

The new model will be able to better predict the impacts of population growth and climate change and better account for the sediment build-up behind the Conowingo Dam on the Susquehanna River in Maryland.

Ten additional years of water quality monitoring data doubles the amount of real-time data and provides more insight into how pollution loads have changed as best management practices, which are practices used to control pollution entering the environment, have been implemented.

High-resolution land cover data allow for a one-by-one meter resolution, providing 900 times the amount of information than was previously available. This ground-breaking improvement will enable the prioritization and targeting of restoration, conservation, education and public access efforts.

Additional categories of land use data are included.

New inputs from the agricultural community, particularly the poultry industry, and improved and updated information on the application of fertilizer and manure will improve accuracy.

Additional best management practices are now credited and incorporated, including a few that have been re-analyzed for their effectiveness.

Improved nutrient input data have been added.

Combining multiple models (such as the former Scenario Builder) into one new model provides an entirely new approach to water quality simulation.

A simulation period that runs over 20 years rather than 10 years allows for finer-scale analysis and planning.

Resources

To access the Phase 6 Watershed Model, or the Chesapeake Bay Assessment Tool (CAST), visit https://cast.chesapeakebay.net. For more information on modeling at the Chesapeake Bay Program, visit https://www.chesapeakebay.net/what/programs/modeling.

What is a model?

- Scenarios, or model simulations, of an ecosystem can estimate the impact of various changes or actions on water quality, wildlife and aquatic life.
- Model simulations, when combined with research and observations, provide best estimates based on the most up-to-date and corroborative science.

Why use a model?

- The Chesapeake Bay, its watershed and airshed are large and complex, so scientists and decision-makers rely on computer models for information about the ecosystem and the impact of efforts to reduce pollution and improve water quality.
- The models used by the Chesapeake Bay Program partnership play a key role in the process of understanding and managing nutrient pollution throughout the Chesapeake Bay watershed and airshed.
- The Chesapeake Bay Program partnership models can support development of planning targets and watershed implementation plans, or WIPs.

Chesapeake Bay Program models

- The Chesapeake Bay Program partnership uses a suite of computer models that are among the most sophisticated, studied and respected in the world.
- The Chesapeake Bay Program partnership applies state-of-the-art models of land use, the watershed, the airshed and the tidal Bay that are extensively peer-reviewed by the science community.
- These models provide a comprehensive view of the Chesapeake Bay ecosystem, from the depths of the Bay to the upper reaches of the watershed, including the land and the air deposition of nitrogen.
- The suite of modeling tools used by the Chesapeake Bay Program partnership include the Watershed Model, Estuary Model, Airshed Model and Land Change Model.
- The full Watershed Model is available online as the Chesapeake Assessment Scenario Tool, or CAST.
- The Estuary and Airshed models are open and free for anyone to use, although it is highly recommended that one has a familiarity and knowledge of how these models work to use them.

Airshed Model

- The Airshed Model uses information about nitrogen emissions from power plants, vehicles and other sources to estimate the amount of and location where reactive nitrogen oxides and ammonia are deposited on the tidal Chesapeake Bay and its watershed.
- Information from the Airshed Model on atmospheric nitrogen loads is used as input into the Watershed Model and Estuary Model.
- The Airshed Model is a national model run by the Environmental Protection Agency.

Estuary Model (Water Quality and Sediment Transport Model)

- The Estuary Model, also called the Water Quality and Sediment Transport Model, examines the effects that pollution loads generated by the Watershed Model and Airshed Model have on water quality in the tidal waters of the Bay.
- This model uses a water quality standard analysis system to examine model estimates of dissolved oxygen, chlorophyll a and water clarity to assess in time real-time the attainment of Chesapeake Bay living resource-based water quality standards.

Land Change Model

- The Land Change Model analyzes and forecasts the effects of urban land use and population on sewer and septic systems in the Chesapeake Bay watershed.
- The forecasts are based on reported changes from the U.S. Census Bureau in housing, population and migration; and land cover trends (including the conversion of forests and farmland to development) derived from analysis of high-resolution land cover data and satellite imagery.

Watershed Model

- The Watershed Model incorporates information about land use, fertilizer applications, wastewater plant discharges, septic systems, air deposition, farm animal populations, management practices, watershed characteristics, stream characteristics, weather and other variables to estimate the amount of nutrients and sediment reaching the Chesapeake Bay and where these pollutants originate.
- The Watershed Model divides the 64,000-square-mile Chesapeake Bay watershed into more than 2,000 segments delineating political and physical boundaries.
- The Watershed Model was built through a collaborative process through Chesapeake Bay Program partnership, which directed a development team made up of federal, academic, nonprofit and contractor staff.
- The Watershed Model uses multiple models and multiple lines of evidence to estimate the delivery of nutrients and sediment to the Chesapeake Bay.
- The Watershed Model can be used at the Chesapeake Bay watershed scale as well as smaller scales for state-developed Total Maximum Daily Loads (TMDLs).
- The success of the Watershed Model depends on the real world data that feeds it, which requires a partnership with many stakeholders in the states, local governments and science agencies.
- The Watershed Model helps connect monitoring data and the planning and implementation of restoration practices.
- The Watershed Model can generate simulations of the past, present and future state of the Chesapeake Bay watershed to explore potential impacts of management actions and evaluate alternatives based on a variety of factors (e.g., land uses and management actions).

Web-based models

- Currently both Virginia and Maryland have their own web-based modeling tool based on the Watershed Model, called the Virginia Assessment Modeling Tool (VAST) and Maryland Assessment Modeling Tool (MAST), respectively.
- The Chesapeake Bay Facility Assessment Scenario Tool, or BayFAST, is a web-based version of the Watershed Model that is geared toward facilities.

New features in the Phase 6 Watershed Model

- The Phase 6 Watershed Model is the most recent version of the Chesapeake Bay Watershed Model, replacing version 5.3.2 which has been used to set the 2011 planning targets and track the Phase II Watershed Implementation Plans.
- The Phase 6 Watershed Model brings more scientific and partnership input into the model than ever before.
- This new version of the model includes new science, new data and new inputs from the agriculture community.
- The Phase 6 Watershed Model will take into account policy decisions made about the Conowingo Dam, climate change and growth projections (including humans, animals, zoning and land use).
- The Phase 6 Watershed Model contains a more simplified structure that makes it easier to work with and understand.
- The new model contains almost double the amount of data than was in the Phase 5.3.2 version, including 10 more years of monitoring data.
- The model now includes over 30 years' worth of monitoring data that can be used to calibrate or determine the accuracy of the land use and location simulations that it produces.
- Phase 6 contains a few new types of best management practices, or BMPs, as well as a few BMPs that have been re-analyzed for their effectiveness.
- The Phase 6 Watershed Model includes high-resolution land cover data, allowing for a one-by-one meter resolution of land cover data, which provides 900 times the amount of information as previously available.
- In the Phase 6 Watershed Model, all pollution loads will be identical between CAST and the Watershed Model because the calculation engine will be the same and only the interfaces will differ.
- With the unification of these modeling tools, the Maryland Assessment Scenario Tool (MAST) and the Virginia Assessment Scenario Tool (VAST) will be replaced by CAST.

How does the model work?

- Models are built on current and specific uses of land in the watershed, such as forests, farms and development.
- Land uses are determined by using authoritative sources, such as satellite imagery and the U.S. Department of Agriculture Census of Agriculture.
- Models are further refined by inputting land management features, such as cover crops on farm fields and stormwater controls in urban areas.
- The types and amounts of pollution that run off a particular land use are based on multiple lines of evidence including several existing regional models.

- Pollution loads are cross-checked with comprehensive reviews of the latest scientific literature.
- Delivery of these loads through the land and water is estimated based on observed data and measureable characteristics of the landscape.
- Pollution loads are further adjusted based on in-stream monitoring data, which increases accuracy for land use and location.
- Once the model is successfully simulating the past, details about conservation practices, management actions and pollution controls that may be implemented in specific places are entered into the model to estimate reductions from these factors.

Links

- Chesapeake Assessment Scenario Tool (CAST)
- Chesapeake Bay Facility Assessment Scenario Tool (BayFAST)

DYK? @chesbayprogram uses a suite of computer models to simulate how changing conditions could impact the ecosystem. https://www.chesapeakebay.net/news/blog/groundbreaking_land_cover_data_to_support_chesapeake_bay_restoration_effort

.@chesbayprogram's Watershed Model is available as the Chesapeake Assessment Scenario Tool (CAST). Check it out: https://cast.chesapeakebay.net/

#DidYouKnow? @chesbayprogram's Watershed Model has been completely updated and is now available to help local governments and planners reduce pollution. https://www.chesapeakebay.net/news/blog/groundbreaking_land_cover_data_to_support_chesapeake_bay_restoration_effort

#DidYouKnow? @chesbayprgoram uses a suite of four models to provide a comprehensive view of the watershed. https://www.chesapeakebay.net/news/blog/groundbreaking_land_cover_data_to_support_chesapeake_bay_restoration_effort

Learn more about how modeling works in estimating how much pollution reaches the Chesapeake Bay. https://www.chesapeakebay.net/what/programs/modeling

Check out @chesbayprogram's video to learn how modeling and monitoring help reduce pollution across the #ChesBay region. https://www.chesapeakebay.net/discover/bay-101/bay_101_monitoring_and_modeling_the_chesapeake_bay

#DidYouKnow that @chesbayprogram's updated Watershed Model includes high resolution land cover data? @ChesConserv https://www.chesapeakebay.net/news/blog/groundbreaking_land_cover_data_to_support_chesapeake_bay_restoration_effort

Facebook

Since the Chesapeake Bay watershed is so vast, the Chesapeake Bay Program uses models for information on the ecosystem and to estimate the reduction of pollution loads. #DidYouKnow? The model has recently been updated to include decades of new data and high-resolution land cover data—all of which will help local governments learn how to effectively reduce pollution and plan for the future.

https://www.chesapeakebay.net/news/blog/updated_tools_help_address_pollution_and_plan_for_the_future

The Chesapeake Bay Program's updated Watershed Model includes high-resolution land cover data that provides 900 times the amount of information that was available in the previous model. Learn more about the high-resolution land cover data and the Bay Program's partnership with the @ChesapeakeConservancy. https://www.chesapeakebay.net/news/blog/groundbreaking_land_cover_data_to_support_chesapeake_bay_restoration_effort

The Chesapeake Bay Program has updated its Watershed Model to help state and local governments plan to reduce pollution. The new model contains almost double the amount of data as the previous version, including ten more years of monitoring information. Check out this Bay 101 video on modeling and monitoring to find out how it all works. https://www.chesapeakebay.net/discover/bay-101/bay_101_monitoring_and_modeling_the_chesapeake_bay

#DidYouKnow that the Chesapeake Bay Program uses a suite of four models to help understand and manage pollution in the watershed? Learn more about how modeling works at the Chesapeake Bay Program. https://www.chesapeakebay.net/what/programs/modeling

The Chesapeake Bay Program is revamping its current Watershed Model! The Phase 6 Watershed Model is now available for free as the Chesapeake Assessment Scenario Tool, or CAST. https://cast.chesapeakebay.net/