Climate Change & the Midpoint Assessment: Methods, Process and Key Decisions

CHESAPEAKE BAY TMDL 2017 MIDPOINT ASSESSMENT WEBINAR SERIES
OCTOBER 18, 2016

Chesapeake Bay Program
Science. Restoration. Partnership.

Welcome to the Climate Change Webinar

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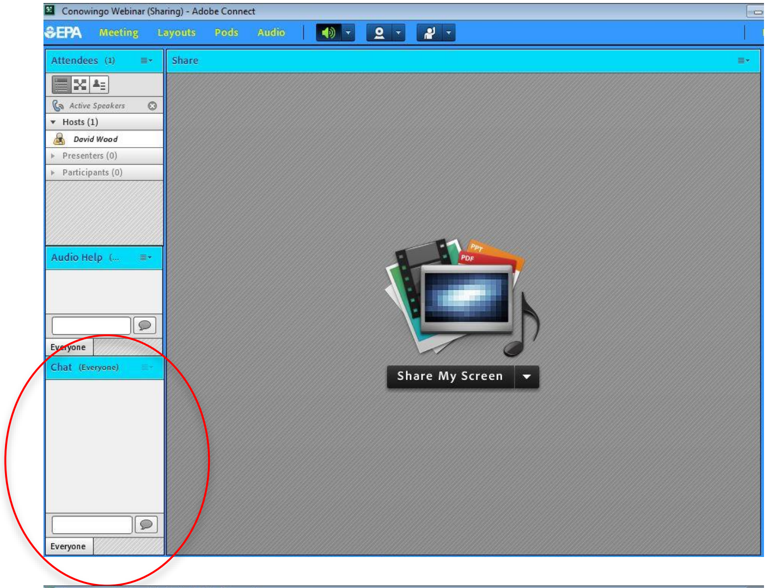

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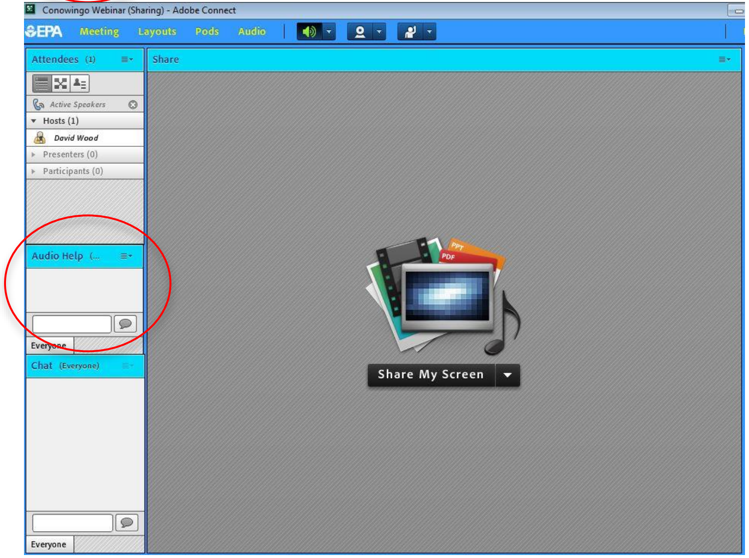

Welcome to the Climate Change Webinar

- We ARE Recording this Session
  - The recording and related resources will be available on the Chesapeake Bay Program's calendar page for today's webinar.
  - http://www.chesapeakebay.net/calendar/event/24332/

Goals for Today's Webinar

- Increase understanding of what current science, research, modeling and assessment are telling us about climate change and its impacts on Chesapeake Bay water quality standards attainment.

- Review preliminary modeling results and gain insights into how the impacts could influence expectations for the states' nutrient and sediment pollutant load reductions between 2018 and 2025.

- Explore options for how to integrate consideration of climate change into the Phase III WIPs.

- Overview of partnership timeline for deciding when and how to factor climate change considerations into the Phase III WIPs.

Today's Speakers

Zoë Johnson
National Oceanic and Atmospheric Administration
CBP Climate Change Coordinator

Mark Bennett
U.S. Geological Survey
CBP Climate Resiliency Workgroup Co-Chair

Lew Linker
U.S. Environmental Protection Agency
CBP Modeling Workgroup Coordinator

David Wood
Chesapeake Research Consortium
CBP Water Quality Goal Implementation Team Staff

Setting the Stage: Climate Change in the Chesapeake Bay Program Partnership

Zoë Johnson
National Oceanic and Atmospheric Administration
CBP Climate Change Coordinator

2014 Chesapeake Bay Agreement

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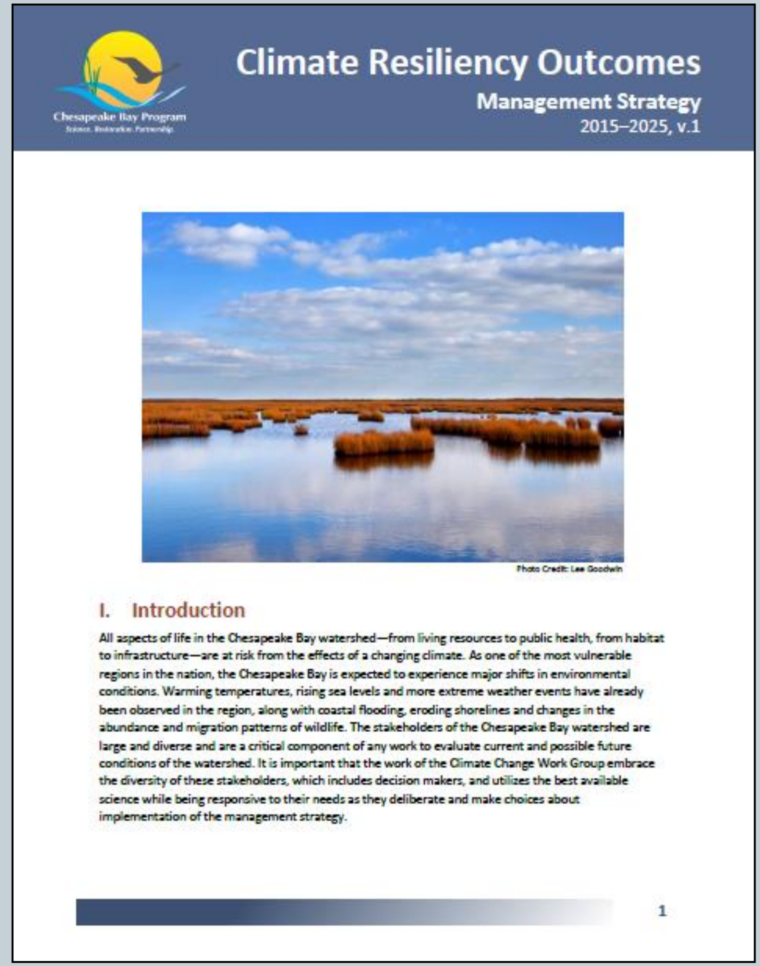
CLIMATE RESILIENCY

GOAL: Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure and communities, to withstand adverse impacts from changing environmental and climate conditions.

- **Monitoring and Assessment Outcome:** Continually monitor and assess the trends and likely impacts of changing climatic and sea level conditions on the Chesapeake Bay ecosystem, including the effectiveness of restoration and protection policies, programs and projects.
- **Adaptation Outcome:** Continually pursue, design and construct restoration and protection projects to enhance the resiliency of Bay and aquatic ecosystems from the impacts of coastal erosion, coastal flooding, more intense and more frequent storms and sea level rise.

Key Partnership Climate Change-Related Commitments and Recommendations

- *2010 Chesapeake Bay TMDL*
- *2010 Executive Order 13058: Strategy for Protecting and Restoring the Chesapeake Bay Watershed*
- *2014 Chesapeake Bay Watershed Agreement*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Climate Resiliency Outcomes

Management Strategy
2015–2025, v.1

Photo Credit: Lee Goodwin

I. Introduction

All aspects of life in the Chesapeake Bay watershed—from living resources to public health, from habitat to infrastructure—are at risk from the effects of a changing climate. As one of the most vulnerable regions in the nation, the Chesapeake Bay is expected to experience major shifts in environmental conditions. Warming temperatures, rising sea levels and more extreme weather events have already been observed in the region, along with coastal flooding, eroding shorelines and changes in the abundance and migration patterns of wildlife. The stakeholders of the Chesapeake Bay watershed are large and diverse and are a critical component of any work to evaluate current and possible future conditions of the watershed. It is important that the work of the Climate Change Work Group embrace the diversity of these stakeholders, which includes decision makers, and utilizes the best available science while being responsive to their needs as they deliberate and make choices about implementation of the management strategy.

1

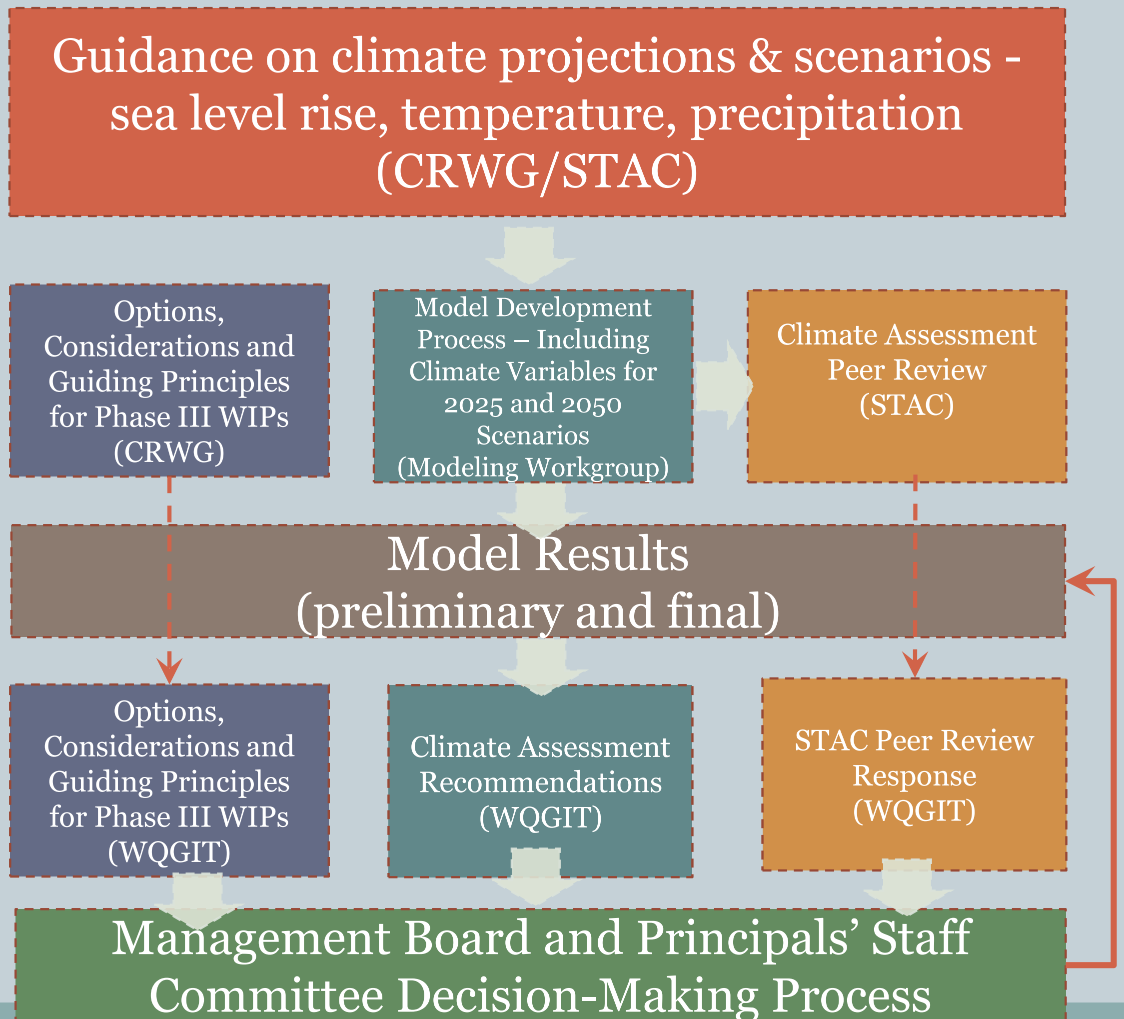
Climate Change & the TMDL Midpoint Assessment Considerations

- Assess how climate change may affect current water quality standards (i.e., nutrient and sediment source loads over time)
  - Precipitation change (increased volume and intensity)
  - Temperature increase (air and water)
  - Sea level rise (hydrodynamics and impacts to beneficial resources (i.e., wetlands)

- Evaluate climate impacts on the effectiveness of existing water quality BMPs over time
  - BMP water quality efficiencies
  - "Climate-smart " siting and design guidance for BMP implementation

- Explore options for how and when to address projected climate-related changes in water quality standards
  - Incorporate changes into Phase III WIPS
  - Add an explicit Margin of Safety (MOS)
  - Strategically incorporate into select BMP practices (e.g., wetland restoration, storm water)
  - Seek opportunities to prioritize BMP's with ancillary "climate resilience" benefits (storm surge and flood attenuation, shore protection)
  - Defer integration but continue to monitor, assess and adaptively manage

Decision-Making Process



Guidance on climate projections & scenarios - sea level rise, temperature, precipitation

Mark Bennett
U.S. Geological Survey
CBP Climate Resiliency Workgroup Co-Chair

The Development of Climate Projections for Use in Chesapeake Bay Program Assessments

Scientific and Technical Advisory Committee (STAC) Workshop

March 7-8 2016

STAC Workshop Goals

1. What climate change variables are of most concern to the CBP partners in the consideration of the 2017 Midpoint Assessment decisions and for longer term climate change management decisions?

2. What are the approaches that can be taken to select climate change scenarios for CBP assessments?

3. What characteristics of those climate variables need to be specified, e.g., temporal, spatial, and other relevant characteristics? In what format are scenarios needed to provide the most utility at the regional, state, and local levels?

4. What climate change scenarios meet CBP decision making needs for the 2017 Midpoint Assessment as well as for longer term climate change management decisions and programmatic assessments?

Workshop Recommendations

- The Partnership should seek agreement on the use of consistent climate scenarios for regional projections of Chesapeake Bay condition and the benefits of an integrated source of climate change projection simulation data that all seven jurisdictions could draw from.
- For the 2017 Midpoint Assessment, use historical (~100 years) trends to project precipitation to 2025 as opposed to utilizing an ensemble of future projections from GCMs. Shorter term climate change projections using GCMs have large uncertainties because climate models are structured to look further out and at much larger scales.
- The Program should carefully consider the representation of evapotranspiration in watershed model calibration and scenarios because the calculation method for evapotranspiration has a strong influence on the strength and direction of future water balance change.
- Looking forward, the 2050 timeframe is more appropriate for selecting and incorporating a suite of global climate scenarios and simulations to provide long-term projections for the management community, and an ongoing adaptive process to incorporate climate change into decision-making as implementation moves forward.

Workshop Recommendations

- Beyond the 2017 Midpoint Assessment, it is recommended that the CBP use 2050 projections for best management practice (BMP) design, efficiencies, effectiveness, selection, and performance – given that many of the BMPs implemented now could be in the ground beyond 2050.
- For any 2050 assessment, use an ensemble or multiple global climate model approach, selecting model outputs that bound the range of key climate variables (e.g., temperature, precipitation) for the Chesapeake Bay region. Use multiple scenarios covering a range of projected emissions (RCP 4.5 and 8.5 are a reasonable range to select and are currently being utilized for Fourth National Climate Assessment). Include the 2 °C emissions reduction pathway (RCP 2.6) as well as more "business as usual" assumptions.
- Select an existing system to access GCM downscaled scenario data (such as ‘LASSO’ described in more detail in Section II) in lieu of conducting a tailored statistical climate downscaling process for the Chesapeake Bay watershed.

Chesapeake Bay TMDL 2017 Midpoint Assessment

Recommendations on Incorporating Climate-Related Data Inputs and Assessments: Selection of Sea Level Rise Scenarios and Tidal Marsh Change Models

Climate Resiliency Workgroup

August 5, 2016

Climate Resiliency Workgroup Recommendations - SLR

- The CRWG recommends that the CBP leadership consider the application of the plausible range of sea level rise projections for CBWQSTM modeling efforts, with upper and lower limits, for the years 2025 and 2050.

- In selecting the range of scenarios, the upper bound should be consistent with a higher emissions scenario (but not the extreme upper scenario). This would result in the upper bound corresponding with the 99.5% probability, plus 0.1m to account for interannual variability.

- The lower range value should be within the “likely” range, as presented by Dr. Kopp, consistent with a lower emission scenario (RCP 2.6), but not be the extreme lower scenario which depicts historical tide gauge trend.

- Based on the considerations above, the CRWG recommends that the following range of sea level rise projections for 2025 (.2 - .4 m) and 2050 (.3-.8 m) be applied in the CBWQSTM.

Climate Resiliency Workgroup Recommendations - Wetlands

- Use a multi-model approach, tied to the CRWG's recommended range of sea level rise projections for 2025 and 2050, to gain estimates of current wetland area and projected wetland loss/gain. Use these estimates to inform watershed loads in the CBWQSTM modeling effort.

- To estimate project wetland gain/loss, analyze data results available through the National Wildlife Foundation, Sea Level Affecting Marsh Model v.5 of the Chesapeake Bay (2008) and data available through NOAA's Office for Coastal Management Sea Level Rise Marsh Impacts and Migration Tool.

- In interpreting the data available through these two products, assess whether the sea level rise projections used for the studies were consistent with the 2025 and 2050 SLR projections (as recommended by the CRWG); or, in the case of the NOAA Marsh Tool, whether data runs could be acquired for a different SLR scenario.

- The USGS/CBP GIS Team, which is working to compile the land use/land cover data set for the Midpoint Assessment, should work with the EPA/CBP Modeling Team to ensure there is consistency among the wetland classifications included in the marsh loss modeling outputs (NWF SLAMM (2008) and the NOAA Marsh Tool) to allow for side by side comparison of results.

Developing the Ability to Understand Climate Change Impacts and Implications for CBP Management Actions

Lew Linker
U.S. Environmental Protection Agency
CBP Modeling Workgroup Coordinator

Introduction:

- The Modeling Workgroup is developing the tools to quantify the effects of climate change on watershed flows and loads, storm intensity, increased estuarine temperatures, sea level rise, and ecosystem influences including loss of tidal wetland attenuation with sea level rise, as well as other ecosystem influences.
- Current efforts are to frame initial future climate change scenarios based on estimated 2025 (potential TMDL application) and 2050 conditions (future condition scoping scenario application).

Water Quality Standards of Deep Water, Deep Channel, Open Water, and Shallow Water Dissolved Oxygen (DO) are key for protection of living resources. Chlorophyll and SAV/clarity standards are also designed to protect living resources.

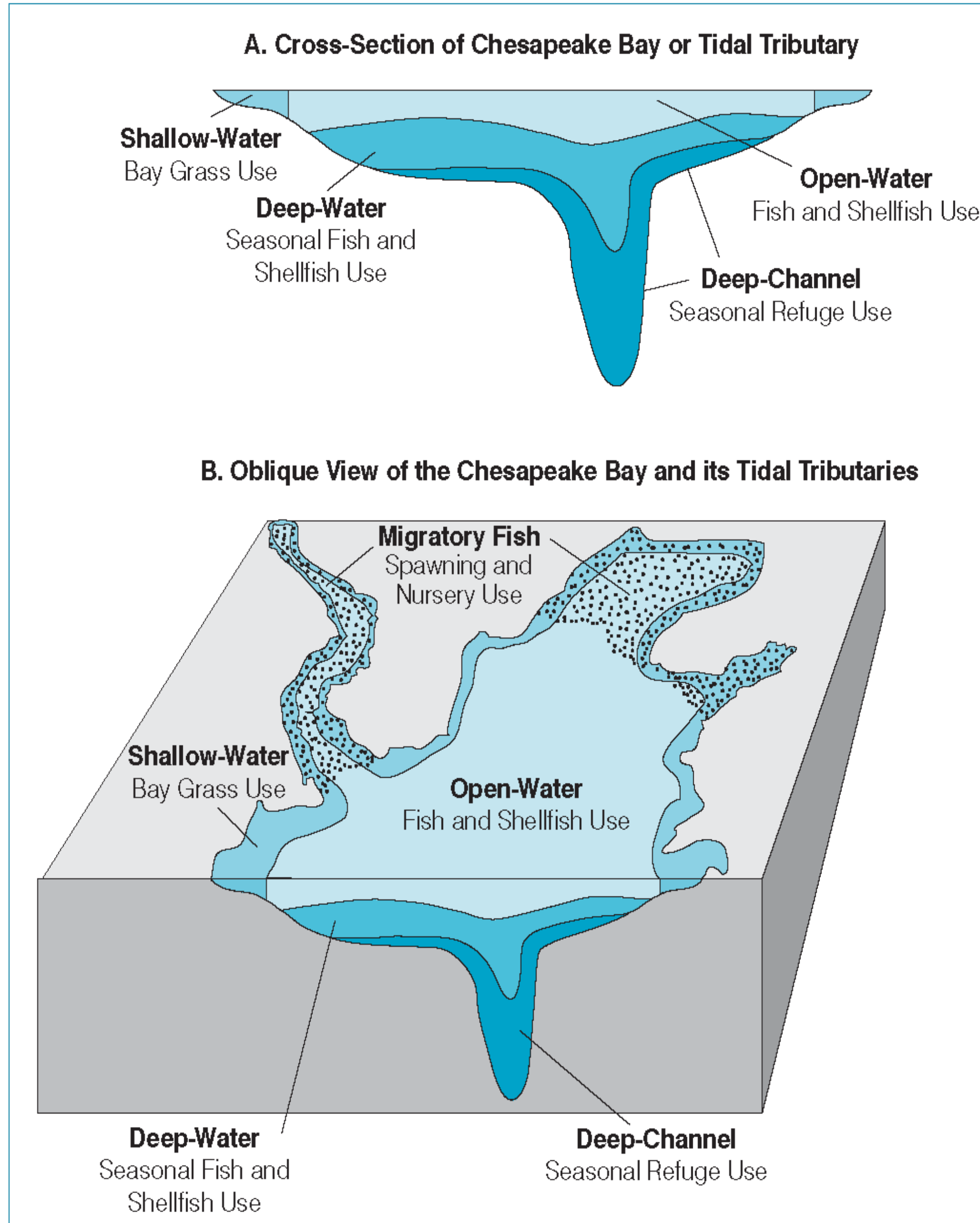
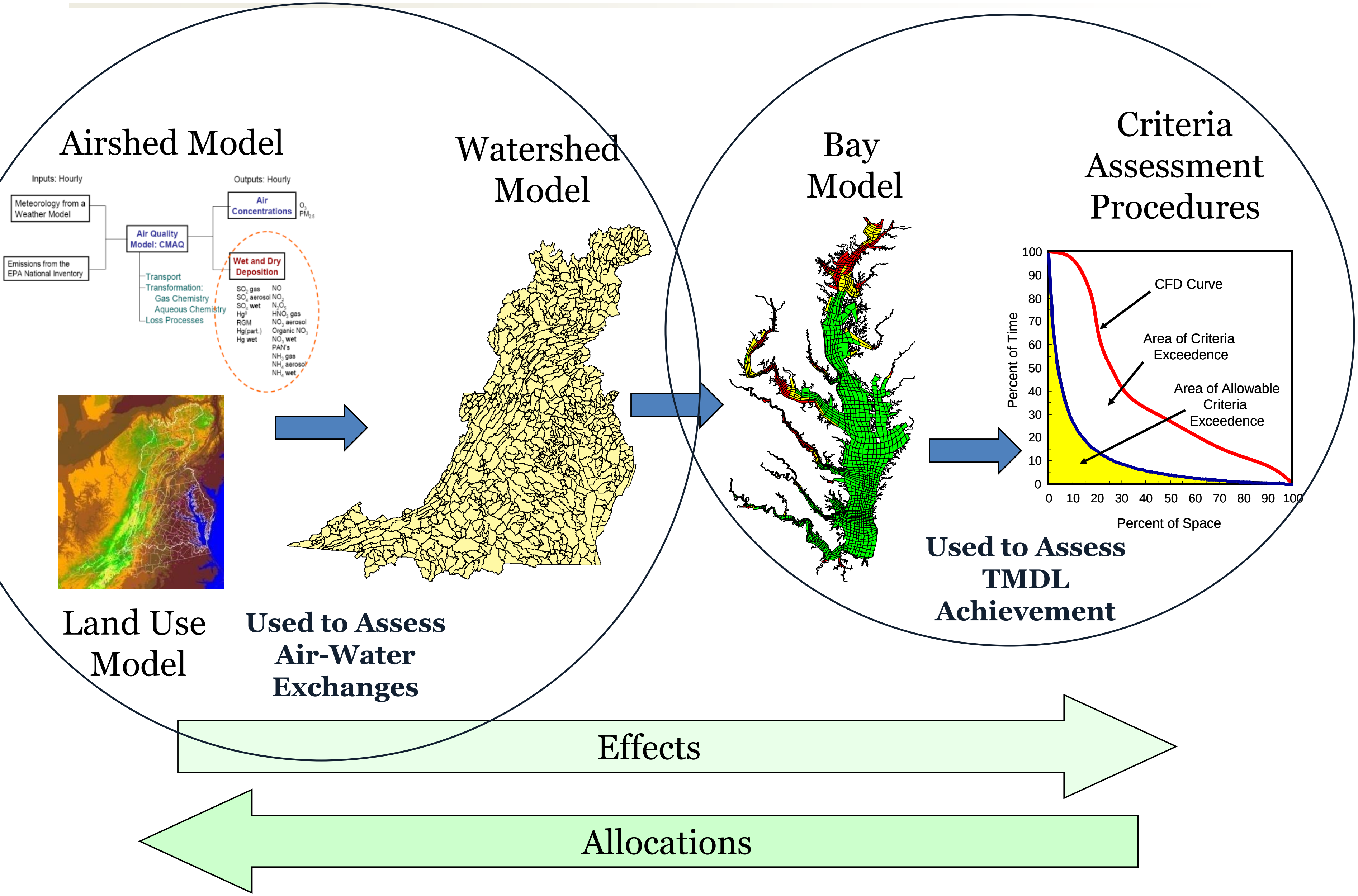


Figure IV-5. Conceptual illustration of the five Chesapeake Bay tidal-water designated use zones.

Source: Batiuk (2003)

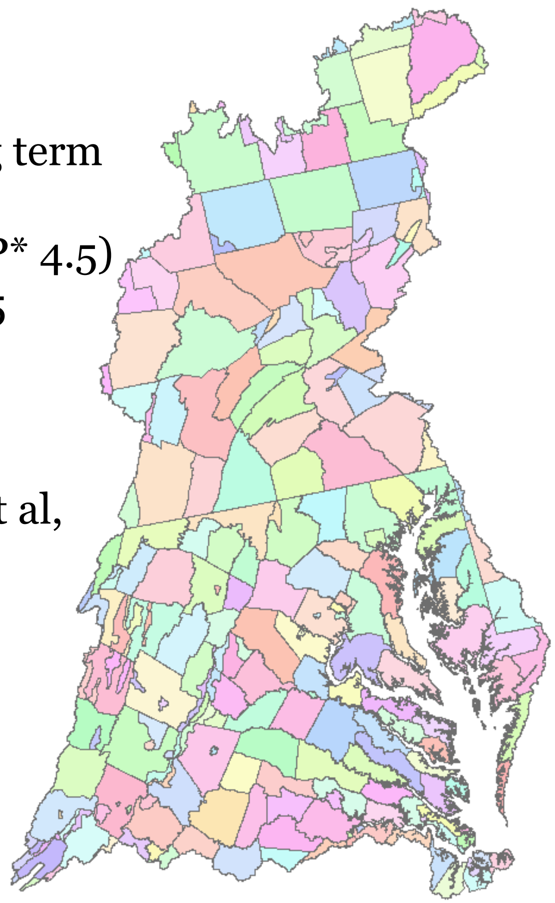
Water Quality Standard Assessment System

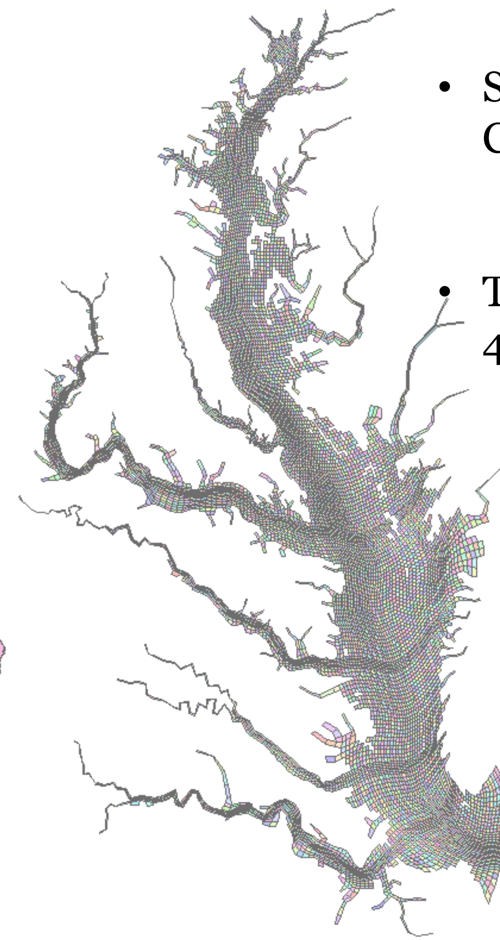


Model Climate Inputs

Model inputs were consistent with STAC Workshop and Climate Resiliency Workgroup Guidance

- Precipitation Volume
  - 2025: +3.1% (long term trends)
  - 2050: +7.3% (RCP* 4.5)
- Temperature: RCP 4.5
  - 2025: +1.05 ^{0}C
  - 2050: +2.08 ^{0}C
- CO_2 Concentration: Meinhausen, Malte, et al, (2011)
  - 2025: 427 ppm
  - 2050: 487 ppm





- Sea Level Rise: CRWG**
  - 2025: +0.3 m
  - 2050: +0.5 m
- Temperature: RCP 4.5
  - 2025: +0.95 ^{0}C
  - 2050: +1.86 ^{0}C

*RCP 4.5 signifies a specific Representative Concentration Pathway scenario as defined by the Intergovernmental Panel on Climate Change

**Based upon guidance provided by the Climate Resiliency Workgroup

Today We're Examining:

Watershed Hydrologic and Loading Changes (2025)

- Changes in precipitation volume
- Changes in precipitation intensity

Increased Estuarine Temperature (2050)

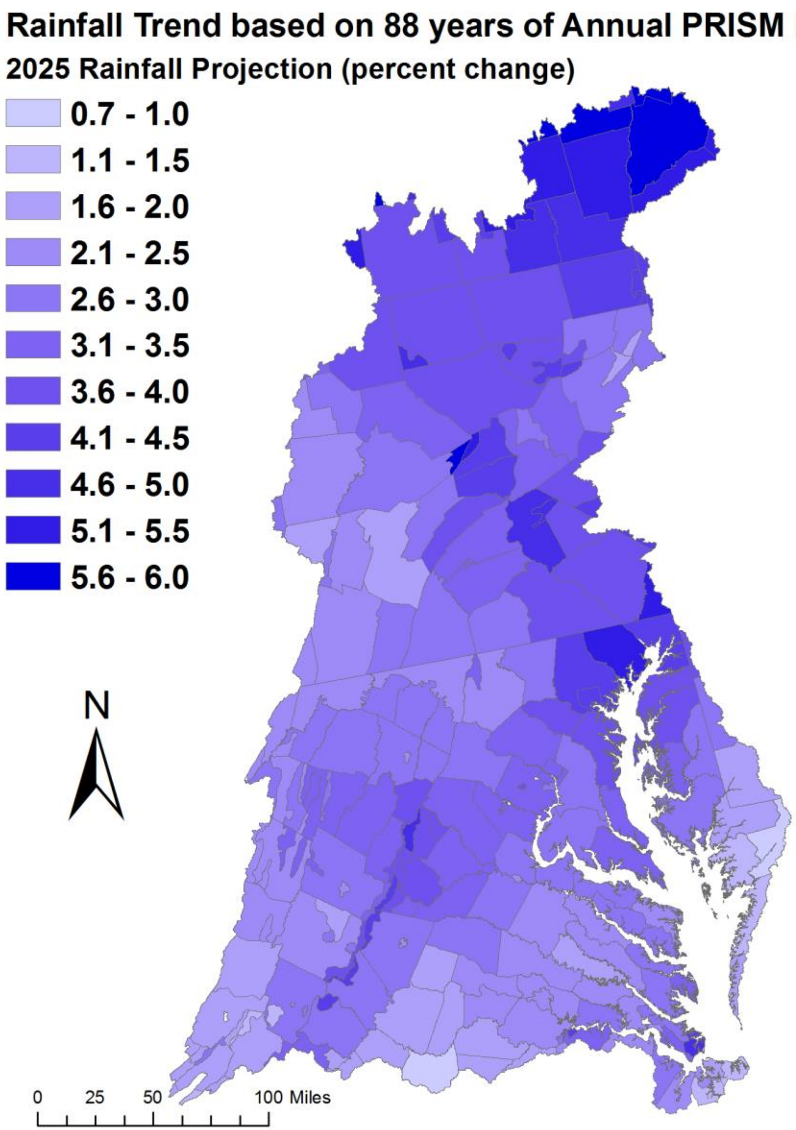
- Direct warming of tidal water
- Indirect warming from watershed inputs
- Indirect warming from ocean boundary inputs

Sea Level Rise (2050)

- Influence on hydrodynamics
- Influence on tidal wetland loss and associated loss of nutrient attenuation

Influence of 2025 Increased Precipitation Volume & Intensity

Change in Rainfall using Annual Trend in PRISM data (88 Years)

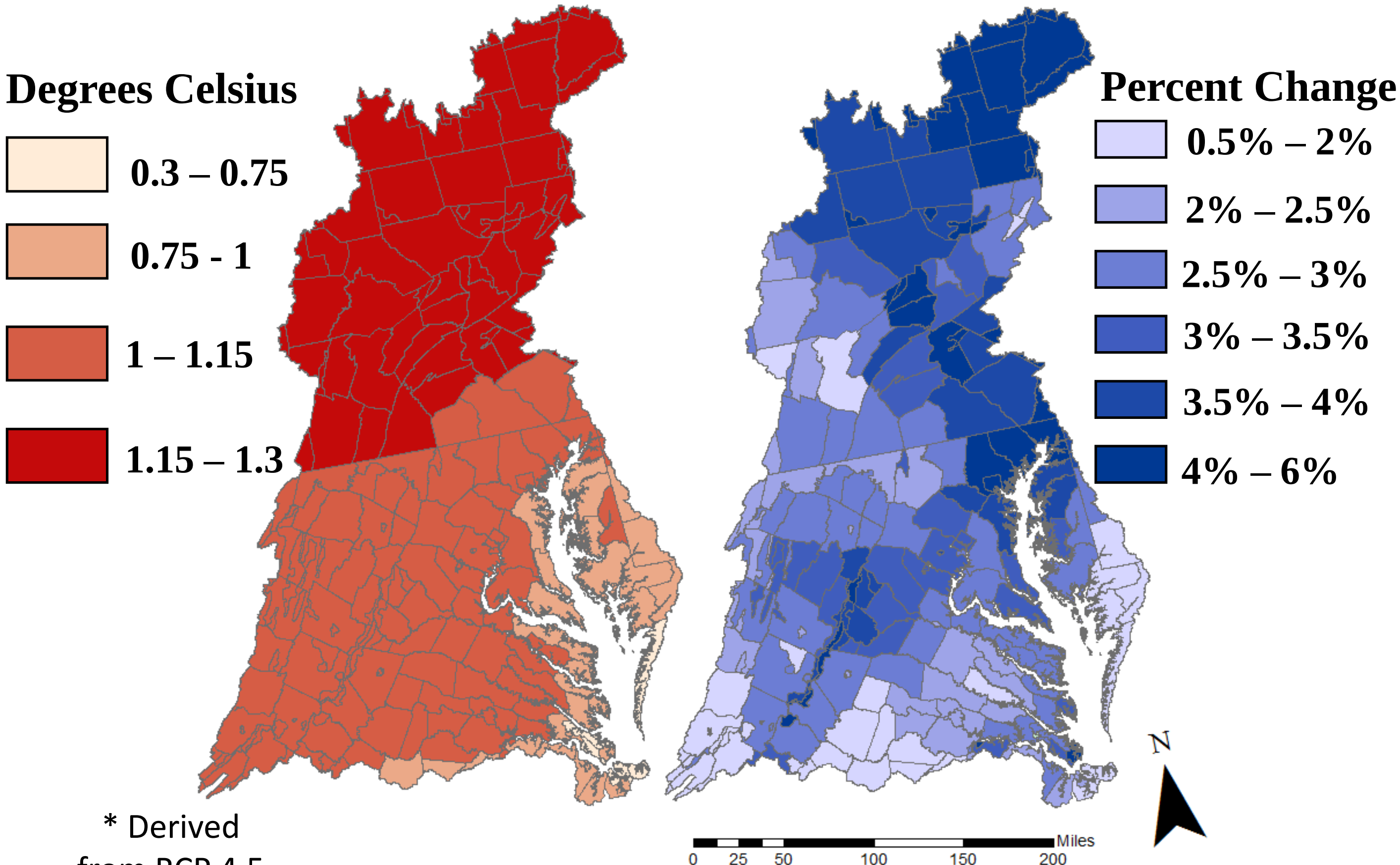


Change in Rainfall Volume 2021-2030 vs. 1991-2000

Major Basins	PRISM Trend
Youghiogheny River	2.1%
Patuxent River Basin	3.3%
Western Shore	4.1%
Rappahannock River Basin	3.2%
York River Basin	2.6%
Eastern Shore	2.5%
James River Basin	2.2%
Potomac River Basin	2.8%
Susquehanna River Basin	3.7%
Chesapeake Bay Watershed	**3.1%**

Source: Gopal Bhatt, Penn State and Kyle Hinson, CRC

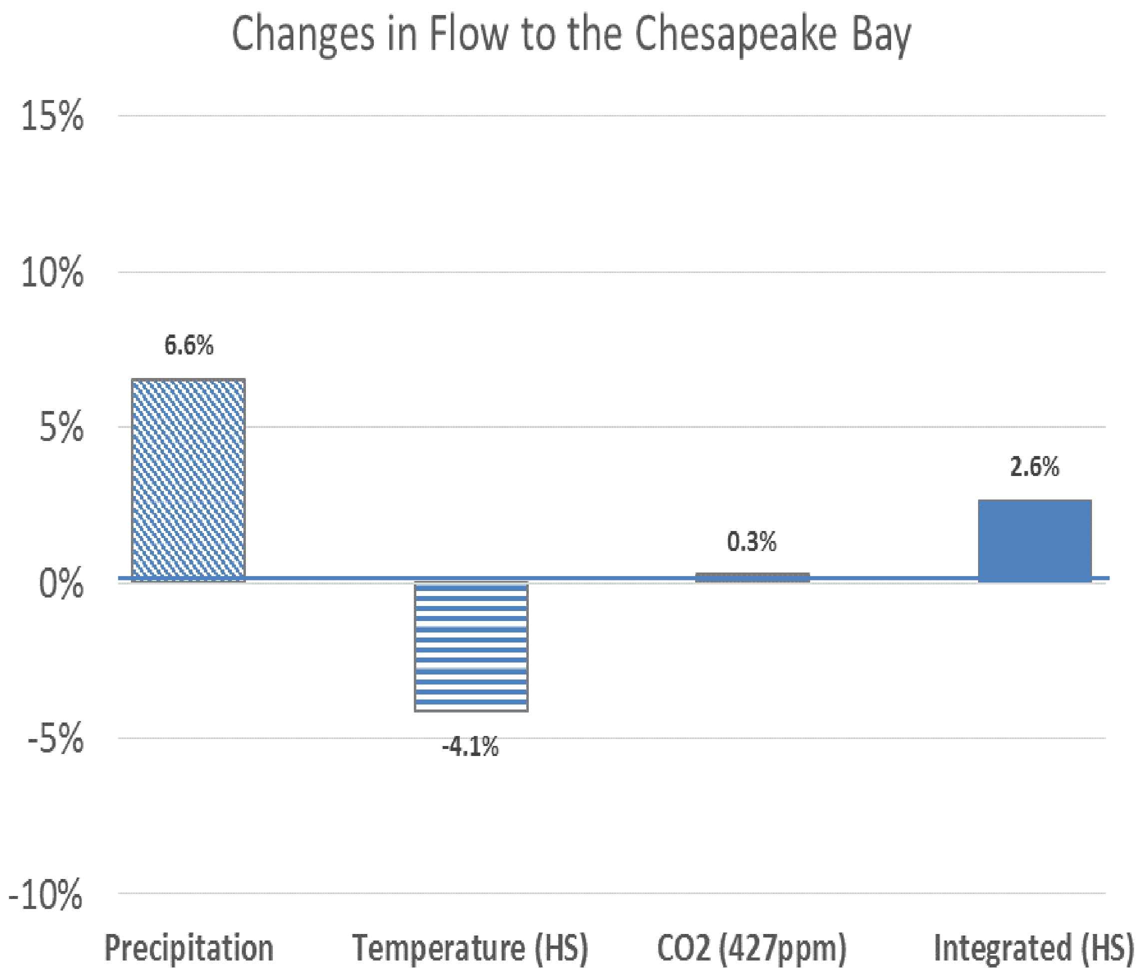
CB Watershed 2025 Changes in Temperature* and Precipitation



* Derived from RCP 4.5

Source: Gopal Bhatt, Penn State and Kyle Hinson, CRC

Estimated Influence of 2025 Increased Precipitation Volume & Intensity on Flow



The influence of estimated precipitation increase alone on Chesapeake flow is a 7% increase.

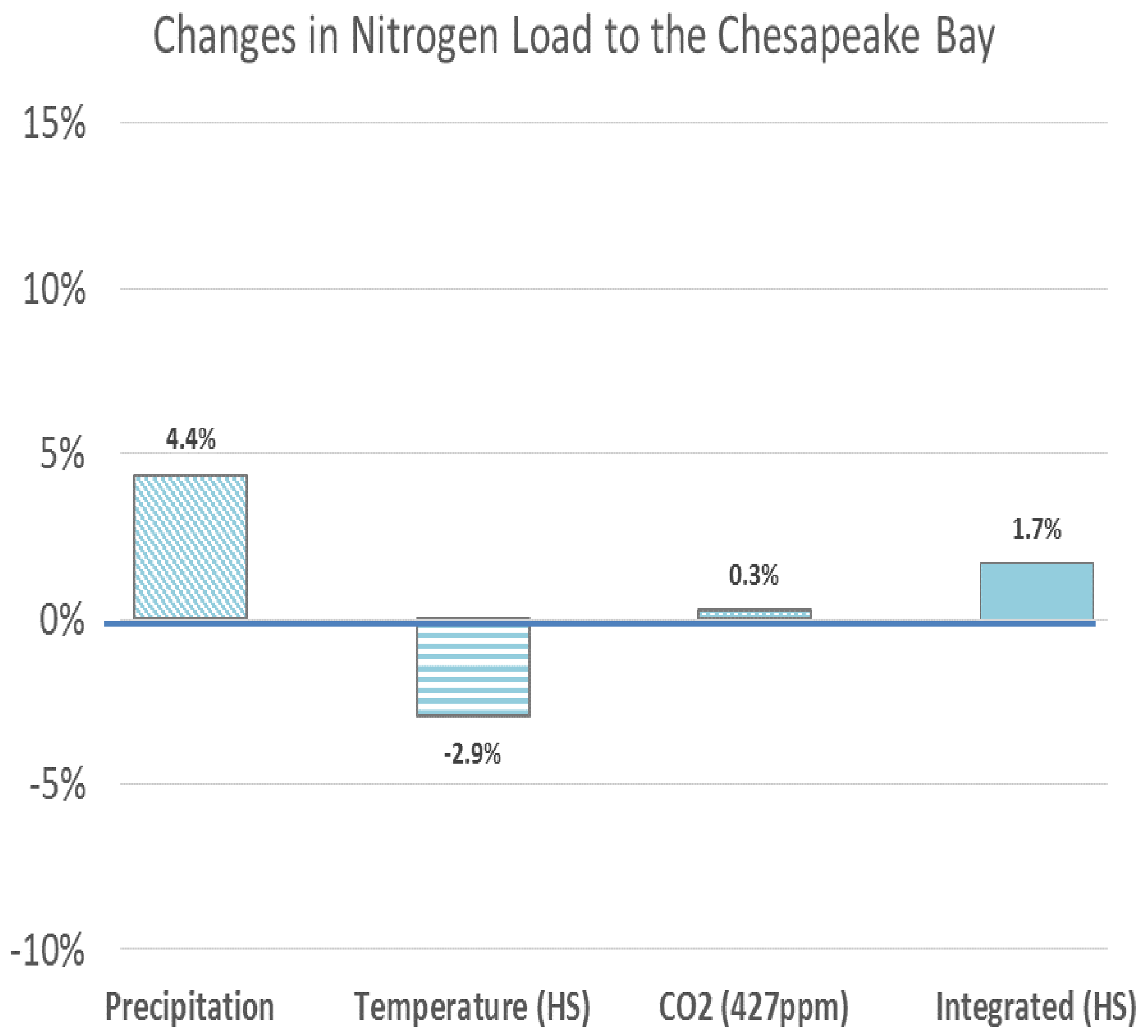
The influence on flow due to the estimated 2025 temperature increase (evapotranspiration via Hargreaves method) is an overall flow decrease of 4%.

The sole influence of CO_2 is to increase flow by 0.3%.

Overall the combined influence of estimated climate change on flow is an increase of 3%.

Source: Gopal Bhatt, Penn State; Kyle Hinson, CRC; and Andrew Sommerlot, UMCES

Estimated Influence of 2025 Increased Precipitation Volume & Intensity on Total Nitrogen Loads



The influence of estimated precipitation increase alone on nitrogen loads is a 4% increase.

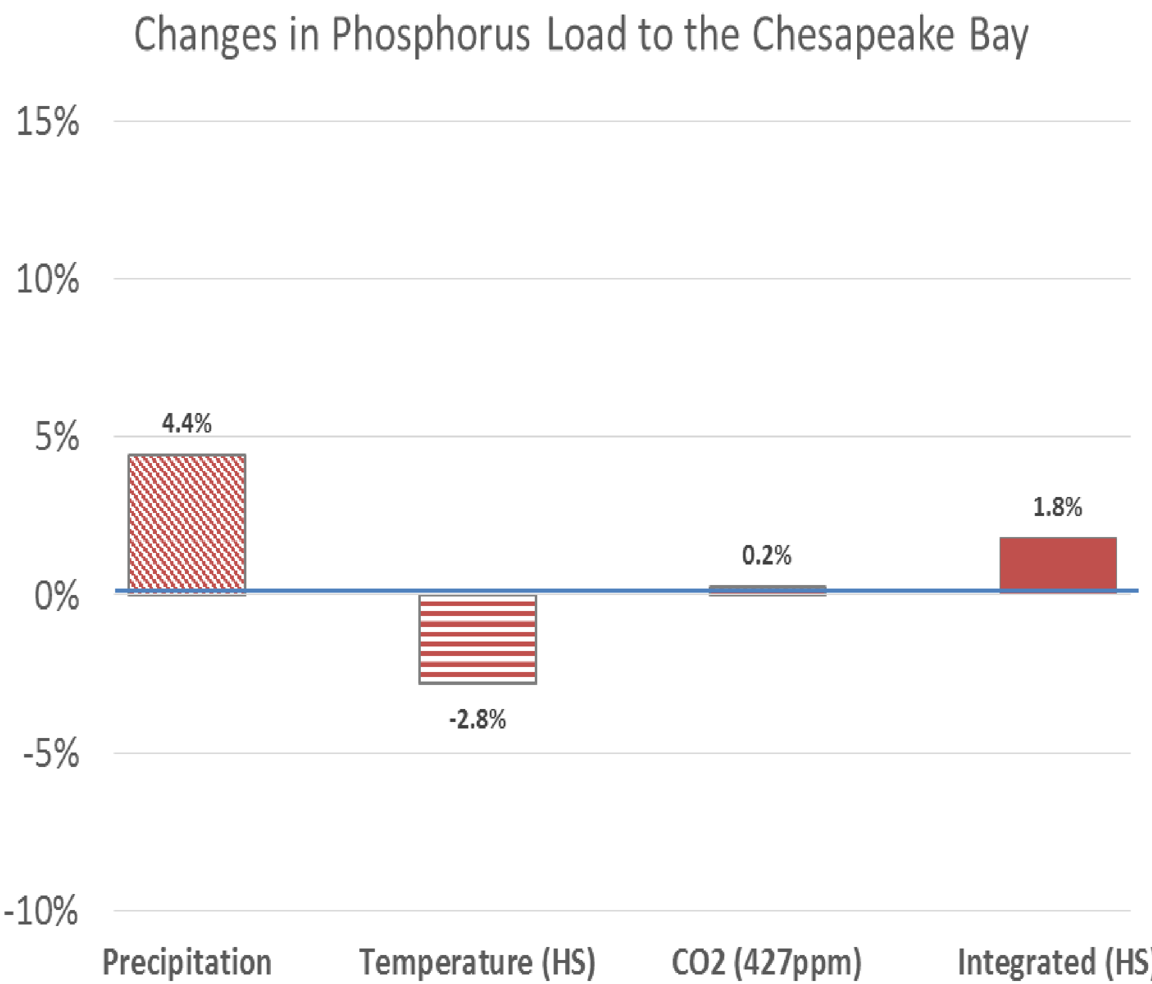
The influence of the estimated 2025 temperature increase on evapotranspiration (Hargreaves method) alone results in an overall nitrogen load decrease of 3%.

The sole influence of CO_2 is to increase nitrogen loads by 0.3%

Overall the combined influence of estimated climate change on nitrogen loads is an increase of 2%.

Source: Gopal Bhatt, Penn State; Kyle Hinson, CRC; and Andrew Sommerlot, UMCES

Estimated Influence of 2025 Increased Precipitation Volume & Intensity on Total Phosphorus Loads



The influence of estimated precipitation increase alone on phosphorus loads is a 4% increase.

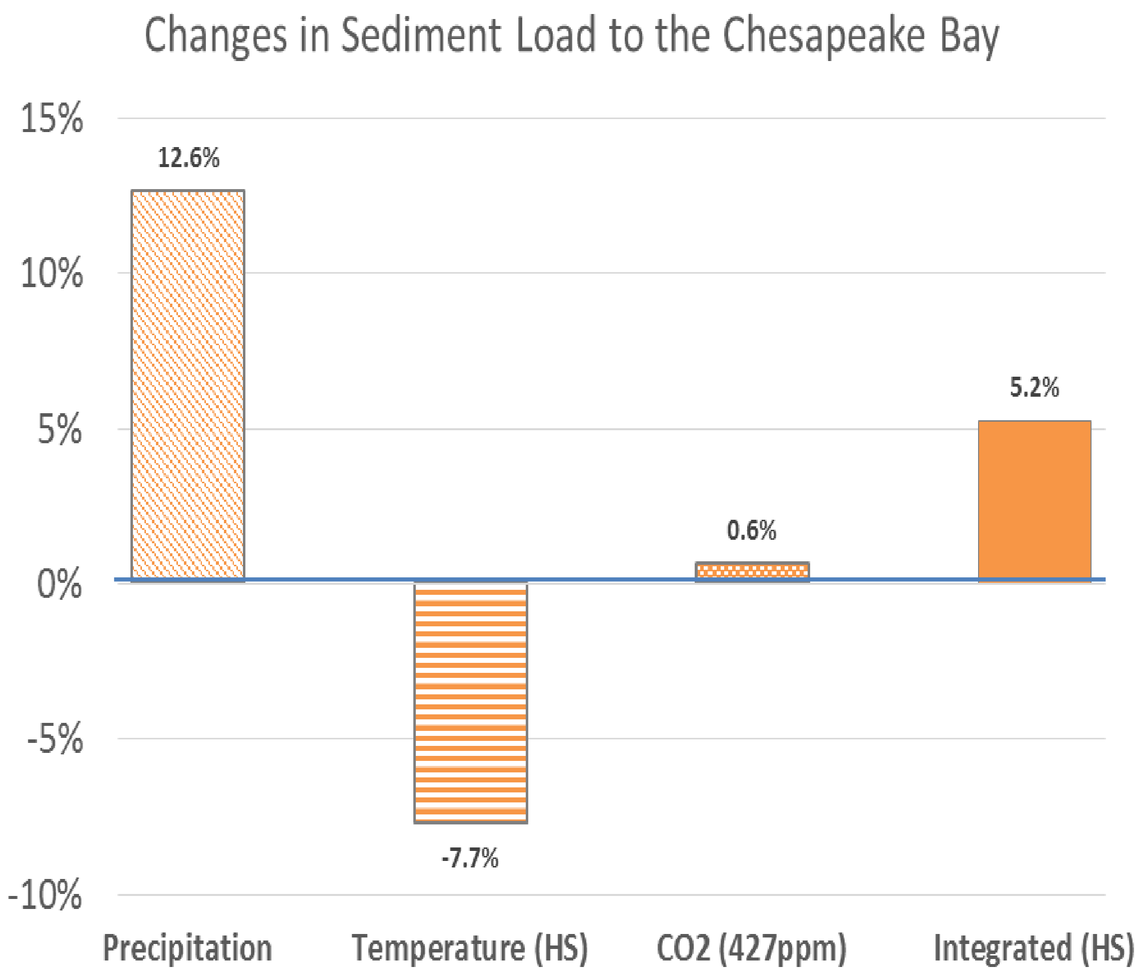
The influence of the estimated 2025 temperature increase on evapotranspiration (Hargreaves method) alone is an overall phosphorus load decrease of 3%.

The sole influence of CO_2 is to increase phosphorus loads by 0.2%

Overall the combined influence of estimated climate change on phosphorus loads is an increase of 2%.

Source: Gopal Bhatt, Penn State; Kyle Hinson, CRC; and Andrew Sommerlot, UMCES

Estimated Influence of 2025 Increased Precipitation Volume & Intensity on Sediment Loads



The influence of estimated precipitation increase alone on sediment loads is a 13% increase.

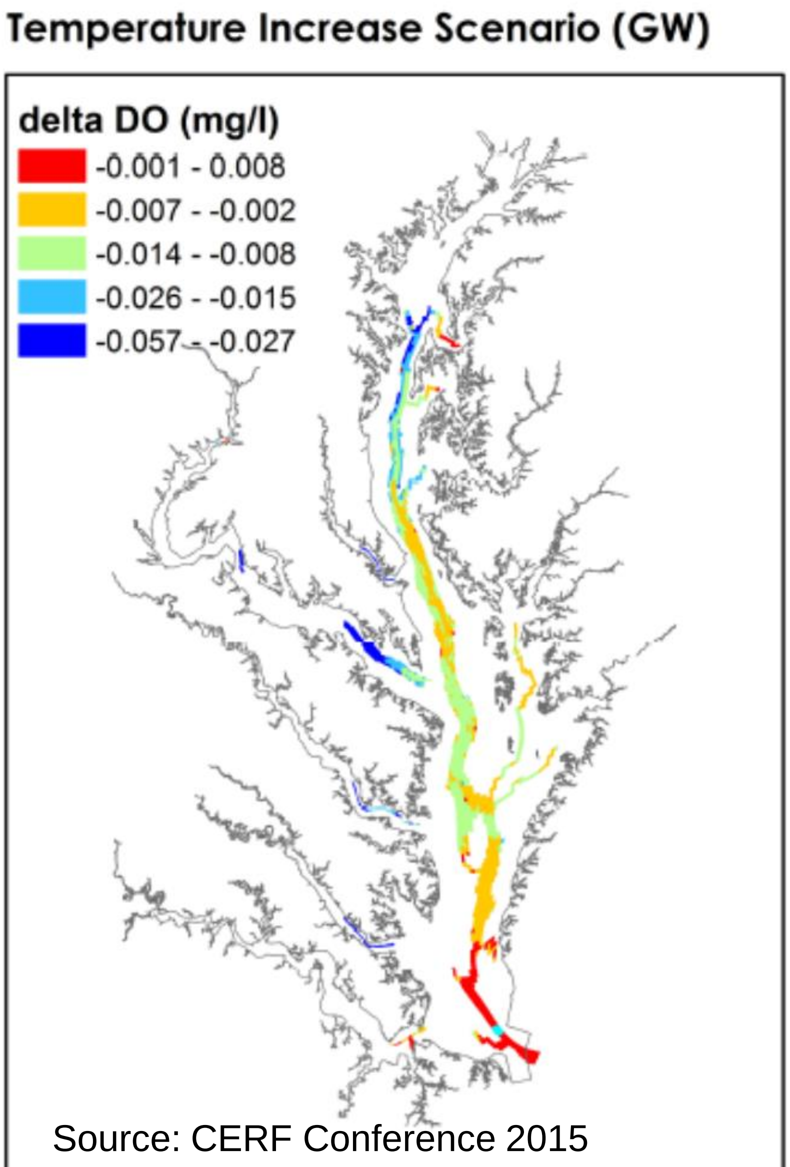
The influence of the estimated 2025 temperature increase on evapotranspiration (Hargreaves method) alone is an overall sediment load decrease of 8%.

The sole influence of CO_2 is to increase phosphorus loads by 0.6%

Overall the combined influence of estimated climate change on phosphorus loads is an increase of 5%.

Source: Gopal Bhatt, Penn State; Kyle Hinson, CRC; and Andrew Sommerlot, UMCES

Influence of Estimated 2050 Estuarine Temperature Increases on Bottom Dissolved Oxygen



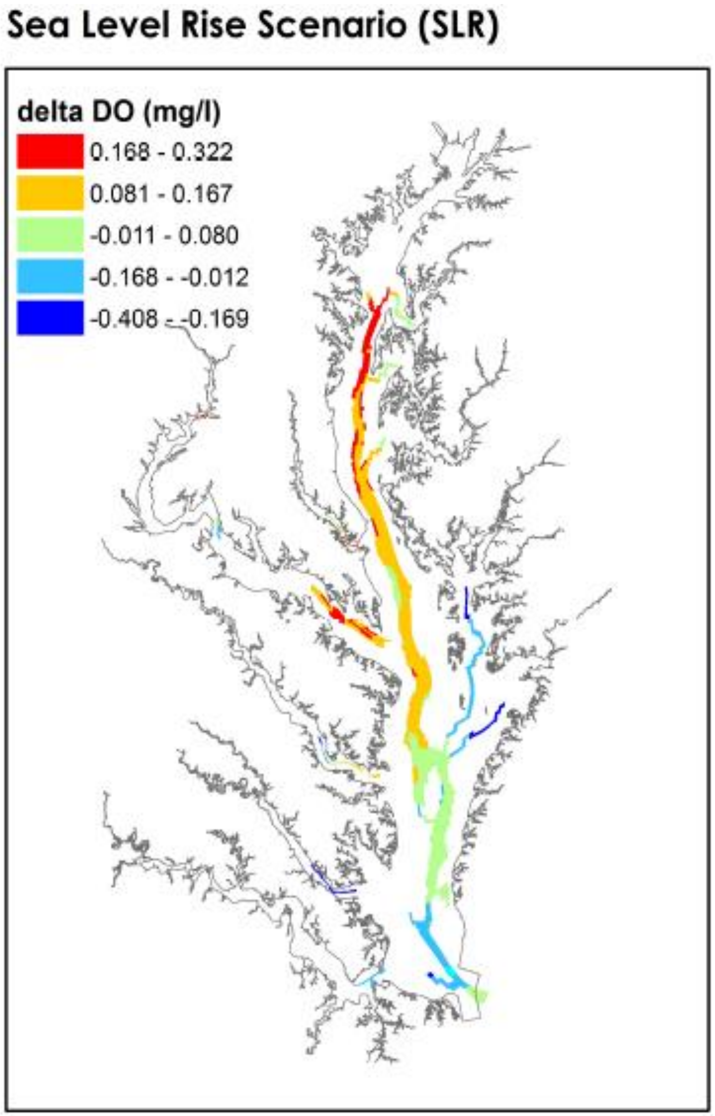
The influence of an 2050 estimated temperature increase on Chesapeake hypoxia is small.

But we can measure in infinitesimal with our models. The estimated increase in Chesapeake hypoxia due to 2050 estimated temperature increases ranges from 0.008 to - 0.06 mg/l.

Hypoxia increases are due to the increase in vertical stratification due to the increased thermocline, reduced oxygen saturation levels, and increased respiration.

By extension, estimated 2025 temperature increases will also have slight influence on water quality standard achievement.

Influence of Estimated 2050 Sea Level Rise (0.5 m) on Bottom Dissolved Oxygen



Source: CERF Conference 2015

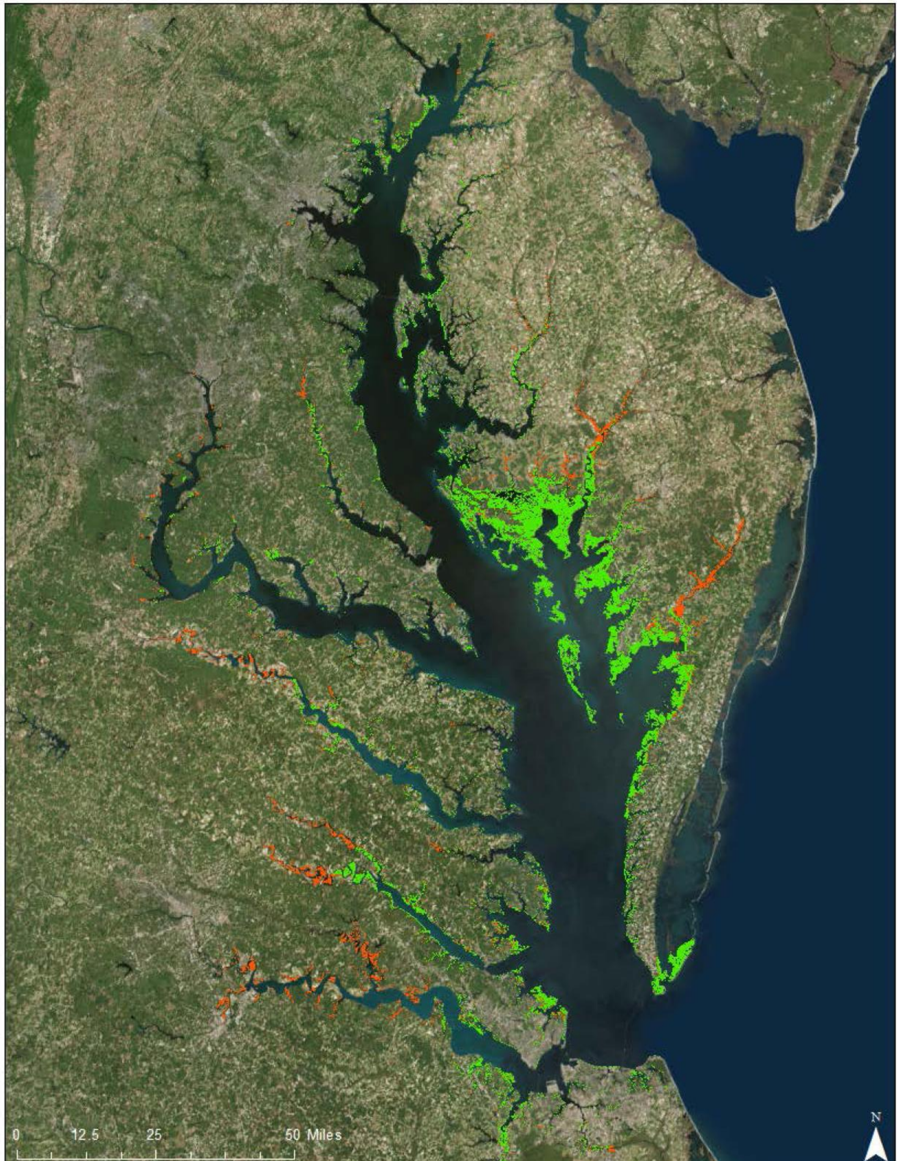
The influence of an 2050 estimated sea level rise on Chesapeake hypoxia is also relatively small.

The estimated change from the base (1991 to 2000) condition in Chesapeake hypoxia due to 2050 estimated sea level rise conditions ranges from 0.3 mg/l to -0.4 mg/l.

Hypoxia decreases in the mid-Bay are due to increased ventilation of deep Chesapeake waters by well oxygenated ocean waters and also because of changes in vertical stratification.

By extension, estimated 2025 (0.3 m) sea level rise increases will also have slight influence on water quality standard achievement.

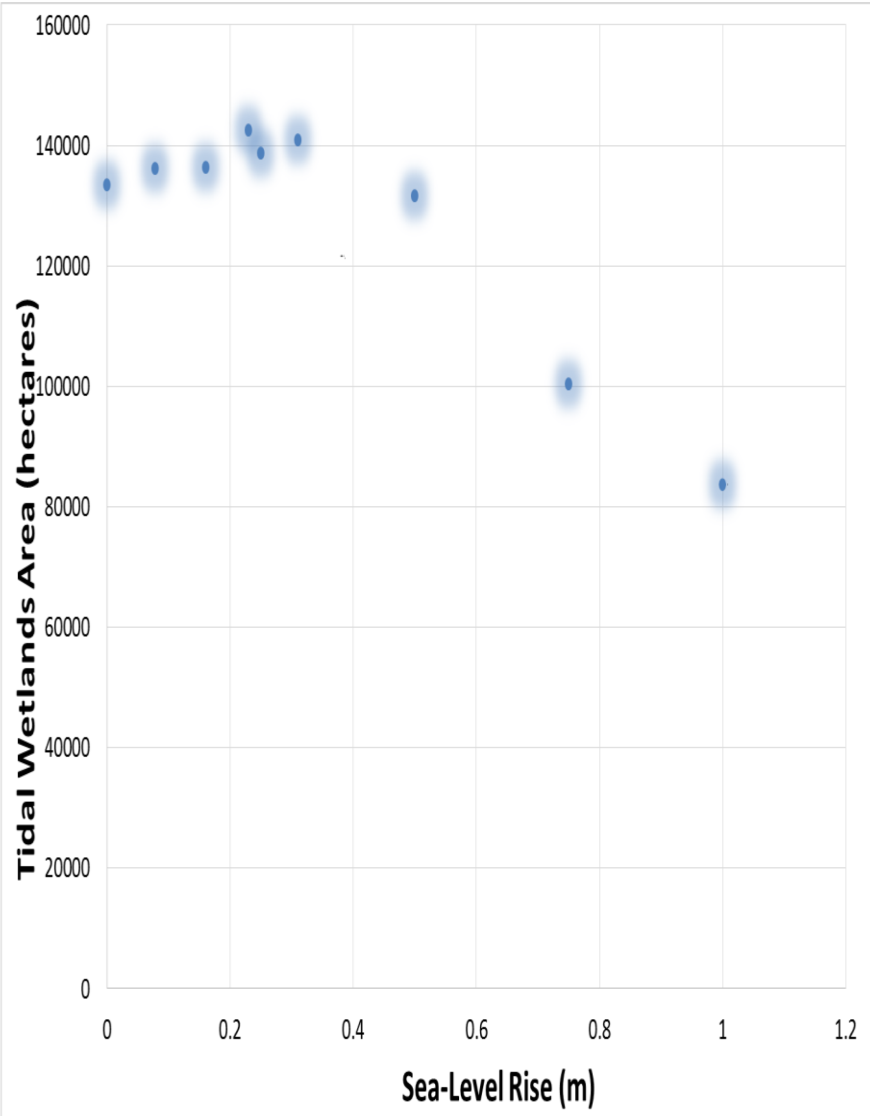
Chesapeake Bay Tidal Wetlands



Source: Carl Cerco, U.S. CoE ERDC

- The extent from National Wetlands Inventory is determined largely from vegetation perceived via aerial photography.
- 190,000 hectares of estuarine (green) and tidal fresh (red) wetlands.
- A tidal wetlands module is now fully operational in the WQSTM. The module incorporates functions of sediment and particulate nutrient removal and burial, denitrification, and respiration. The loss of wetland function due to sea level rise and inundation will be accounted for explicitly.

Influence of Estimated 2025 (0.3 m) and 2050 (0.5m) Sea Level Rise on Tidal Wetland Attenuation



Source: Carl Cerco, U.S. CoE ERDC

There is little change in estimated total tidal wetland area for 2025 (0.3 m) and 2050 (0.5 m) which equates to negligible changes in tidal wetland attenuation.

Long range (2100) conditions estimate tidal wetland changes to be on the order of a 40% loss in the Chesapeake which could reduce tidal wetland attenuation on the order of about 10 million pounds nitrogen and 0.6 million pounds phosphorus.

Take Away Messages:

- The CBP Modeling Workgroup is factoring into the Chesapeake Bay assessment tools the latest research on climate change with guidance from the STAC and the Climate Resiliency Workgroup.
- The CBP Models are under development, with the current (*Beta* 3) version to be replaced by *Beta* 4 in December 2016 (*Beta* 4) and a final version in March 2017. The results presented today will be refined going forward.
- Influence of estimated 2050 temperature on Chesapeake water quality standards (WQS) is slight.
- Influence of 2050 sea level rise is estimated to be small and variable with both positive and negative impacts on deep channel dissolved oxygen.

Take Away Messages:

- Estimated influence of changes in tidal wetland attenuation is small in 2025 and 2050 because of little change in overall tidal wetland area, but wetland type changes and tidal wetland loss is estimated to increase beyond 2050.
- The range of the influence of estimated watershed loads in future climate change conditions using observed (87 year) increase of precipitation volume (Karen Rice) and precipitation intensity (Karl and Knight) depends on the evapotranspiration method chosen.
- The estimated 2025 range of nutrient (nitrogen & phosphorus) and sediment loads are 0% to 2% and 0% to 5%, respectively.

Take Away Messages:

- Scientific peer reviews of the representation of climate change by the CBP models will be conducted by the CBP Scientific and Technical Advisory Committee (STAC).
- This is a work in progress. Still to come are 13 other Phase 6 Watershed Model climate change scenarios that are in the queue.
- Likewise, the hydrodynamic simulation of the 2025 sea level rise is still underway.

Describing the Range of Policy Options for Addressing Climate Change in the Jurisdictions' Phase III WIPs

Zoë Johnson
National Oceanic and Atmospheric Administration
CBP Climate Change Coordinator

Guiding Principles
WIP Development

1. ***Capitalize on "Co-Benefits"*** – maximize BMP selection to increase climate or coastal resiliency, soil health, flood attenuation, habitat restoration, carbon sequestration, or socio-economic and quality of life benefits.
2. ***Account for and integrate planning and consideration of existing stressors*** – consider existing stressors such as future increase in the amount of paved or impervious area, future population growth, and land-use change in establishing reduction targets or selection/prioritizing BMPs.
3. ***Align with existing climate resiliency plans and strategies*** – align with implementation of existing greenhouse gas reduction strategies; coastal/climate adaptation strategies; hazard mitigation plans; floodplain management programs; fisheries/habitat restoration programs, etc.
4. ***Manage for risk* and *plan for uncertainty*** – employ iterative risk management and develop robust and flexible implementation plans to achieve and maintain the established water quality standards in changing, often difficult-to-predict conditions.
5. ***Engage Local Agencies and Leaders*** – work cooperatively with agencies, elected officials, and staff at the local level to provide the best available data on local impacts from climate change and facilitate the modification of existing WIPs to account for these impacts.

Guiding Principles
WIP Implementation

1. ***Reduce vulnerability*** - use "Climate-Smart" principles to site and design BMP's to reduce future impact of sea level rise, coastal storms, increased temperature, and extreme events on BMP performance over time. Vulnerability should be evaluated based on the factor of risk (i.e. consequence x probability) in combination with determined levels of risk tolerance, over the intended design-life of the proposed practice.

2. ***Build in flexibility and adaptability*** - allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options (load allocations, BMP selections, BMP redesign). Use existing WIP development, implementation and reporting procedures, as well as monitoring results and local feedback on performance, to guide this process.

3. ***Adaptively manage*** - Allow for changes in BMP selection or WIP implementation, over-time, as new climate and ecosystem science, research, or data becomes available and the understanding of the impact of how changing seasonal, inter-annual climatic and weather conditions may affect the performance of watershed restoration practices. Consider new science on climate change impacts in future BMP Expert Panels, following the CBP partnership's BMP Expert Panel Protocols.

Quantitative/Most Comprehensive

Option 1:

Factor Climate Change into the Bay's Assimilative Capacity.

The annual total nutrient and sediment pollutant loads that the CB ecosystem can assimilate and still meet the four Bay jurisdictions' CB water quality standards will be revised based on 2025 or 2050 climate change projections (i.e., CBWQSTM climate model results) that result in a direct effect on the Bay's ecosystem and internal processes (e.g., water column temperature, changes to stratification, loss of tidal wetlands, change in sea level).

Option 2:

Factor Climate Change into Phase III WIP' Base Conditions

Use either the 2025 or 2050 climate projection scenarios as base conditions (informed by CBWM climate modeling results) in the establishment of the jurisdictions' Phase III WIPs. The climate change projection would be an added load that the jurisdictions would need to address in addition to their Phase III WIP planning targets, thereby increasing the level of effort.

Quantitative/Comprehensive

Option 3:

Commit to Factor Climate Change into the Bay's Assimilative Capacity (Option 1) and/or into Phase III WIP Base Conditions (Option 2) with Deferred Implementation until 2025 or beyond.

The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions, but they will not be explicitly factored into the Bay's Assimilative Capacity or incorporated into the Phase III WIP Base Conditions. However, the partnership would establish a timeframe (e.g., 2025, 2030, 2035, etc.) for when climate considerations would be factored into the TMDL and/or Base Conditions.

Option 4:

Factor Climate Change into a Bay TMDL Margin of Safety.

Allocate a specific pollutant load reduction as "explicit" margin of safety to account for any lack of knowledge concerning the relationship between load and waste-load allocations and achieving the four Bay jurisdictions' CB water quality standards.

Qualitative/Comprehensive

Option 5:

Factor Climate Change into the Phase III WIP BMP Optimization.

During development of Phase III WIPs, jurisdictions' would prioritize the selection of BMPs that will better mitigate the anticipated increased nitrogen, phosphorus and sediment loads due to the projected effects of climate change through 2025 or 2050

Option 6:

Adaptively Manage Phase III WIP BMP Implementation (Post Phase III WIP development).

During each two-year milestone development period, jurisdictions would consider new information on the performance of existing BMPs, including the contribution of seasonal, inter-annual climate variability and weather extremes on BMP performance. When there is a detectable impact on the effectiveness of a BMP performance, jurisdictions would use this information to re-prioritize the selection of BMPs to implement in the Phase III WIPs that will better mitigate the anticipated increased in nitrogen, phosphorus and sediment loads.

Qualitative/Least Comprehensive

Option 7:

Factor Climate Change into Programmatic Commitments with Set Expectations.

The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions. Jurisdictions would provide a narrative that describes their programmatic commitments to address climate change in their Phase III WIPs. Jurisdictions are expected to consult the Guiding Principles when developing their narratives. Narratives may vary among jurisdictions, but would include a description of their method(s) for gathering and assessing scientific data and information, their conclusions based on that information, and how those conclusions guide their programmatic commitments.

Option 8:

Factor Climate Change into Programmatic Commitments with No-Set Expectations.

The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions. Jurisdictions would narratively demonstrate how they are addressing climate change in their Phase III WIPs. No prescriptive guidance or specific expectations would be established.

Guidance for Decision-Making

Considerations	**Example**
- Options presented are intended to represent the full-range of approaches. - Options should be viewed as a menu of approaches. - More than one option, time-step alternative, or components thereof, could be selected. - The Water Quality GIT is encouraged to offer or suggest additional Options (or combinations) for consideration.	*Factor 2025 Climate Change into Phase III WIPs' Base Conditions with BMP Optimization for 2050 Climate Change.* - Use the 2025 climate projection scenarios as base conditions in the establishment of the Phase III WIPs. Jurisdictions would develop Phase III WIPs that would offset increased loads due to 2025 projected climate change. - Jurisdictions would use climate change impacts projected through 2050 to inform the selection of BMPs and geographic areas to be targeted for implementation.

Packages and Alternatives

Quantitative/Most Comprehensive		Qualitative/ Comprehensive	
Option 1: Assimilative Capacity	**Option 2:** Base Conditions	**Option 5:** BMP Optimization	**Option 6:** Adaptively Manage
Quantitative/ Comprehensive		**Qualitative/ Least Comprehensive**	
Option 3: Commit with Deferred Imp.	**Option 4:** Margin of Safety	**Option 7:** Programmatic with Set Expectations	**Option 8:** Programmatic with No Set Expectations

Packages and Alternatives

Quantitative/Most Comprehensive		Qualitative/ Comprehensive	
Option 1: Assimilative Capacity	**Option 2:** Base Conditions	**Option 5:** BMP Optimization	**Option 6:** Adaptively Manage
Quantitative/ Comprehensive		**Qualitative/ Least Comprehensive**	
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Packages and Alternatives

Quantitative/Most Comprehensive	Qualitative/ Comprehensive
Option 1: Assimilative Capacity; **Option 2:** Base Conditions	**Option 5:** BMP Optimization; **Option 6:** Adaptively Manage
Quantitative/ Comprehensive	**Qualitative/ Least Comprehensive**
Option 3: Commit with Deferred Imp.; **Option 4:** Margin of Safety	**Option 7:** Programmatic with Set Expectations; **Option 8:** Programmatic with No Set Expectations

Packages and Alternatives

Quantitative/Most Comprehensive

Option 1: Assimilative Capacity

Option 2: Base Conditions

Qualitative/ Comprehensive

Option 5: BMP Optimization

Option 6: Adaptively Manage

Quantitative/ Comprehensive

Option 3: Commit with Deferred Imp.

Option 4: Margin of Safety

Qualitative/ Least Comprehensive

Option 7: Programmatic with Set Expectations

Option 8: Programmatic with No Set Expectations

Packages and Alternatives

Quantitative/Most Comprehensive	Qualitative/ Comprehensive
Option 1: Assimilative Capacity **Option 2:** Base Conditions	**Option 5:** BMP Optimization **Option 6:** Adaptively Manage
Quantitative/ Comprehensive	**Qualitative/ Least Comprehensive**
Option 3: Commit with Deferred Imp. **Option 4:** Margin of Safety	**Option 7:** Programmatic with Set Expectations **Option 8:** Programmatic with No Set Expectations

Key Findings to Date and Next Steps To Support Partnership Decision-Making

Mark Bennett
U.S. Geological Survey
CBP Climate Resiliency Workgroup Co-Chair

Key Messages & Next Steps

- Current efforts are to frame initial future climate change scenarios based on estimated 2025 (potential TMDL application) and 2050 conditions (future condition scoping scenario application).
  - Next Steps: 1) Seek input and approval on the climate assessment approach; 2) decisions on using a 2025 and/or 2050 climate change analysis; and, 3) if additional scenarios should be run.
- The CBP Models are under development, with the current (*Beta* 3) version to be replace by *Beta* 4 in December 2016 (*Beta* 4) and a final version in March 2017.
  - Next Steps: The results presented today will be refined going forward with 2025 estuarine model hydrodynamics and 2050 Watershed Model Scenarios, which are underway. Additional model runs will be informed by partnership input and decisions.
- Assessment approach informed by sound science.
  - Next Steps: Scientific peer reviews of the representation of climate change by the CBP models will be conducted by the CBP Scientific and Technical Advisory Committee (STAC).
- Range of options have been developed for how and when climate considerations could be addressed within Phase III WIPs.
  - Next Steps: Consideration of full range of options and partnership decision for how and when to factor climate considerations into the Phase III WIPs

2017 Midpoint Assessment
Climate Integration Timeline

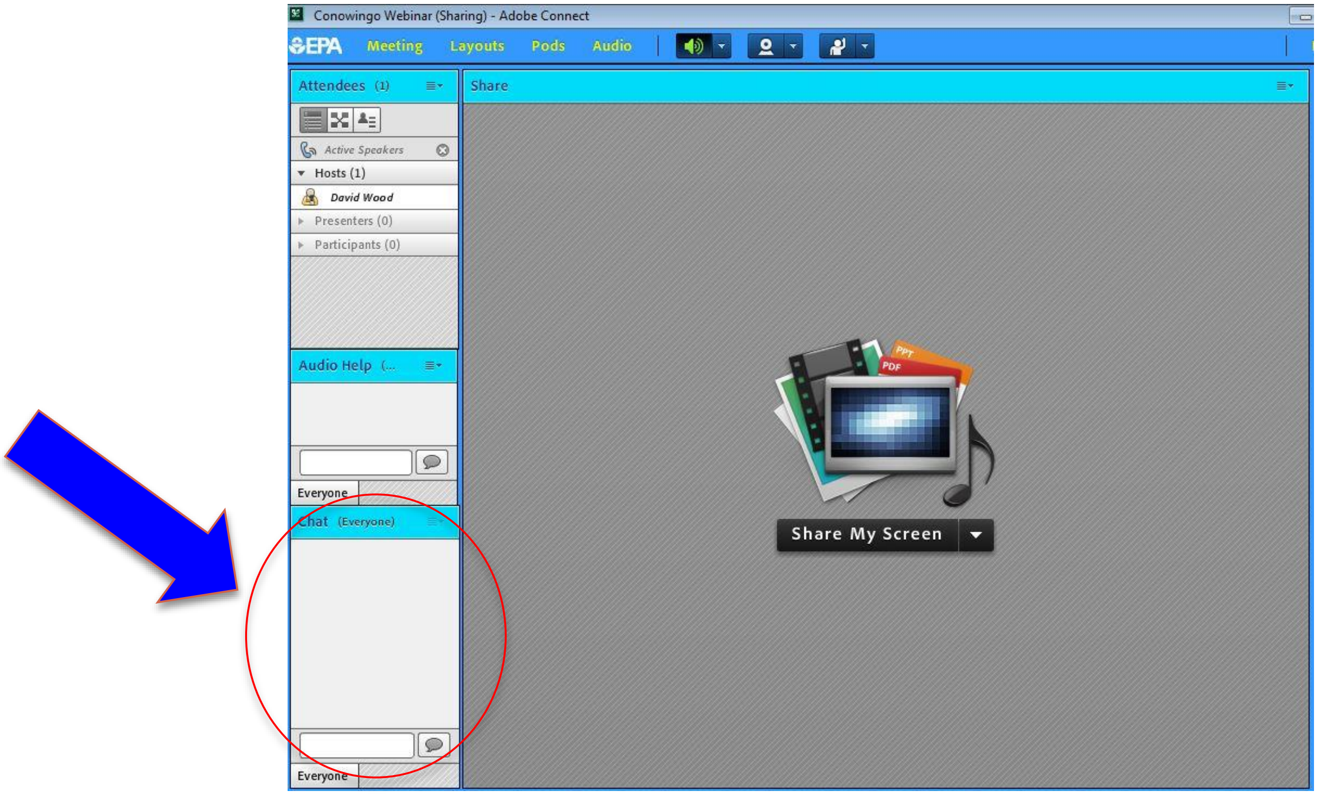
Key Upcoming Partnership Decisions:

- **December 2016*:** Proposed climate change assessment procedures.
- **December 2016*:** Proposed ranges of options for when and how to factor climate change considerations into the jurisdictions Phase III WIPs with decisions in spring 2017 informed by the outcomes of the proposed climate change assessment procedures.
- **May 2017*:** When and how to incorporate climate change considerations into the Phase III WIPs as the partners work on the draft Phase III WIP planning targets due in June 2017.
- **December 2017**: Final Phase III WIP planning targets fully reflect partnership decision regarding how and when to incorporate climate change considerations.

* Date of PSC approval – WQGIT and MB recommendations will be made in preceding months

Questions and Answers Session

- To Ask a Question
  - Submit your question in the chat box, located in the bottom left of the screen.



CBP Climate Change Resources

Development of Climate Projections for Use in Chesapeake Bay Program Assessments (STAC, in press).

Recommendations on Incorporating Climate-Related Data Inputs and Assessments: Selection of Sea Level Rise Scenarios and Tidal Marsh Change Models to Inform the Chesapeake Bay TMDL 2017 Mid-Point Assessment (CRWG, 2016).

Guiding Principles and Options for Addressing Climate Change Considerations in the Jurisdictions' Phase III Watershed Implementation Plans (CRWG, 2016)

CBP Climate Resiliency Workgroup Webpage

Chesapeake Resiliency Newsletter Subscription

Access to Climate Change Webinar Recording

A recording of this webinar along with the presentation will be posted to the following page on the Chesapeake Bay Program Partnership's website:

Climate Change Webinar Calendar Page:
http://www.chesapeakebay.net/calendar/event/24332/

Please Note: A second, follow-up Climate Change Webinar will be scheduled for March 2017