2016 ANNUAL REPORT

MARYLAND COMMISSION ON CLIMATE CHANGE

Prepared for:

Larry Hogan, Governor
State of Maryland

and the Maryland General Assembly

Commission Membership

Commission Chair

Secretary Ben Grumbles
Maryland Department of the Environment

Co-Chairs

Anne Lindner
Business Community Representative

Stuart Clarke
Town Creek Foundation

Commission Members

Nancy K. Kopp
Maryland State Treasure

Secretary Joseph Bartenfelder
Maryland Department of Agriculture

Secretary Pete Rahn
Maryland Department of Transportation

Mary Beth Tung
Director of Maryland Energy Administration

Donald Boesch
President of UMCES

Dr. Russell Dickerson
Climate Change Expert

Senator Paul G. Pinsky
Maryland General Assembly

Lori Arguelles
Alice Ferguson Foundation

Jim Strong
Organized Labor Representative

Michael Powell
Business Community Representative

Councilwoman Deni Taveras
Maryland Association of Counties

Karen Salmon
Superintendent of Maryland Schools

Secretary Mark Belton
Maryland Department of Natural Resources

Secretary Wendi Peters
Maryland Department of Planning

Charles Deegan
Chair of Critical Area Commission

Chuck Fry
Maryland Farm Bureau

Dr. Jane Kirschling
Public Health Expert

Delegate Dana Stein
Maryland General Assembly

C. Richard D'Amato
Retired Attorney

Larry Kasecamp
Organized Labor Representative

Mike Tidwell
Chesapeake Climate Action Network

Mayor Jacob Day
Maryland Municipal League

Table of Contents

Chapter 1 - Introduction

Background

In 2007, the Maryland Commission on Climate Change (MCCC) was established by Executive Order (01.01.2007.07) and charged with developing an action plan and firm timetable for mitigation of and adaptation to the likely consequences and impacts of climate change in Maryland, including strategies to reduce Maryland's greenhouse gas (GHG) emissions to 1990 levels by 2020 and 80 percent of 2006 levels by 2050. As a result of the work of more than 100 stakeholders and experts, the MCCC produced a climate action plan which was the catalyst for the Greenhouse Gas Emissions Reduction Act (GGRA) of 2009. In 2014, a second Executive Order (01.01.2014.14) expanded the scope of the MCCC and its membership to include non-state government participants. The Commission currently has representatives from the administration, the legislature, business, non-profit organizations and local governments.

The Maryland General Assembly codified the MCCC during the 2015 legislative session.[1] The law requires that the Commission issue a yearly report to the Governor and the General Assembly "on the status of the State's efforts to mitigate the causes of, prepare for, and adapt to the consequences of climate change, including future plans and recommendations for legislation, if any, to be considered by the General Assembly". The first report, issued in 2015, provided background and recommendations on key challenges and opportunities related to the status of Maryland's response to climate change.[2]

Report Overview

This report contains a background on the history and structure of the Commission, updates on the progress of science and climate action in the global and local community, and an examination of potential and realized climate impacts to the State; culminating with the Commission's recommendations for future state climate action. In order to protect the State's economy, the local environment, and the health of its citizens, Maryland must continue to strengthen its climate change mitigation and adaptation actions. At the same time, it is important to remember that climate change is a global problem, and Maryland's programs and policies must be part of a larger climate action plan to be broadly effective at preventing many of the costs of unmitigated climate change to the State. Maryland's efforts contribute to national GHG reduction targets in accordance with the United States' international commitment to reduce the impacts of global climate change; and, perhaps more significantly, can serve as model to inspire similar action from our neighboring states.

1 Appendix G

2 Maryland Commission on Climate Change, 2015. 2015 Maryland Commission on Climate Change Report.

Chapter 2 - The Maryland Commission on Climate Change

History and Structure

Maryland has historically been at the forefront of states taking action to address both the drivers and consequences of climate change, demonstrated by the State's policy record. Beginning with the development of A Sea-level Rise Response Strategy for Maryland in 2000; the passage of the Healthy Air and Clean Cars Acts of 2006 and 2007 respectively; participation in the Regional Greenhouse Gas Initiative (2007-present); creation of the Coast Smart Council in 2014; and reauthorization of the GGRA in 2016; Maryland has consistently advanced efforts to combat climate change.

When the MCCC was first created by Executive Order in 2007, its primary task was developing a 2008 plan of action for the Governor and General Assembly to address the causes of climate change and prepare for the likely repercussions in Maryland. The initial composition of the Commission was members of the administration and legislature, and their objective was heavily supported by three working groups - the Scientific and Technical Working Group (STWG), the Mitigation Working Group (MWG) and the Adaptation and Response Working Group (ARWG) - consisting of appointees "who broadly represent both public and private interests in climate change".[1] Each working group was charged with creating a document which would serve as one component of the recommendations in the 2008 plan. The STWG was tasked to develop a *Comprehensive Climate Change Impact Assessment*, to advise on the scientific and technical aspects of climate change. This assessment was based on an extensive literature review and model projections used to estimate the responses of climate to increased GHG concentrations and project future conditions in Maryland. The MWG was tasked with developing a *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*, including evaluating and recommending short- and long-term goals and strategies to reduce Maryland's GHG emissions. The ARWG was tasked to develop a *Comprehensive Strategy for Reducing Maryland's Climate Change Vulnerability*, which focused on Maryland's coastline and the burgeoning risks that climate change posed to the State's people, property, natural resources, and public investments. This document presented a timetable for the development of adaptation strategies to reduce climate change vulnerability among the affected sectors.

In August 2008, the MCCC compiled these reports into its *Climate Action Plan* (CAP), which proposed a short-term goal of reducing GHG emissions at least 25 percent by 2020, and interim reductions of 10 percent by 2012 and 15 percent by 2015 (from a 2006 baseline). The plan also suggested a long-term goal of 90 percent reduction by 2050.[2] In order to attain these benchmarks, the Commission put forward a suite of 42 policy options to mitigate GHG emissions, including mechanisms for moving to cleaner, renewable energy and making the State more energy-efficient. Complementary to the mitigation goals and proposals, the Commission included 19 potential actions to prepare for and adapt to the consequences of climate change in Maryland, composed of two phases. Phase I, initiated in 2008, addresses the impacts associated with sea-level rise and coastal storms; Phase II, initiated in 2011, deals with the impacts that changes in precipitation patterns and increased temperatures will have on human health, agriculture, forest and terrestrial ecosystems, bay and aquatic environments, water resources, and population growth and infrastructure.

In 2009, guided by the recommendations of the 2008 CAP, the GGRA was signed into law, requiring the State to achieve a 25 percent reduction in GHG statewide emissions from 2006 levels by 2020. The 2009 GGRA tasked the Maryland Department of the Environment (MDE) with the development of a plan to achieve this goal in a way that ensured positive impact on Maryland's economy, protected existing manufacturing jobs and created new jobs in the State. MDE's 2012 GGRA Plan was the result of an in-depth process involving more than a dozen State agencies and numerous non-governmental organizations. It outlined more than 150

1 Maryland Executive Order 01.01.2007.07

2 Maryland Commission on Climate Change, 2008. Climate Action Plan.

programs and initiatives designed to reduce GHG emissions, and included ongoing evaluation of the economic and jobs impacts on Maryland's manufacturing sector, as well as electricity reliability in the State.

Although the work of the MCCC was essentially complete with the issuance of their 2008 CAP, a 2014 Executive Order noted new reports on the consequences of climate change in Maryland and reinstated the working groups, charging the MCCC with strengthening and maintaining "existing State action plans to further mitigate the causes and drivers of climate change, and address (prepare for and adapt to) the consequences of climate change".[3] The Commission was to prioritize working group actions, and the working groups themselves met to establish individual work plans, focused on the same general areas as their initial charges. The membership of the MCCC at this time was expanded to include representatives from local governments, the business community, the university system, and nonprofit organizations.

2015 Law: Changes and Responsibilities

During its 2015 session, the Maryland General Assembly codified the MCCC into law, maintaining many of the tasks and responsibilities that had been assigned under the 2014 Executive Order; and officially charging the Commission with advising the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change".[4] The MCCC is chaired by MDE Secretary Ben Grumbles and consists of 26 members representing State agencies and legislature, local government, business, environmental non-profit organizations, organized labor, philanthropic interests, and the State university system. In addition to the MWG, ARWG and STWG, a fourth working group was established to support the Commission: the Education, Communication and Outreach (ECO) Working Group. The members of the working groups are appointed by the Commission Chair, and embody both public and private interests in climate change, including representatives of academic institutions, renewable and traditional energy providers, environmental organizations, government agencies, labor organizations and business interests. The MWG focuses on regulatory, market-based and voluntary programs to reduce GHG emissions while supporting economic development and job creation. The ARWG is charged with developing a comprehensive strategy for reducing Maryland's climate change vulnerability, providing state and local governments with tools to plan for and adapt to the more extreme weather and rise in sea levels anticipated as a consequence of climate change. The STWG is responsible for updating and informing the MCCC on the science of climate change, and the ECO Working Group assists with the Commission's public outreach and public meetings on climate change as well as educating Marylanders on what the State is doing to address its causes and impacts.

The 2015 law requires the MCCC to prioritize working group actions, including strengthening state climate action plans; developing a variety of broader partnerships at the local, state and federal level; educating Maryland residents about the urgency of taking action to mitigate and adapt to climate change; and addressing impacts of climate change across various groups and sectors. The Commission is also responsible for maintaining an inventory of Maryland's GHG emission sources and sinks, as well as a comprehensive action plan with 5-year benchmarks; and issuing an annual report to the Governor and General Assembly with the status of the State's efforts, future plans and any recommendations for supporting legislature.

The full Commission meets at least four times per year, and in 2016 it convened in April, June, September, October and November. These meetings are open to the public, and a portion of each meeting is set aside for public comment. The Steering Committee for the MCCC met on a monthly basis from March through October, to review and guide Working Group progress in the interim. The four Working Groups held numerous meetings in 2016 to advance each of their contributions to the Commission goals.

Details of the meetings and activities of the MCCC and its working groups can be found at:
http://mde.maryland.gov/programs/Marylander/Pages/mccc.aspx

3 Maryland Executive Order 01.01.2014.14

4 Appendix G

Chapter 3 - Science and Policy: A Global Update

A thorough understanding of the ramifications which accompany unmitigated climate change, as well as the complexity of costs and benefits (economic, environmental and human) associated with climate action, is essential to the core function of the MCCC. The scientific community is constantly strengthening the models and projections for various emission reduction scenarios, providing the Commission with increasingly detailed information on which to base its policy and program recommendations. According to the 2014 report from the Intergovernmental Panel on Climate Change (IPCC), "effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national".[1] It is important to recognize that the actions Maryland takes to mitigate climate change at the state level are integral to protecting the future and prosperity of not only the state of Maryland but also the United States of America and the global community of which it is a part.

International Consensus

Science has demonstrated with a high degree of certainty that Earth's climate is being altered by human activities, particularly by the emission of heat-trapping GHGs into the atmosphere.[2] In their most recent report released in 2014, the IPCC published that anthropogenic GHG emissions (including carbon dioxide, methane, and nitrous oxide) have increased since the pre-industrial era and are currently at atmospheric concentrations "unprecedented in at least the last 800,000 years".[1] The effects of these and other anthropogenic drivers are "extremely likely to have been the dominant cause of the observed warming since the mid-20th century".[1] The consensus among experts in the scientific community continues to be reinforced, as exemplified by a review published this past April citing six distinct studies which found 90 to 100 percent of climate scientists publishing peer-reviewed research agree that global warming is anthropogenic.[3]

Science has provided a reliable projection of the impact of future emissions levels on climate change, including consequences for human society and the natural systems on which it depends; as well as the amount and timing of emissions reductions required to avoid the most devastating consequences of climate change.[2] The 2014 IPCC Report noted that "continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems"; and that substantial mitigation and adaptation is required to limit these risks.[1] Based on IPCC analysis, which rated global risks due to climate change in five areas of concern across a spectrum of temperature increases (Figure 1), avoiding an increase of greater than 2 degrees Celsius has become an internationally accepted goal.[2] In order to reach this goal, IPCC calculates that global GHG emissions must be reduced by 40-70 percent from 2010 levels by 2050, and further to near zero by 2100.[1] The STWG, in their 2015 report, noted that because these reduction goals were global, and

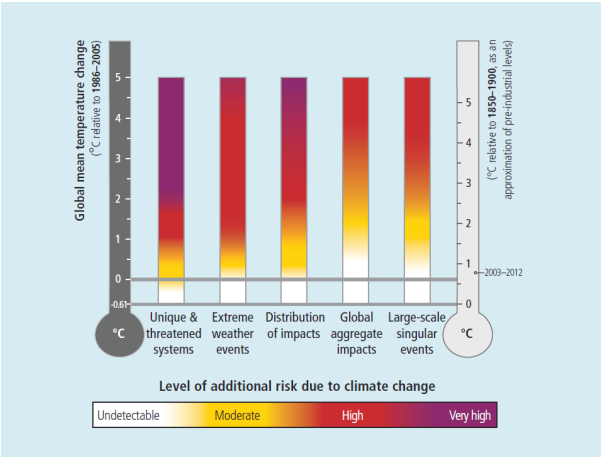


Figure 1. *Risks associated with the five areas of concern shown for a range of global mean temperature change (IPCC, 2014).*

1 Intergovernmental Panel on Climate Change, 2014. Climate Change 2014: Synthesis Report

2 Maryland Commission on Climate Change Scientific and Technical Working Group, 2015. Appendix 1 of 2015 Maryland Commission on Climate Change Report. "Reducing Emissions of Greenhouse Gases Beyond 2020".

3 J. Cook et al., 2016. Consensus on consensus: a synthesis of consensus estimates on human-caused global warming.

the U.S. has far higher per capita emissions than all but a few nations in the world, the U.S. emissions must be reduced at least to the upper end of the range in order to make an effective contribution.[4]

Regardless of mitigation, the IPCC projects that some level of adaptation is required, as we are very likely to experience an increase in the quantity and intensity of heat waves and extreme precipitation events.[5] The U.S. Environmental Protection Agency (EPA) projects similar regional impacts of climate change for the Maryland area, noting that the heat waves and heavy precipitation events "threaten human health and strain aging infrastructure".[6] At the end of this past July, Maryland experienced a sample of this destruction; a heavy rainstorm devastated homes and businesses in the Ellicott City region when the Patapsco River rose 16.5 feet in just over two hours, and went from carrying 85 cubic feet of water per second to 28,500.[7]

It is the ongoing work of the Commission to ensure that we are utilizing the best science available, as supported by the STWG, in order to move forward with progress on mitigation (MWG) and adaptation (ARWG), keeping open lines of communication in both directions with the residents of Maryland (ECO).

The Paris Agreement

The United States is among 180 countries that have signed the United Nations Paris Climate Agreement since April of 2016; a document which is in full force as of November 4, 2016.[8] The agreement aims to strengthen the global response to the threat of climate change through a standard commitment by as many nations as possible to expeditiously peak and reduce GHG emissions, in order to maintain the average global temperature increase under 2 degrees Celsius (above pre-industrial levels). It also acknowledges the "common but differentiated responsibilities and respective capabilities" of each nation to contribute to the common objective, placing developed countries in a leading role.[9] In his opening statement during the signature ceremony, UN Secretary-General Ban Ki-moon noted "we are in a race against time… the window for keeping global temperature rise well below 2 degrees Celsius, let alone 1.5 degrees, is rapidly closing".[10] As previous agreements such as the Kyoto Protocol have lacked potency, the Secretary General urged all countries to make this more than an inconsequential promise; and to commit to actions "on behalf of this generation and all future generations… that reduce climate risk and protect communities… [and] that place us on a safer, smarter path".[10] The recommendations contained in this report are consistent with the objectives and intentions of the accord signed onto by the U.S. in Paris, and ensure that Maryland takes actions to fulfill its share of a national commitment.

Federal Efforts

Implementation of the Federal Clean Power Plan (CPP) is currently stayed by the Supreme Court of the United States, pending judicial review. If upheld, the CPP will set the first national carbon pollution standards for power plants, and provide guidance for states to "establish standards of performance or other measures for affected [power plants]" that will allow them to meet these federal emission standards.[11] Maryland is already in a good position to comply with the CPP, as a part of the Regional Greenhouse Gas Initiative (detailed in the following section), and the requirement for neighboring states to take similar action benefits Maryland in several ways. Maryland's electricity comes from the PJM Interconnection, a regional transmission organization which coordinates the movement of wholesale electricity in the central eastern part of the United States. In its emissions inventory reports, MDE accounts for carbon dioxide (CO_2) emissions from electricity on the

4 Maryland Commission on Climate Change Scientific and Technical Working Group, 2015. Appendix 1 of 2015 Maryland commission on Climate Change Report. "Reducing Emissions of Greenhouse Gases Beyond 2020".

5 Intergovernmental Panel on Climate Change, 2014. Climate Change 2014: Synthesis Report

6 U.S. EPA, "Climate Impacts in the Northeast".

7 Readings were taken at USGS station 01589025 Patapsco River; 0.9 mi south of Ellicott City <http://waterdata.usgs.gov/usa/nwis/uv?01589025>

8 United Nations Framework Convention on Climate Change. "The Paris Agreement" <http://unfccc.int/paris_agreement/items/9485.php>

9 United Nations Framework Convention on Climate Change, 2015. Paris Agreement.

10 Transcript and video of the speakers at the Paris Climate Agreement Signing Ceremony is available at: <http://www.un.org/sustainabledevelopment/22april/>

11 U.S. EPA, "Clean Power Plan: Regulatory Actions". <https://www.epa.gov/cleanpowerplan/regulatory-actions>

basis of consumption rather than production. As a net importer of electricity (at least 42 percent of its energy in 2014[12]), this inventory is largely impacted by the energy portfolio mix of the entire PJM region. Regulations proposed by the CPP would therefore reduce the emissions of the region, helping Maryland reach its overall reduction goals under the GGRA. Additionally, this improves the economic prospects of in-state power plants, since all generators selling electricity into the PJM market will be following similarly stringent regulations, creating a more equal market.

The Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by seven New England states, Delaware and Maryland that aims to reduce CO_2 emissions from the electric generation sector. Maryland formally joined RGGI in 2007. The program is based on a "cap and reduce" scheme, with a collective 91 million ton cap set for all participating states in 2014 declining by 2.5 percent annually until 2020. The states are allocated a portion of the total cap, and sell most of their emission allowances at quarterly auctions. Auction proceeds fund various programs which promote energy efficiency, renewable energy or other consumer benefits. Maryland invests auction revenue in the Strategic Energy Investment Fund (SEIF), which is administered by the Maryland Energy Administration (MEA). SEIF is used in part to fund EmPOWER Maryland projects, including energy efficiency upgrades for low-to-moderate income families; and is also allocated for direct bill assistance and projects that promote affordable, reliable and clean energy across Maryland. According to the most recent update by MDE, the potential emissions reductions over the lifetime of the RGGI program are estimated to be 3.60 $MMtCO_2e$ by 2020; and the program is anticipated to continue driving emissions reductions into the future.[13]

Currently the RGGI states are discussing plans for the program beyond 2020. Updates, including news and auction results, can be found at https://www.rggi.org/

The Greenhouse Gas Emission Reduction Act

As noted in an earlier chapter, the GGRA of 2009 was created based on the recommendations of the MCCC's 2008 Climate Action Plan. The original law required Maryland to achieve a 25 percent reduction in statewide GHG emissions from 2006 levels by 2020. MDE's *2015 GGRA Plan Update*, showed that Maryland was on target to not only meet but exceed the emission reduction goal; and that this was being accomplished with an estimated economic benefit between $2.5 and $3.5 billion in increased economic output by 2020 as well as creation and maintenance of between 26,000 and 33,000 new jobs.[14] The *2015 GGRA Plan Update,* along with the MCCC's *2015 Annual Report*, informed a review of the State's progress that occurred at the end of last year. The review by the Governor and General Assembly was mandated by the original law, and culminated in a determination of whether to continue, adjust or eliminate the requirements and plans set in place by the GGRA of 2009.

Reauthorized and Enhanced: The GGRA of 2016

Upon review of the reports presented by MDE and the Commission, the Governor and General Assembly reauthorized the GGRA. The updated law includes the same balanced requirements and safeguards as the original, such as additional reporting and a mid-course reaffirmation of goals by the General Assembly, as well as incorporating protection of jobs and the economy. The most significant enhancement is a new benchmark goal of a 40 percent reduction of emissions from 2006 levels by 2030.

This additional benchmark was included in order to ensure continued progress after 2020 towards the State's long-term GHG emission reduction goals. According to the text of Senate Bill 323, these numbers were chosen "in recognition of the finding by the Intergovernmental Panel on Climate Change that developed countries will

12 Maryland Department of the Environment, 2015. Maryland 2014 Periodic GHG Emissions Inventory.

13 Maryland Department of the Environment, 2016. State Agency Report on Program C. The Regional Greenhouse Gas Initiative.

14 Maryland Department of the Environment, 2015. 2015 Greenhouse Gas Emissions Reduction Act Plan Update.

need to reduce greenhouse gas emissions by between 80 percent and 95 percent from 1990 levels by 2050".[15] The 2015 MCCC Report supported this move forward, explicitly recommending "that the State adopt a goal and develop a plan to reduce Maryland's GHG emissions 40 percent from 2006 levels by 2030, with continued inclusion of safeguards, exemptions... and other relevant language contained in the 2009 Act".[16] This endorsement by the Commission was informed by STWG calculations which were based on the IPCC's conclusion that global emissions must be reduced 40-70 percent from 2010 levels by 2050 in order to minimize the impacts of climate change.[16,17] The STWG utilized the upper end of the reduction range for their calculations, in consideration of the large per capita emissions in the U.S (Figure 2).[18] MDE's report also called for efforts to enhance current progress, based on the scientific consensus that achieving worldwide emissions reductions as high as 72 percent by 2050 is critical to minimizing the negative impacts of climate change.[19] It also noted that Maryland is already experiencing loss of land from sea-level rise, and has experienced floods, heavy rains, heat and strong winds over the years since 2012; which has led to millions of dollars in property losses and the loss of human life. [19]

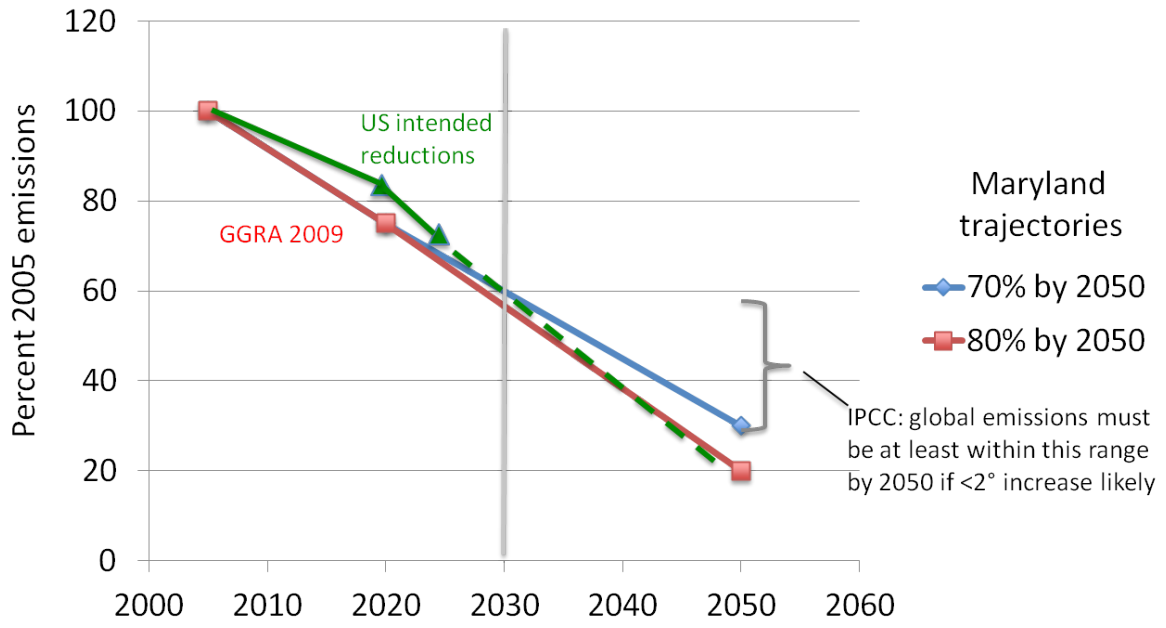


Figure 2. Simplified linear trajectories to reach 2050 emissions reduction goals for Maryland and the United States (STWG, 2015).

15 Maryland General Assembly SB0323, 2015. "Greenhouse Gas Emissions Reduction Act – Reauthorization".

16 Maryland Commission on Climate Change, 2015. 2015 Maryland Commission on Climate Change Report.

17 Intergovernmental Panel on Climate Change, 2014. Climate Change 2014: Synthesis Report.

18 Maryland Commission on Climate Change Scientific and Technical Working Group, 2015. Appendix 1 of 2015 Maryland Commission on Climate Change Report. "Reducing Emissions of Greenhouse Gases Beyond 2020".

19 Maryland Department of the Environment, 2015. 2015 Greenhouse Gas Emissions Reduction Act Plan Update.

MDE is currently working on a draft of the 40 by 30 plan, which is due to be presented to the Governor and the General Assembly in 2018. The final plan must be adopted in 2019, and has all the same requirements as the 2012 plan, including consideration of the impacts implementation may have on all segments of the community (rural, low-income, minority) as well as various sectors of the economy (agriculture, manufacturing); ensuring reliable and affordable electrical service; producing a net economic benefit for Maryland and a net increase in jobs in the State; encouraging new "green jobs" in Maryland; and special provisions protecting the manufacturing industry. MDE will also submit a report in 2022 describing the State's progress toward achieving the GHG reduction goals and an update on the state of science regarding emissions reductions needed by 2050 to avoid the most dangerous impacts of climate change.

An independent study on the economic impacts of these GHG reduction goals is to be performed by an institution of higher education in Maryland, and overseen by the Commission. This report is due to the Governor and General Assembly in 2022, and will supplement the MDE progress report to inform the General Assembly's decision regarding continuation of the 40 by 30 goals, as well as the special manufacturing provisions. The law will terminate in 2023 if not reauthorized.

Chapter 4 - The State of Maryland: Present and Future

Many of the most fundamental aspects of both the "natural" and "built" environment have evolved based on a climate which had until recently been changing very slowly in the years since the last ice age. More rapid changes in temperature and precipitation regimes, as well as their direct and indirect impacts, can be tolerated within a certain range based on the resiliency of a given system. Once this threshold is surpassed, the pervasive effects are potentially devastating to the environment, the economy, and human health. Expectations for these key areas, as well as some of the positive actions already being taken in the State to enhance resiliency, are illustrated in the following chapter.

Jobs and the Economy

Agriculture

Agriculture remains the largest single land use in the State in 2015 (almost one third of total land), and employs approximately 350,000 Marylanders.[1] Saltwater intrusion, loss of coastline, and changes in temperature and precipitation patterns are among the most significant impacts of climate change likely to burden the State's agricultural sector. Moreover, the EPA believes reduced yields of farms and fisheries will be one of the main issues for the Northeast region related to climate impacts, "potentially damaging livelihoods and the regional economy".[2]

Flooded cropland during heavy rains in Maryland. (Jane Hawkey, IAN, UMCES)

According to the U.S. Department of Agriculture (USDA) *2015 State Agricultural Overview*, the value of the most productive grains and fresh market produce in Maryland totaled over $630 million,[3] and in 2014 the market value of all agricultural products was over $2.4 billion.[1] Changes in temperature and precipitation patterns have a very direct effect on agriculture, and according to the Maryland Department of Natural Resources (DNR), Maryland is already experiencing warmer winters and summers, wetter autumns and springs, and dryer summers.[4] Wet springs delay planting, heavy precipitation and extreme heat events can damage crops, and plants require extra water during increasingly hot summers, further stressing amplified water demand in other sectors.[5] While longer growing seasons could benefit some crops initially, warm weather and mild winters will also increase pressure from weeds and pests, and shifting habitats may introduce novel insects and diseases to the region.[5] As irrigation needs increase, over-pumping can lead to saltwater intrusion of aquifers, exacerbated by sea level rise. Saline

1 Maryland State Archives, "Maryland at a Glance: Agriculture". <http://msa.maryland.gov/msa/mdmanual/01glance/html/agri.html>

2 U.S. EPA, "Climate Impacts in the Northeast". <https://www.epa.gov/climate-impacts/climate-impacts-northeast>

3 Grain included corn, soybeans, hay, wheat and barley; fresh market fruits and vegetables included melons, potatoes, apples, corn, peaches, beans and cucumbers. The full data set can be accessed at: <https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=MARYLAND>

4 Maryland Department of Natural Resources, "Climate Change in Maryland". <http://dnr2.maryland.gov/climateresilience/Pages/about_climatechange.aspx>

5 R. Horton et al., 2014. Chapter 16: Northeast, Climate Change Impacts in the United States.

Green Business in Maryland

Bambeco is a Maryland-based company devoted to "products for planet and people".[1] The company already takes many actions to reduce their carbon emissions, and in October they announced their commitment to become completely carbon neutral by 2020, which appears to make them the first net-neutral home goods company.[2]

In 2003, Ecoprint identified themselves as the first printing company in the Mid-Atlantic region to be 100% wind-powered.[3]

MOSAIC is carbon neutral marketing and communications company in Maryland that uses 100% wind power. Their investment in reforestation programs helps to avoid approximately 2.5 million pounds of CO2 emissions annually.[4]

1 www.bambeco.com

2 http://www.theclimategroup.org

3 http://www.ecoprint.com

4 mosaic.buzz

water may also flood fields during storm events, leaving salt behind after evaporation which can disrupt the soil structure and leach vital trace minerals from the soil.

Fisheries

Many commercially important fisheries species are projected to move northward as waters warm and suitable habitats shift; and similarly to pests and diseases on land, this shift could also bring new pests, or increase the damages done by diseases such as bacteria which thrive in warmer waters.[6] Maryland fisheries, including blue crabs, clams and oysters, were valued at $67 million in 2013.[6] In addition to a change in temperature, all bodies of water are becoming more acidic as the concentration of carbon dioxide in the atmosphere increases. When the atmospheric concentration rises, this changes the chemical equilibrium between the atmosphere and surface water, causing more carbon dioxide to be absorbed into the ocean and thus lowering the pH. Dissolved inorganic carbon tends to exist in several forms depending on the pH of the water, and the carbonate ion which is used by shellfish to build their shells is far less available at a low pH.[7] This could potentially impact the productivity and profitability of Maryland's already struggling blue crab and oyster populations. Currently the National Oceanic and Atmospheric Administration (NOAA) is doing a wide variety of research on the impacts of ocean acidification on coastal ecosystems; and the Maryland Ocean Acidification Task Force released a 2015 report identifying the need for enhanced monitoring networks as critical in Maryland to understanding the multitude of complex interactions that causes acidification in shallow, estuarine Bay waters, as well as the effects on the ecologically and commercially important species that inhabit them.[8]

Tourism

The State's $16.7 billion tourism sector is also likely to feel the impact of climate change.[8] Tourism in the State supported 140,288 direct full-time equivalency jobs in 2014, bringing in wages of $5.4 billion[9]; while visitor spending generated over $2 billion in state and local taxes.[9,10], The Maryland Office of Tourism Development touts Maryland as "America in miniature", noting the wide array of regional activities: boating, winter sports and mountain scenery in the west; downtown nightlife, restaurants and shopping in the central cities; winery tours, fishing and historic and natural history in the south; and seafood, beaches and marshlands on the eastern shore.[9] All of these various activities and natural beauty will suffer the effects of climate change, robbing Maryland residents and visitors of this wealth of experiences.

The University of Cambridge released a report based on key findings from the IPCC Report that highlighted the implications of climate change on various sectors of tourism, several of which are potentially significant to Maryland.[10] Snow sports such as skiing "are at obvious risk from rising temperatures, with lower-elevation

6 Maryland State Archives, "Maryland at a Glance: Economy". <http://msa.maryland.gov/msa/mdmanual/01glance/economy/html/economy.html>

7 Maryland Ocean Acidification Task Force, 2015. Task Force to Study the Impact of Ocean Acidification on State Waters Report to the Governor and the Maryland General Assembly.

8 Maryland Office of Tourism Development, 2015. FY2015 Tourism Development Annual Report.

9 This number includes income taxes from the wages of industry employees, sales taxes for tourism goods and services, hotel occupancy taxes, property taxes, and other corporate taxes.

10 University of Cambridge, 2014. Climate Change: Implications for Tourism.

resorts facing progressively less reliable snowfalls and shorter seasons".[11] Wisp Mountain Park is a popular skiing destination in Western Maryland, and the only ski resort in the State. In late December of 2015, the resort reported that only one of their 35 trails was open, having been unable to keep snow on the ground due to temperatures consistently above freezing.[11] Although this was an unusually mild winter (November's average low was 8 degrees Fahrenheit higher than the historical average, and December's was 14 degrees Fahrenheit higher[12]), it demonstrates how important dependably cold weather is to the resort's seasonal functionality, which increasing global temperatures could debilitate. Maryland's sizable sport fishing industry has stock in streams, rivers, lakes and coastal waters. Increased water temperatures have direct impacts on some species such as cold-water loving trout; and indirect impacts on others such as Bay species which will be subject to expanding dead zones. In line with concerns for the general agricultural sector, the suitability of central Maryland for growing wine grapes will be threatened, having a negative impact on wine tourism in the State. Maryland's beaches will be susceptible to more extreme weather events as well as sea-level rise, and are difficult to protect from storms and erosion without negatively impacting their aesthetics.[11] *Maryland's Greenhouse Gas Reduction Act Plan* from 2012 stated "it is estimated that beaches will move inland at a rate 50 to 100 times faster than the rate of sea-level elevation and that the cost of replenishing the coastline after a 20-inch rise in sea-level would be between $35 and $200 million".[13] Even cities and urban centers are expected to be impacted by climate change, experiencing extreme heat events, water shortages and flooding. Overall, rising temperatures could potentially result in a 5 percent loss in tourism revenues across the State.[14]

Dredging for Oysters (Amy Kehring, IAN, UMCES).

Paddlers on the upper Patuxent River (Jane Thomas, IAN, UMCES).

Energy

The energy sector tends to be thought of in terms of its potential impact on emissions; however it is also at risk from negative impacts of climate change. Hotter summer temperatures are expected to increase peak electricity demand in the summer due to increased use of air conditioning units. This makes it more difficult and potentially more expensive for utilities to meet the immediate peak demand, and also increases the risk of system failure precisely when it is most needed.[15] Based on a 3.5-5 degree Celsius increase in global average temperature, it is estimated that a 10-20 percent increase in total U.S. electric generating capacity will be required by 2050.[16] Programs such as enhanced urban tree canopies can help increase resiliency by providing shade relief to buildings during the summer, which alleviates demand for electric cooling.

11 University of Cambridge, 2014. Climate Change: Implications for Tourism.

12 Weather.com, "Wisp Four Seasons Resort, MD". <https://weather.com/weather/monthly/l/USMD0433:1:US>

13 Maryland Department of the Environment, 2013. Maryland's Greenhouse Gas Reduction Act Plan.

14 Center for Climate and Energy Solutions, 2015. Climate Change: Cost of Inaction for Maryland's Economy.

15 R. Horton et al., 2014. Chapter 16: Northeast, Climate Change Impacts in the United States (p. 371-395).

16 U.S. EPA, "Climate Impacts on Energy". <https://www.epa.gov/climate-impacts/climate-impacts-energy>

Maryland Invests in Green Energy

In 2016, Maryland invested $410 million in solar installations (167 MW capacity), and is expected to install an additional 1,792 MW over the next five years.[1] In June, the Maryland Public Service Commission announced a Community Solar Pilot Program which will help ensure all Marylanders have access to the benefits of renewable energy.[2]

1 Solar Energy Industries Association

2 Maryland Public Service Commission

Almost 84 percent of the water used in Maryland in 2010 was surface water withdrawn for cooling thermoelectric power plants.[17] As atmospheric temperatures increase, the temperature of surface water also increases, especially in shallow reservoirs such as the Chesapeake Bay, which has warmed by more than 2 degrees Fahrenheit since the 1940s and could warm by another 5 to 9 degrees by 2100.[18] Warmer water is obviously a less effective coolant, and reduces the efficiency of electricity generation. Since the majority of the water used in this manner is for once-through cooling[18], this also means that warmer water is being discharged back into the Bay. Maryland law regulates thermal discharge based on the ambient water temperature, so power plants will not have issues maintaining conformity to the law; however there is a potential for negative impacts to the Bay's ecological system that Maryland has made considerable investments in protecting and restoring.

Maryland's Environment

Projecting Future Climactic Conditions

In its 2008 assessment of climate change impacts for Maryland, the STWG applied the results of climate models developed for the IPCC 2007 assessment to project future climactic conditions in Maryland through the 21st century[19]. The larger number of improved models employed in the IPCC's 2014 assessment projected similar increases in summer temperatures (between 7 and 11 degrees Fahrenheit) and winter rainfall (around 20 percent) by the end of the century if the global GHG emissions continue to grow at recent rates.[19] Heat waves would be more severe and longer lasting, and more extreme precipitation events would punctuate summer droughts, very much consistent with the STWG 2008 report. However, the IPCC 2014 assessment included a new scenario under which emissions were rapidly reduced sufficient to minimize the risk of a 2 degrees Celsius increase in global mean temperature over pre-industrial conditions precisely the objective of the Paris Agreement. If this objective were achieved, Maryland's climate would continue to change; however it is more likely than not that summer warming would be kept below 3 degrees Celsius and that the severe extremes of precipitation could be avoided. Beyond the motivation this provides Marylanders to reduce their GHG emissions, the new analyses make clear that adaptation will still be a priority even if the objectives of the Paris Agreement are achieved.

Sea-Level Rise and Infrastructure

Scientific understanding of the causes and rates of sea-level rise is rapidly evolving. In 2013 the STWG updated its projections of sea-level rise for Maryland over the rest of the 21st century in order to provide reference points for planning state facilities under the Coast Smart Program.[20] Since then, new projections made in the IPCC 2014 report and even more recent peer-reviewed articles merit reconsideration of the Maryland projections. In particular, the development of probability distributions for sea-level rise projections that include the new IPCC low emissions scenario of a 2 degrees Celsius change increases the utility of sea-level rise projections for risk management in the face of inherent uncertainties and unknown pathways. Figure 3 presents such probabilistic projections for Baltimore based on the methods of Kopp et al.[21] The red shading

17 U.S. Geological Survey, "Water Use Data for Maryland". <http://waterdata.usgs.gov/md/nwis/water_use?>

18 D.F. Boesch (editor), 2008. Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland.

19 Maryland Commission on Climate Change Scientific and Technical Working Group, 2016. Re-Examining Projected Climate Changes for Maryland.

20 D.F. Boesch et al., 2013. Updating Maryland's Sea-level Rise Projections.

21 R.E. Kopp et al., 2014. Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites.

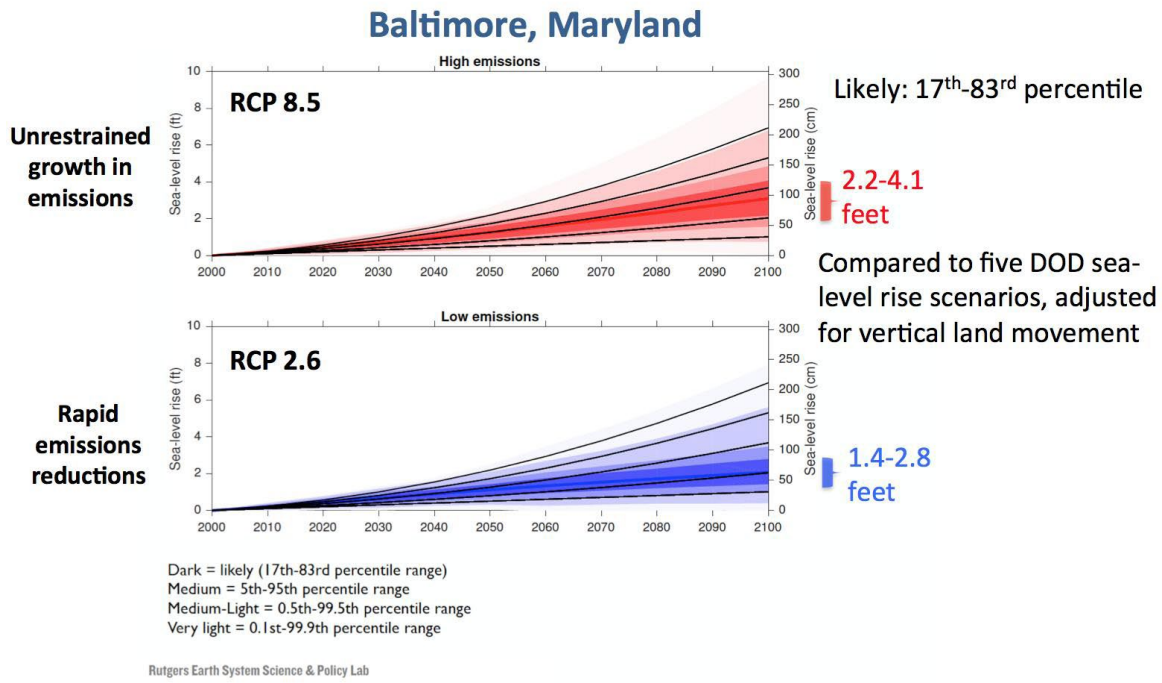
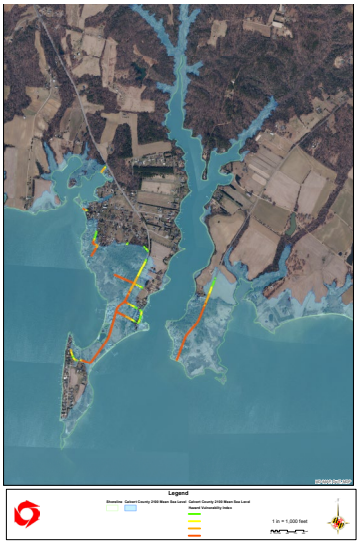


Figure 3. Probablistic projections of relative sea-level rise for Baltimore for the unrestrained growth in emissions (RCP 8.5) and rapid emissions reductions (RCP 2.6) scenarios.

in the top graph depicts projections assuming unrestrained growth in emissions of greenhouse gases, and the blue shading in the bottom graph shows projections assuming the 2 degrees Celsius warming objective is met. Even under the unrestrained growth scenario, these projections indicate somewhat less sea-level rise through the 21st century than projected by the STWG 2013 update, with the 50% probability at 3.1 feet and 90% confidence that sea-level rise will fall between 1.6 and 4.9 feet in Baltimore.[22] Achieving the Paris Agreement objective would reduce the amount of sea-level rise with which Maryland would have to contend by over one foot this century and by much more during the next century.

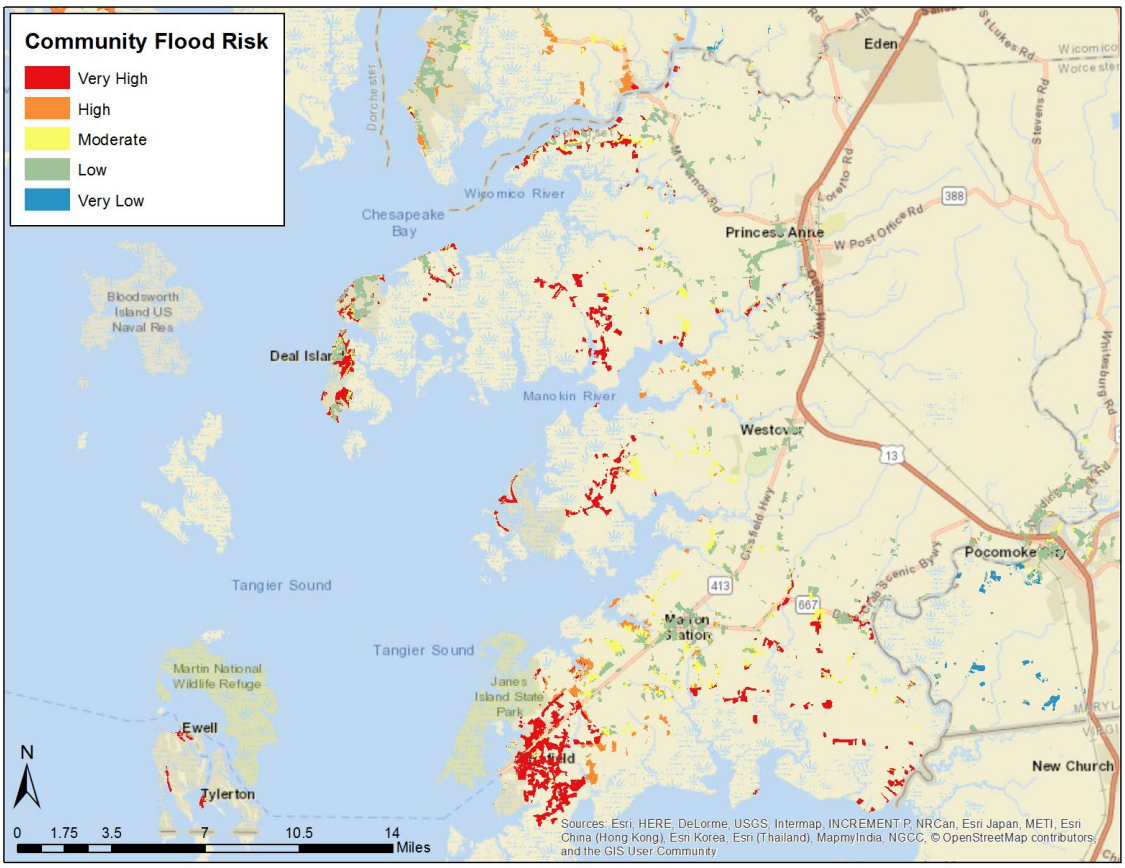
According to the State Highway Administration (SHA), Maryland has approximately 7,920 linear miles of roadways. Of those which are state-maintained, 2 percent are expected to be impacted by sea-level rise in 2050, and 4.5 percent by 2100.[23] The SHA has been analyzing the potential impacts of severe weather on the roadway network to climate stressors such as sea-level change, storm surges and precipitation. Bridges and roadways were identified in the two pilot counties. These assets were then comparatively scored based on their potential risk to impact from various climate stressors. For roadways, this included application of the Hazard Vulnerability Index, which is used to identify and rate roads based on risk to flooding. Methodology included identification of assets (i.e. bridges and roadways) in two pilot counties; followed by an assessment



State Highway Administration, Example of roadway analysis risk calculations for 2100 in Brooms Island, using the Hazard Vulnerability Index.

22 Maryland Commission on Climate Change Scientific and Technical Working Group. 2016. Re-Examining Projected Climate Changes for Maryland.

23 Maryland State Highway Administration, 2014. Climate Change Adaptation Plan with Detailed Vulnerability Assessment.



The Coastal Community Flood Risk Areas rank residential areas from very low to very high risk based on probability of exposure to a flood event, population density, and social demographics. The Coastal Resiliency Assessment tool can be found here:

of climate stressors on these assets, and comparative scoring based on risk. This pilot program (completed in 2014) served as a model for carrying out vulnerability assessments in several low-lying counties in Maryland (completed in 2016), with one of the final goals being prioritization of adaptive actions throughout the State.

This year DNR worked with the Nature Conservancy and other state, federal and non-governmental partners to complete a Coastal Resiliency Assessment that identified statewide priorities for conservation and restoration of coastal habitats which reduce the risk of flooding and other hazardous impacts in vulnerable coastal communities.[24] DNR also continued their work to implement buffer reforestation, wetland restoration, and conservation shoreline practices "to enhance ecosystem resilience to sea-level rise and coastal erosion impacts"; and the department's Chesapeake and Coastal Service Unit has selected six projects to fund under the new Coastal Resiliency Grants Program.[25]

Maryland Ecosystems

According to DNR, an estimated 18,000 people depend either directly or indirectly on the forestry industry for their livelihood.[25] In addition, forests provide many ecosystem services to all residents, such as decreasing the peak discharge and total runoff from storm events which reduces incidents of riverine flooding; capturing or retaining soil and nutrients from runoff thereby helping the State meet its Bay TMDL goals and keeping our drinking water reservoirs cleaner; acting as a sink for atmospheric carbon; and providing essential habitat for wildlife and recreational opportunities for people. In quantifiable terms, MDE estimates that forests contribute

24 Appendix A

25 Maryland Department of Natural Resources, "Forestry Facts". <http://dnr.maryland.gov/forests/Pages/mdfacts.aspx>

$2.2 billion to Maryland's economy, and an additional $24 billion in ecological services.[26]

The Chesapeake Bay ecosystem is also an invaluable and iconic part of Maryland, and some of the risks to aquatic fisheries species have already been discussed in the previous section. The warming projections noted earlier are of particular concern for species that are already at the southernmost edge of their climatic range, including eelgrass which provides food and habitat for fish, crabs and waterfowl.[27,28] In addition, warmer water inherently contains lower concentrations of dissolved oxygen, exacerbating dead-zones.[29] Bay acidification poses a potential problem for pH sensitive species, including crabs and oysters which require specific chemical conditions in order to create and maintain their shells. DNR currently engages in extensive water quality monitoring in the Bay in order to track and report many of these changes.

Maryland SWAP

Maryland's State Wildlife Action Plan for 2015-2025 includes a chapter on climate change which notes that "climate change threatens species and their habitats due not only to warming temperatures and changes in precipitation patterns, but also to the exacerbation of already present stressors".[1] This report was compiled by Maryland biologists at the Department of Natural resources, in order to guide conservation and adaptation measures in the State.

1 Maryland Department of Natural Resources, 2016. Chapter 6: Climate Change. Maryland State Wildlife Action Plan.

Public Health and Equity

Climate change is expected to have a broad range of impacts on human health, including many indirect effects related to impacts discussed previously (e.g. reduced agricultural yields contributing to malnutrition). There are also more direct impacts on health and welfare from increased incidents of extreme heat and weather events, declining air quality, and changes in the distribution of vector-borne diseases. It is important to keep in mind that many of these health impacts as well as the economic and job impacts, and sea-level rise all have frequently disproportionate impacts on communities that are more vulnerable either based on the nature of the impact or the community's ability to adapt and respond.

Co-Pollutants

The most immediate human health concern caused by the burning of fossil fuels is not carbon dioxide, but co-pollutants associated with combustion. For fossil-fuel fired power plants, these tend to be sulfur dioxide, carbon monoxide, hydrocarbons and particulate matter such as fly ash. Coal in particular is often referred to as the "dirtier" fuel source, while natural gas tends to burn "more cleanly". Some co-pollutants cause issues directly, while others undergo reactions in the atmosphere to create harmful secondary pollutants such as ground-level ozone, acid rain, and photochemical smog. Several pollutants related to the production and combustion of fossil fuels[30] are federally regulated as hazardous under the Clean Air Act (CAA), including nine out of the 30 pollutants identified as Urban Air Toxics.[31,32] Polycyclic organic matter, a category which includes known carcinogens, is formed from combustion.[32] In fact, of the EPA's six criteria pollutants regulated under the CAA, five are associated with combustion of fossil-fuels used in power plants. Reductions in fossil-fuel combustion, therefore, results in reduced emissions of co-pollutants as well as carbon dioxide; and our efforts in mitigation may actually have some "unintended consequences" of a positive nature.

26 Maryland Department of the Environment, 2015. 2015 Greenhouse Gas Emissions Reduction Act Plan Update.

27 Maryland Department of the Environment, 2015. 2015 Greenhouse Gas Emissions Reduction Act Plan Update.

28 Chesapeake Bay Program. "Climate Change". <http://www.chesapeakebay.net/issues/issue/climate_change>

29 NOAA Chesapeake Bay Office, 2011. Climate Change and the Chesapeake Bay.

30 The majority are specifically related to burning coal and oil, rather than natural gas

31 National Center for Biotechnology Information, U.S. National Library of Medicine. PubChem Database. <https://pubchem.ncbi.nlm.nih.gov/>

32 U.S. EPA, "Hazardous Air Pollutants". <https://www.epa.gov/haps>

Heat

Many chronic diseases increase sensitivity to heat stress, including diabetes, cardiovascular disease, and certain medications prescribed for mental illness. In addition, those with asthma or other chronic respiratory diseases are very sensitive to the decreased air quality associated with increased temperatures.[33] The *Maryland Climate and Health Report* released this year by the Department of Health and Mental Hygiene (DHMH) provided an analysis on the impacts of climate change on health, including observations on historic hospitalizations due to extreme heat events and predictions for the future. The report defined extreme heat events as compared to baseline maximum daily temperatures between 1960-1989, and found that the occurrence of extreme summer heat events (95th percentile for that baseline day) in the 1980's, 1990's and 2000's was more than double the occurrence in the 60's and 70's; and climate projections anticipate a continued increase in events through 2040. The report found that, between 2000 and 2012, these events "increased the risk of hospitalization for heart attack by 11 percent during summer months", and by up to 43 percent in some areas.[34] In addition, the report found that extreme heat events in Maryland increased the risk of hospitalization due to asthma by 22 percent.[35]

Individuals vulnerable to respiratory illness may be at an increased risk in Maryland's future climate.

Equity

The IPCC 2014 report recognized that "risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development".[35] Many of the impacts discussed in the previous chapters may be felt more strongly by Marylanders who are more vulnerable either because of their direct proximity to impacts such as sea-level rise, or because of reduced ability to respond to these events based on the resources at their disposal. It is one of the charges of the Commission to address any disproportionate impacts of climate change, and it is also important to the Commission's work to consider how secondary impacts of adaptation and mitigation efforts might negatively affect these communities. As evidenced by mention of equity and inclusion of diverse stakeholders in all working group plans, this is a charge that the Commission takes very seriously. It is imperative that, in making decisions regarding mitigation and adaptation, we do not inadvertently leave our most vulnerable neighbors behind.

33 U.S. Global Change Research Program, 2009. Chapter 1: Climate and Health Assessment. Global Climate Change Impacts in the United States.

34 Maryland Department of Health and Mental Hygiene, 2016. Maryland Climate and Health Profile Report.

35 Intergovernmental Panel on Climate Change, 2014. Climate Change 2014: Synthesis Report.

Chapter 5 – Progress Made in 2016 and Recommendations

2015 MCCC Report and Priorities Established for 2016

2015 MCCC Report

The 2015 MCCC report was officially released in December 2015, and reflected the broad range of perspectives and insights brought to bear on the work of government by the members of the MCCC throughout 2015. The report highlighted the many costs associated with climate change, including its disproportionate impacts on Maryland's most vulnerable communities and the costs and benefits of taking action to limit climate change and its impacts. The 2015 MCCC Report was guided by the best available science as supported by the MCCC's STWG. In the 2015 science update (Appendix 1 of the 2015 MCCC Report) the STWG concluded that science has demonstrated with a high degree of certainty that Earth's climate is being changed by human activities, particularly the emission of GHGs.

Additionally, the 2015 MCCC Report provided a thorough opinion on strengthening the framework for assessing Maryland's GHG reduction planning and programs. The report focused on the likely costs of inaction on jobs and the economy, specifically including infrastructure, tourism, agriculture, forestry and terrestrial ecosystems, and bay and aquatic ecosystems. Further, the report addressed the costs of inaction related to climate change on public health, and discussed equity concerns related to the environment and energy.

The 2015 MCCC Report also provided a summary of MDE's *2015 GGRA Plan Update* and recommendations to the Governor and General Assembly for future state climate action, including maintenance of the 25 percent GHG emissions reduction required under the GGRA by 2020 and its extension to 40 percent by 2030. Finally, as mandated by law, the MCCC report provided guidance to its working groups as they developed work plans for 2016.

Priorities Established for 2016

The MCCC instructed its working groups to prepare work plans for 2016 that were designed to analyze and address the following MCCC priorities:

1. **Reporting.** Ensuring that the State of Maryland is adopting the best and most comprehensive practices for measuring, tracking and reporting regularly on the progress that Maryland is making to address the causes, impacts and economics of climate change.

2. **Methane leakage.** Analyzing and generating recommendations to determine whether and how to incorporate out-of-state methane leakage into the State's GHG emissions inventories and projections, employing the best available science and analysis.

3. **Additional strategies.** Identifying additional climate strategies, goals, policies and programs that would put Maryland on a path of leadership towards GHG emissions reductions by 2050, informed by science and international agreements and that would:

    - Have the potential for significant near-term reductions in GHG emissions ("fast-acting climate changers");
    - Produce economic, environmental and public health benefits that are equitably distributed across Maryland's population (including addressing the economic dislocations that they may generate); and
    - Effectively address the impacts climate change will have on the State's most vulnerable populations and communities.

- In particular, the MCCC's 2016 priorities included an analysis of possible additional climate strategies, goals, policies and/or programs in renewable energy, energy efficiency and conservation and zero-emission vehicles and transportation.
- Additionally, the MCCC sought to better understand how the public health co-benefits of climate action translate into economic growth and how that is reflected through net economic benefits, job creation and annual wages paid to workers.

4. **Building Resilience.** To advance Maryland's ability to address known threats and future vulnerabilities to climate change, adaptation and response efforts will work to increase and broaden public and private partnerships; address the challenge that low-income and otherwise vulnerable communities will likely be disproportionally impacted by climate change; assess the impacts that climate change will likely have on the State's economy, revenues and investment decisions; and continue to deliver and refine tools and assistance for local governments.

Adoption of GGRA of 2016

Following the release of the *2015 GGRA Plan Update*, MDE proposed recommendations to the Governor and General Assembly that the GGRA be renewed with the requirement that Maryland reduce statewide GHG emissions by 40 percent from 2006 levels by 2030. The 2015 MCCC Report supported MDE's recommendation, and explicitly recommended that the State adopt a goal and develop a plan to reduce Maryland's GHG emissions 40 percent from 2006 levels by 2030, with continued inclusion of safeguards, exemptions, studies of those exemptions, reassessment provisions and other relevant language contained in the 2009 GGRA law.

The MCCC believed that the approach to achieving the 40 percent by 2030 goal must continue to have a net positive impact on both the economy and job creation in Maryland and should emphasize technology innovation, economic development, jobs and consumer protection, as well as public health and well-being. The MCCC endorsed MDE's recommendation to incorporate beneficial economic impacts into the 2030 climate action objectives, and believed that Maryland's 2030 climate action goals and plans should be broadened to include the following additional items:

- The degree to which climate action strategies, policies and programs produce economic benefits that are equitably distributed across Maryland's population;
- The degree to which climate action strategies, policies and programs produce economic benefits that are sustainable;
- The degree to which climate change strategies, policies and programs effectively address the economic dislocations that they may cause;
- The degree to which climate action strategies, policies and programs produce public health benefits;
- The degree to which climate action strategies, policies and programs reduce energy burdens in low-income households; and
- The degree to which climate action strategies, policies and programs improve resilience in vulnerable communities.

On April 4, 2016, Governor Lawrence J. Hogan signed the GGRA of 2016 into law, which requires Maryland to reduce statewide GHG emissions by 40 percent from 2006 levels by 2030. Through this legislation, Maryland will take actions to address carbon emissions in all sectors while simultaneously enhancing Maryland's economy. As MDE develops a plan for the 2016 GGRA, it will work with the MCCC to explore many of the additional items outlined in the 2015 MCCC Report.

Working Group Recommendations

This year's report is delivered on the heels of a renewed Greenhouse Gas Reduction Act, and shows efforts made by the working groups to begin building on that success and working towards identifying recommendations for the 30 by 40 plan due in 2018. The goals and priorities which the groups have established for themselves represent the basis of each working group's 2017 Work Plan, which will contain additional detail and more specific targets for the upcoming year. It is the expectation of the Commission that the contents of this report will provide the Governor and General Assembly, in the interim, with some guidance to aid in making informed policy and program decisions which benefit all Marylanders now and in the future.

Adaptation and Response Working Group

The Adaptation and Response Working Group (ARWG) is chaired by the Secretary of the Maryland Department of Natural Resources with administrative support provided by DNR staff. The ARWG is charged with developing a comprehensive strategy for reducing Maryland's climate change vulnerability, as well as providing the State and local governments with tools to plan for and adapt to the more extreme weather and rise in sea-levels anticipated as a consequence of climate change. The working group advances its work through the active involvement of and leadership from other working group members, agencies and stakeholders. The ARGW has in the past relied upon input from a range of stakeholders, and recommends continued collaboration and conversations to determine when, how and if implementation of adaptation measures move forward. The recommendations set forth in the ARWG 2016 annual report will continue to be guided and informed in this manner.

Located in the north end of Kent Narrows within Ferry Point Park, the property is a 41-acre parcel of marshland that provides habitat for a variety of wildlife, such as horseshoe crabs, terrapins, bald eagles and osprey. After nearly five years of planning and five months of construction, the heavily deteriorating coast along Ferry Point has been fully transformed to a resilient living shoreline.

Adaptation efforts are closely tied to the other working groups. For instance, the STWG issues sea-level rise projections and updates that are used in a wide variety of ARWG-related vulnerability assessments and future planning activities. Additional engagement is being pursued with the MWG to better understand possible connections between adaptation/resilience and mitigation efforts; as well as with the ECO Working Group to ensure that adaptation efforts are communicated clearly to a wide variety of audiences.

The ARWG, and associated State agencies, have been working this year to create and refine tools that help the State and local governments anticipate and plan for sea-level rise, among other impacts. Several actions and initiatives from the past year were highlighted in the preceding chapters, and the ARWG's full 2016 update can be found in Appendix E.

A full outline of the working group's recommendations can be found in Appendix A.

The ARWG has identified three main priority recommendations for the upcoming 2017 year.

Supporting Local Partners

In order to continue to address the four adaptation challenge areas, it will require work not only among state partners and at the state level, but also across local towns, municipalities and counties to ensure that our people, economies and resources are positioned to thrive into the future in a changing climate. The ARWG has made it a priority to strengthen efforts in 2017 to place greater emphasis on supporting adaptation at the local level. This will be done by working on continuing to understand capacity needs, delivering assistance to communities, encouraging development of local adaptation plans, and highlighting local progress to foster advances across the State.

Focus and Accelerate Adaptation Progress on Non-Coastal Impacts

At the same time as progress continues on coastal climate impacts such as sea-level rise and coastal flooding, the work of the ARWG and its members - as well as the challenges of different climate impacts - continues to evolve. Following its 2016 quarterly meetings, the ARWG identified an increasing need to focus on adaptation in non-coastal jurisdictions and the wider set of climate impacts outlined in both Phase I and II adaptation strategies. The group recommends that increasing emphasis be placed on accelerating adaptation progress on non-coastal issues and communicating ongoing progress in these areas in a more tangible way.

Expand Partnerships

Climate adaptation requires work across sectors and stakeholder groups. The ARWG has identified the need to expand public and private partnerships and working group participation to include business, organized labor and industry representatives as well as local, state and federal partners.

Mitigation Working Group

The Mitigation Working Group (MWG) is co-chaired by three balanced commission members (State agency, business representative, and environmental advocate), with administrative support provided by MDE staff. The MWG focuses on regulatory, market-based and voluntary programs to reduce GHG emissions while supporting economic development and job creation. This year the working group focused inquiry and discussion on three main areas identified as priorities: methane emissions, enhanced economic analysis and social equity issues, and zero emission vehicle initiatives. The MWG collaborated extensively with the STWG on methane, and worked with ECO and other members of the environmental justice community during equity discussions and planned outreach. The group welcomes additional collaboration with both of these groups and the ARWG in the coming year, in order to coordinate and enhance the efforts of the Commission, and to take full advantage of the assets at their disposal.

The MWG has produced a number of consensus recommendations for the three main priorities discussed this year, as well as identified several plans and priorities for further examination in the upcoming 2017 year.

A full outline of the working group's recommendations can be found in Appendix B.

An Update on the "25 by 20" and the "40 by 30" Goals

The 25 percent by 2020 plan is being implemented, and when combined with external trends such as vehicle miles travelled and increased natural gas use in electricity generation, GHG emission reduction estimates appear to show that the State is on the path to the 2020 goal. MDE is currently working on the 40 by 30 plan; this is due as a draft in 2018, with the final to follow in 2019. Preliminary expectations are that many existing programs will continue to generate deeper GHG emission reductions through 2030, though additional programs will likely be necessary to achieve the full goal. Updates to the Commission will continue through 2017 and will have a specific focus on this new reduction progress that may be needed.

Methane Emissions

The MWG supports MDE's efforts to reduce methane emissions from landfills, natural gas infrastructure (e.g. compressor stations and underground storage), and waste water treatment plants, and recommends further

research into additional sources such as agriculture and fuel production/transport. In support of this effort, the working group recommends an analysis to better account for methane emissions; including analysis by MDE to calculate out-of-state emissions due to in-state consumption, as well as emissions from existing natural gas infrastructure within the State. This analysis/accounting will not be incorporated into the state GHG emission inventory used to show compliance with Maryland's GHG laws, but will be available and transparent for all interested parties.

The methane analysis will be shared by MDE with the MWG and STWG, and the group anticipates discussion of the results. A discussion will also need to be initiated on the economic and equity impacts of attempting to offset out-of-state methane. In recognition of the fact that Maryland has little ability to regulate these out-of-state emissions once accounted for, the MWG recommends that the Commission and the State strongly support the need for robust Federal regulations and strong regulations in other states to minimize these out-of-state emissions. The MWG does not have a consensus either supporting or opposing hydraulic fracturing in Maryland, however it is agreed that *should* hydraulic fracturing commence in Maryland, methane emissions must be minimized to the maximum extent possible.

Enhanced Economic Analysis/Social Equity Issues

The MWG supports MDE's efforts to develop and implement enhanced and spatially explicit tools for economic analysis and analysis of social equity issues as part of the planning process to research, analyze and develop new and enhanced GHG emission reduction programs. This is anticipated to greatly support the draft 40 by 30 plan, which is due in 2018. In addition, the MWG supports MDE's efforts to hold public outreach meetings and listening sessions, which started in late 2016 and will continue into 2017, to specifically seek input from underserved communities that will be significantly impacted by climate change. In its own work for the Commission, the MWG will consistently include both social equity and economic and employment analysis in its considerations for all future actions and recommendations. The group will continue to consult with Commission on Environmental Justice and Sustainable Communities (CEJSC) and the ECO Working Group to inform the equity considerations; and engage a range of stakeholders to ensure that robust economic and employment analysis.

Electric and Other Zero Emission Vehicle Initiatives

The MWG supports the efforts of MEA and the Electric Vehicle Infrastructure Council (EVIC) on potential 2017 legislation, and recommends that incentives be provided for the purchase of EVs, EV equipment, and EV infrastructure. The working group also supports the efforts of MDOT, MDE, MEA and EVIC to expand electric vehicle infrastructure and usage within Maryland, and recommends that local government continue to be consulted as part of this process. In regards to the anticipated Volkswagen settlement in 2017, the MWG proposes that a significant amount be utilized for EV infrastructure; for leveraging EV-related manufacturing in Maryland; and for demonstrations and evaluation of electric transportation in other aspects such as transit, fleet utilization, and port and airport support vehicle applications.

Additional Recommendations for 2017

In 2017, the MWG would like to continue advancing many of the core 2016 efforts, as well as further exploring several emerging issues identified over the past year. As previously noted, MWG has engaged in several outreach sessions in the 2016 year, and will be continuing this effort into 2017 through a partnership with the CEJSC to identify and conduct outreach meetings/listening sessions with environmental justice and underserved communities. The MWG also supports MDE efforts to enhance the GHG emissions inventory to include methane, black carbon, and two radiative forcing estimates (20-year and 100-year). The working group supports an enhanced effort by the State and the business community to bring additional clean energy businesses and manufacturing jobs to Maryland, and to sustain those already in existence. At the same time there should be efforts by the MWG to identify fossil-fuel dependent workers and communities in Maryland; and to identify, as specifically and quantitatively as possible, the existing and prospective GHG reduction programs and policies that may or do have negative or positive impacts on these groups.

The working group has proposed several areas for enhanced investigation and collaboration in mitigation programs and efforts that may provide information and recommendations helpful to creating the 40 by 30 plan and reaching this new reduction goal. Those so far identified include collaboration with the ARWG on an enhanced effort and research on climate friendly agricultural practices, including carbon sequestration and the healthy soils initiative; expansion of MWG research on zero emission vehicles to include additional research and emphasis into the role of the transportation sector in emission reductions, including mass transit and other travel demand management strategies as well as federal regulations; and an effort to develop and implement innovative financing programs to support a transition to proven new technologies that can reduce GHG emissions while saving consumers money. A more specific timeline and strategy for tackling these varied efforts will be provided in the MWG 2017 Work Plan.

Intersection of Routes 95 and 395 in Baltimore, on the middle branch of the Patapsco River (Jane Thomas, IAN, UMCES).

Scientific and Technical Working Group

The Scientific and Technical Working Group (STWG) is responsible for updating and informing the Commission on the science of climate change. This year they have done research on methane[1], which was a valuable contribution to the discussions and recommendations provided by the MWG. The STWG also provided updated temperature, precipitation and sea-level rise projections, which were included in previous chapters. These were utilized by the ARWG in a wide variety of vulnerability assessments and future planning activities. The following are recommendations for additional research and scientific considerations for the Commission in the coming year.

A full outline of the working group's recommendations can be found in Appendix C.

Although methane emissions presently contribute only a small part of Maryland's GHG emissions, actions should be taken to incrementally reduce methane emissions from major in-state sources (landfills, wastewater treatment, agriculture and natural gas distribution) to the degree practicable. The rate of methane emissions from sources which are currently poorly quantified (such as landfills, and old wells and coal mines) should be evaluated for potential mitigation. Additional evaluation should be performed to account for out-of-state emissions associated with production and processing of natural gas consumed in Maryland; and ensure that potential natural gas production and transshipment in Maryland have strict federal or state controls on emissions, or effective offsets, to avoid adding to the State's methane emissions.

Black River wastewater treatment plant near Baltimore, Maryland (Jane Thomas, IAN, UMCES)

Additionally, the STWG proposes that GHG emission inventories should be enhanced by better quantifying presently poorly accounted for sources, including "natural" sources and sinks such as wetlands and surface waters affected by human activities and management strategies. The impact analysis of costs and benefits of mitigation options

1 Maryland Commission on Climate Change Scientific and Technical Working Group, 2016. Scientific Perspectives Related to Methane Emissions in Maryland.

should be broadened beyond conventional economic metrics to better account for employment, human health and well-being, social vulnerability and environmental quality. Adaptation and response strategies should be revised or fine-tuned in light of updated climate impacts assessment, which should focus in the near term on incorporating probabilistic sea-level projections in coastal resilience planning; and take climate change into account in Chesapeake Bay restoration, while recognizing uncertainties of its effects on Total Maximum Daily Load restoration goals.

Education, Communication and Outreach Working Group

The Education, Communication and Outreach (ECO) Working Group assists with the Commission's public outreach and public meetings on climate change, as well as educating Marylanders on what the State is doing to address its causes and impacts. This year they placed a particular focus on how the Commission might enhance public outreach and support education on and distribution of the Annual Report. Next year the working group would like to formalize partnerships with the Commission's diverse sectors to support communications on the distribution of report and to improve education and outreach in communities vulnerable to climate change, as well as increase working group members in private and government sectors and with unique expertise in education and communication with communities vulnerable to climate change.

A full outline of the working group's recommendations can be found in Appendix D.

Commission outreach must be guided by the 2015 Maryland law, which requires the Commission to (1) develop broader non-profit/for-profit community and state, federal and local government partnerships; (2) communicate with and educate Maryland residents about the urgency of acting to reduce the impacts of climate change; and (3) address any disproportionate impacts of climate change on low-income and vulnerable communities. The ECO Working Group recommends that, in efforts to improve the education, communication and outreach surrounding the Annual Report, the Commission should (in this upcoming year) provide guidance on approaches to develop tools, resources, or meeting models that both provide education on climate change for and receive input from diverse stakeholders and communities in Maryland. These approaches should increase the Commission's capacity for communications and outreach by leveraging existing models across the Commission's sectors, in Maryland, and beyond. Successful approaches on climate change education, communications, and outreach should be shared through presentations to the ECO Working Group. Overall, the Commission's engagement and outreach should prioritize climate change and respond to issues identified by communities vulnerable to climate change. Enhanced outreach location considerations should include issues faced by environmental justice communities experiencing disproportionate impacts of climate change. Best practices for communications on climate change should inform the Commission's outreach and education; and ECO should inform the Commission on emerging practices to support the working groups. This includes ECO support of efforts to design a Climate Ambassadors program or another emerging platform to improve communication about the urgency of climate change. Existing Maryland educational resources on climate change should be compiled and shared electronically with an emphasis on diverse geographic areas, literacy levels, and content topics. Overall digital and web capacity to share resources should be improved.

Students learning about sustainability at Greenscape, an environmental leadership celebration hosted by the Baltimore Office of Sustainability (Shan Gordon, Flickr).

Outreach is expected to be informed by input and a letter from both the Commission on Environmental Justice and Sustainable Communities (CEJSC) and the Children's Environmental Health & Protection Advisory Council (CEHPAC) to best identify communities vulnerable to climate change and communities overburdened by pollution related to GHG emissions. The ECO Working Group will work with these organizations to provide guidance on locations for enhanced outreach. Location considerations and tools for education and outreach should include the Commission's priorities and incorporate environmental justice to respond to climate change issues of health, equity, and vulnerability. Vulnerability can be defined by exposure to increased flooding and sea-level rise and other climate factors and/or by ability to respond to these events based on socioeconomic status.

ECO specifically recommends several components to be included in Commission reports, in order to enhance the accessibility and utility to a variety of stakeholders. The report should include an Executive Summary translated into Spanish, and other languages as a need is identified or requested. Additionally key report findings should be designed into summaries for audiences including but not limited to State and County policy makers, Maryland residents, and educators of adults and children. A resource appendix should be included to educate the public on ways to contact state offices working on climate change, and to compile research and resources that inform the findings of the 2016 report. A communications toolkit should be created to support distribution through media platforms maintained by Commission stakeholders and to include tools for ongoing education and outreach. Report distribution should be supported by a partnership with stakeholders from government, private, and public sectors.

Appendix A

Adaptation and Response Work Group Annual Report: Recommendations Excerpt

The Adaptation and Response Work Group (ARWG) is chaired by the Secretary of the Maryland Department of Natural Resources with administrative support provided by Department staff. The ARWG advances its work through the active involvement of and leadership from other work group members, agencies and stakeholders. The work group has relied upon and recommends the continued collaboration and conversations with stakeholders to determine when, how and if implementation of adaptation measures move forward. The recommendations set forth in the ARWG 2016 annual report will continue to guided and informed in this manner as they move forward.

Adaptation efforts are also closely tied to the other work groups. For instance, the Scientific and Technical Working Group (STWG) issues sea level rise projections and updates that are used in a wide variety of ARWG-related vulnerability assessments and future planning activities. Additional engagement with the Mitigation Work Group is being pursued to better understand possible connections between adaptation/resilience and mitigation efforts and also with the Education, Communication and Outreach Work Group to ensure that adaptation efforts are communicated clearly to a wide variety of audiences.

The ARWG outlines the following priorities and recommendations for 2017:

1. **Supporting Local Partners –** in order to continue to address the four adaptation challenge areas, it will require work not only among state partners and at the state level, but also across local towns, municipalities and counties to ensure that our people, economies and resources are positioned to thrive into the future in a changing climate. The ARWG has made it a priority to strengthen efforts in 2017 to place greater emphasis on supporting adaptation at the local level. This will be done by working or continuing to understand capacity needs, delivering assistance to communities, and highlighting local progress to foster advances across the State.

2. **Focus and Accelerate Adaptation Progress on Non-Coastal Impacts -** at the same time progress continues on coastal climate impacts such as sea level rise and coastal flooding, the work of the ARWG and its members' - as well as the challenges of different climate impacts - continue to evolve. Following its 2016 quarterly meetings, the ARWG identified an increasing need to focus on adaptation in non-coastal jurisdictions and the wider set of climate impacts outlined in both Phase I and II adaptation strategies. The work group recommends that increasing emphasis be placed on accelerating adaptation progress on non-coastal issues and communicating ongoing progress in these areas in a more tangible way.

3. **Expand Partnerships –** climate adaptation requires work across sectors and stakeholder groups. The ARWG has identified the need to expand public and private partnerships and work group participation to include business, organized labor and industry representatives and local, state and federal partners.

Appendix B

Mitigation Working Group Recommendations

25 by 20 Update

- The 25% by 2020 plan is being implemented, and when combined with external trends such as vehicle miles travelled and increased natural gas use in electricity generation, GHG emission reduction estimates appear to show that the State is on the path to the 2020 goal

40 by 30 Status Report

- MDE is currently working on a draft of the 40 by 30 plan, which is due as a draft in 2018 (final in 2019)
- Preliminary expectations are that many existing programs will continue to generate deeper GHG reductions through 2030; additional programs will also be necessary. Updates to the Commission will continue through 2017 and will have a specific focus on this new reduction progress that may be needed.

Methane Emissions

- The MWG supports MDE's efforts to reduce methane emissions from landfills, natural gas infrastructure (e.g. compressor stations and underground storage), and waste water treatment plants, and recommends further research into additional sources such as agriculture and fuel production/transport
- The MWG recommends that the Commission and the State strongly support the need for robust Federal regulations and strong regulations in other states to minimize out-of-state methane emissions
- The MWG recommends that the upcoming GHG emission inventory incorporate a more extensive accounting of methane emissions; including analysis by MDE to calculate out-of-state emissions due to in-state consumption, as well as emissions from existing natural gas infrastructure within the State
- The MWG does not have a consensus either supporting or opposing hydraulic fracturing in Maryland, however it is agreed that *should* hydraulic fracturing commence in Maryland, methane emissions must be minimized to the maximum extent possible

Enhanced Economic Analysis/Social Equity Issues

- The MWG supports MDE's efforts to develop and implement enhanced and spatially explicit tools for economic analysis and analysis of social equity issues as part of the planning process to research, analyze and develop new and enhanced greenhouse gas emission reduction programs to support the draft 40 by 30 plan due in 2018
- The MWG supports the MDE efforts to hold public outreach meetings and listening sessions, which started in late 2016 and will continue into 2017, to specifically seek input from underserved communities that will be significantly impacted by climate change
- MWG should continue to consult with CEJSC and the ECO Working Group to inform the equity considerations of future actions and recommendations
- MWG should continue to engage a range of stakeholders to ensure that robust economic and employment analyses are included in considerations for all future actions and recommendations

Electric and Other Zero Emission Vehicle Initiatives

- The MWG supports the efforts of MEA and the Electric Vehicle Infrastructure Council (EVIC) on potential 2017 legislation, and recommends that incentives be provided for the purchase of EVs, EV equipment, and EV infrastructure
- The MWG supports the efforts of MDOT, MDE, MEA and EVIC to expand electric vehicle infrastructure and usage within Maryland. Local government should be consulted as part of this process.
- The MWG proposes that a significant amount of the Volkswagen settlement be utilized for EV infrastructure; for leveraging EV-related manufacturing in Maryland; and for demonstrations and evaluation of electric transportation in other aspects such as transit, fleet utilization, port and airport support vehicle applications, and others.

Additional Recommendations for 2017

The MWG also supports the following:

- MDE efforts to enhance the GHG emissions inventory to include methane, black carbon, and two radiative forcing estimates (20-year and 100-year)
- A continued partnership with the CEJSC to identify and conduct outreach meetings/listening sessions with environmental justice and underserved communities
- An enhanced effort by the State and the business community to bring additional clean energy businesses and manufacturing jobs to Maryland, and to sustain those already in existence
- Efforts by the MWG to identify fossil-fuel dependent workers and communities in Maryland; and to identify, as specifically and quantitatively as possible, the existing and prospective GHG reduction programs and policies that may or do have negative or positive impacts on these groups
- In collaboration with the Adaptation and Response Workgroup, an enhanced effort and research on climate friendly agricultural practices, including carbon sequestration and the healthy soils initiative.
- Additional research and emphasis into the role of the transportation sector and potential programs for emission reductions, including mass transit and other travel demand management strategies as well as federal regulations
- An effort to develop and implement innovative financing programs to support a transition to proven new technologies that can not only reduce GHG emissions (and energy use), but also save consumers money. This effort should focus on both energy and transportation technologies.

Appendix C

Scientific and Technical Working Group Recommendations

- Methane emissions presently contribute only a small part of Maryland's GHG emissions, nonetheless actions should be taken to:
  - Incrementally reduce methane emissions from major in-state sources (landfills, wastewater treatment, agriculture and natural gas distribution) to the degree practicable;
  - Account for out-of-state emissions associated with production and processing of natural gas consumed in Maryland; and
  - Ensure that potential natural gas production and transshipment in Maryland have strict federal or state controls on emissions, or effective offsets, to avoid adding to the State's methane emissions.
  - Directly evaluate the rate of methane emissions from such poorly quantified sources, such as landfills and old wells and coal mines, that might be mitigated.
- Broaden impact analyses of the costs and benefits of mitigation options beyond conventional economic metrics to better account for employment, human health and well-being, social vulnerability and environmental quality.
- Enhance GHG emission inventories by better quantifying presently poorly accounted for sources, including "natural" sources and sinks such as wetlands and surface waters affected by human activities and management strategies.
- Revise or fine-tune adaptation and response strategies in light of updated climate impacts assessment. In the near term:
  - Incorporate probabilistic sea-level projections in coastal resilience planning; and
  - Take climate change into account in Chesapeake Bay restoration, while recognizing uncertainties of its effects on Total Maximum Daily Load limitations.

Appendix D

Education, Communications, and Outreach Workgroup

MCCC outreach must be guided by the 2015 Maryland law which requires MCCC to:

1. Develop broader non-profit/for-profit community and state, federal and local government partnerships;
2. Communicate with and educate Maryland residents about the urgency of acting to reduce the impacts of climate change; and
3. Address any disproportionate impacts of climate change on low-income and vulnerable communities.

The Education, Communications, and Outreach Working Group also recommends that Public Outreach to Support Education on the Annual Report be guided by:

- The Commission should provide guidance on approaches to develop tools, resources, or meeting models that both provide education on climate change for and receive input from diverse stakeholders and communities in Maryland. These approaches should increase the Commission's capacity for communications and outreach—by leveraging existing models across the Commission's sectors, in Maryland, and beyond. Successful approaches on climate change education, communications, and outreach should be shared through presentations to the ECO Work Group.
- The Commission's engagement and outreach should prioritize climate change and respond to issues identified by communities vulnerable to climate change. Enhanced outreach location considerations should include issues faced by environmental justice communities experiencing disproportionate impacts of climate change.
- Digital and web capacity to share resources should be improved.
- Existing Maryland educational resources on climate change should be compiled and shared electronically with an emphasis on diverse: geographic areas, literacy levels, and content topics.
- Best practices for communications on climate change should inform the Commission's outreach and education. ECO should inform of the Commission on emerging practices to support Work Groups.
- ECO will support efforts to design a Climate Ambassadors program or emerging platforms to improve communication about the urgency of climate change.
- Formalize partnerships with the Commission's diverse sectors to support communications on the distribution of report and to improve education and outreach in communities vulnerable to climate change.
- Increase work group members in private and government sectors and with unique expertise education and communication with communities vulnerable to climate change.

Outreach should be informed by input and a letter from both the Commission on Environmental Justice and Sustainable Communities (CEJSC) and the Children's Environmental Health & Protection Advisory Council (CEHPAC) to best identify communities vulnerable to climate change and communities overburdened by pollution related to greenhouse gas emissions.

- The ECO Working Group should work with the above mentioned organizations to provide guidance on locations for enhanced outreach.
- Location considerations and tools for education and outreach should include the Commission's priorities and incorporate environmental justice to respond to climate change issues of health, equity, and vulnerability.

- Vulnerability can be defined by exposure to increased flooding and sea-level rise and other climate factors and/or by ability to respond to these events based on socioeconomic status

ECO recommends Commission reports to include:

- Executive Summary should be translated into Spanish. Translations of this and future reports to various languages should occur when a need is identified or requested.
- Key report findings should be designed into summaries for audiences including: State and County policy makers, Maryland residents, educators of adults and children, and when a need is identified.
- Produce resource appendix to report to educate public on ways to contact state offices working on climate change and to compile research and resources that inform the findings of the 2016 report.
- A partnership with stakeholders from government, private, and public sectors to support report distribution.
- A communications toolkit to support distribution through media platforms maintained by Commission stakeholders and to include tools for ongoing education and outreach.

Appendix E

Adaptation and Response Working Group

Annual Report

Maryland's Commission on Climate Change is charged with advising the Governor and General Assembly on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change and maintaining and strengthening the State's existing Greenhouse Gas Reduction Plan. The Commission is supported by a Steering Committee and four working groups. The Adaptation and Response Working Group is charged with developing a Comprehensive Strategy for Reducing Maryland's Climate Change vulnerability. The Strategy includes both short and long-term measures that State and local governments may undertake in planning for and adapting to diverse impacts of climate change.

PURPOSE

Even as the State moves forward with actions that will reduce GHGs and ultimately result in increased energy efficiency, a more sustainable economy, and cleaner air; climate impacts will still be felt into the future. Therefore, adaptation, together with mitigation, is necessary to address climate change. The Maryland Commission on Climate Change (MCCC) has charged the Adaptation and Response Working Group (ARWG) with implementing solutions for reducing Maryland's Climate Change vulnerability.

MEMBERSHIP

Membership of the ARWG is currently comprised of a number of sector leads from seven State agencies, two public sector representatives, two MCCC liaisons, and a number of technical advisors from a variety of state agencies and departments. A priority for the ARWG in 2016 will be to seek opportunities to broaden stakeholder representation to include business and industry representatives, along with local partners with specific expertise in or understanding of the areas of the ARWG's work. A list of working group members may be found: (http://www.mde.state.md.us/programs/Marylander/Pages/MCCC_AR.aspx)

RESPONSIBILTIES

Climate change will affect Maryland in a variety of ways. More obvious impacts could include an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of existing or new vector-born disease; and increased erosion, saltwater intrusion and inundation of low-lying areas along the State's shoreline and coast. In many cases, Maryland is experiencing these problems to some degree today. Climate change raises the stakes in managing these problems by changing the frequency, intensity, extent, and magnitude of these problems. ARWG's vision for future preparedness is targeted at overcoming the following four challenges:

1. Reducing impact to existing built environments, as well as to future growth and development;
2. Shifting to sustainable investments and avoiding financial and economic impact;
3. Enhancing preparedness to protect human health, safety, and welfare;
4. Restoring and protecting Maryland's natural resources and resource-based industries.

SOLUTIONS AND IMPLEMENTATION PROGRESS

In 2008, the ARWG – working collaboratively with more than 80 experts from the governmental, nonprofit and private sectors – developed a comprehensive plan to protect Maryland's people, property, natural resources, and public investments from the impacts of climate change (Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change). This Phase I strategy addressed the impacts associated with sea level rise and coastal storms.

Transitioning beyond anticipated coastal flooding impacts, in 2011 a Phase II strategy was released. This compendium to the Climate Action Plan addresses changes in precipitation patterns and increased temperatures and their likely impacts to human health, agriculture, forest and terrestrial ecosystems, bay and aquatic environments, water resources, and population growth and infrastructure.

ARWG members are working diligently to move forward actions and recommendations made in both Phase I and Phase II strategies. Recognizing that climate adaptation is an extremely complex process and that there is no single means of response, many medium- and long-term actions were identified in these two strategies. In 2016, the ARWG worked to develop performance targets reflective of the most current adaptation work being addressed and implemented across sectors.

The following four climate adaptation challenges are based on major implementation goals currently being advanced in Maryland. Progress from individual ARWG members during the 2015-2016 timeframes are described under one of the four challenges – growth and infrastructure; natural resources and resource based industries; financial and economic well-being; and human health.

CHALLENGE: GROWTH AND INFRASTRUCTURE

Reducing impact to existing built environments, as well as to future growth and development.

Solutions	
1	Take action now to protect human habitat and infrastructure from current and future risks.
2	Retain and expand forests, wetlands and beaches for protection against nuisance flooding.
3	Provide State and local governments the tools to anticipate and plan for sea level rise, precipitation-related events, weather extremes, and changing temperatures.
4	Ensure long-term safe and adequate water supply for humans and ecosystems.

Actions and Initiatives

The Maryland Resiliency Partnership: Maryland's Resiliency Partnership is comprised of the Department of Natural Resources, the Department of the Environment, the Maryland Emergency Management Agency, the Maryland Historical Trust, and the Maryland Environmental Service. All five agencies are working together to leverage funding, personnel, and projects to support efforts that integrate floodplain management, hazard mitigation, and coastal resiliency.

Maryland Resiliency Partnership members at the 10th Annual MAFSM Conference

The Resiliency Partnership has continued to meet throughout 2016 and support resiliency efforts of the partners. One of the focuses for 2016 was to inform and provide implementation strategies for the 2016 update to the Maryland State Hazard Mitigation Plan. This included a conducting meetings for local government and community groups entitled "Beyond the map, a path toward resiliency, a multi-hazard approach." Meetings were held regionally throughout the state and agencies from the partnership gave information on projects, products and programs that are ongoing related to community resiliency. Additionally, the Partership sponsored a booth at the summer MACo meeting. In September, partners along with MTA, SHA & MDP participated in a meeting with FEMA region III and other federal partners (ACOE, USGS, NOAA) to provide details about Maryland's efforts on flood risk reduction in 2016 and discuss upcoming efforts in 2017.

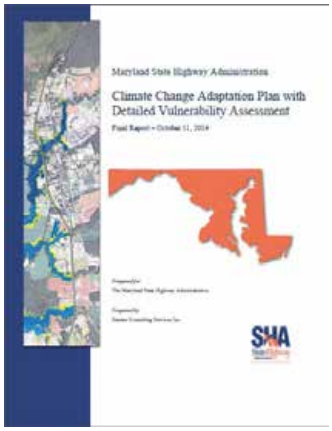
Up Next: The Partnership will continue to meet 2-4 times per year. An emphasis will be to further refine and develop timelines for the strategies defined in the Strategic Implementation Plan of the 2016 State Hazard Mitigation Plan. The partnership would also like to expand and include state agencies not currently represented such as Department of Housing and Community Development (DHCD) and others.

Cultural Resources Hazard Mitigation Planning Program: With funding from the National Park Service Hurricane Sandy Disaster Relief Fund, the Maryland Historical Trust has awarded seven grants throughout the state to help protect historic places and archeological sites from future storms. These grants will be supported by the Trust's Cultural Resources Hazard Mitigation Planning Program, which was created to assist local governments to better plan and prepare for the effects of coastal storms and other hazards that impact historic places and properties. The grant projects – that total nearly $250,000 – are described below:

- Heart of Chesapeake Country Heritage Area, Hazard Mitigation Planning Project, Dorchester County
- Integrating Historic and Cultural Considerations into Baltimore's All Hazards Plan, City of Baltimore
- Archeological Society of Maryland, Inc., Sustainable Models for Sites Endangered by Natural Hazards
- Trust for Preservation, Inc., Phase I Hazard Mitigation Planning for Anne Arundel's Cultural Resources, Anne Arundel County
- Cultural Resources Inventory and Risk Assessment for Cecil Towns, Town of Port Deposit
- Smith Island United, Inc., Cultural Resources Hazard Mitigation Planning Initiative, Smith Island
- Documentation and Assessment of Historic Resources in Western Water-Oriented Villages, Talbot County

Up Next: As these projects are completed, the Maryland Historical Trust will develop case studies so that other jurisdictions can benefit from lessons learned.

Maryland Department of Transportation Vulnerability Assessment: *State Highway Administration (SHA)*
SHA has been studying the effects of severe weather on the roadway network. In 2014, SHA conducted a pilot study under a Federal Highway Administration (FHWA) grant to develop a methodology to assess vulnerability of the State's bridges and roads. This methodology included the Hazard Vulnerability Index (HVI), which is used to identify and rate roadway locations at risk to flooding. HVI was reviewed to improve consistency in assigned categories across all counties. HVI was



completed for Anne Arundel, Calvert, St. Mary's, Charles, Somerset, Worcester, and Wicomico Counties in the summer of 2016. SHA is currently completing detailed vulnerability studies of both state and local roads for all tidally influenced counties in the state.

Calvert County - Broomes Island and Vicinity

SHA completed sea level rise modeling and mapping for 2050 and 2100 using the United States Army Corps of Engineers (USACE) methodology for the entire state of Maryland in 2014. New analytical data developed as part of research related to Hurricane Sandy recently became available. Specifically, Light Detection And Ranging (LiDAR) data was collected with a higher resolution than previously available. SHA reran the sea level rise modeling and storm event scenarios with the new LiDAR data.

Up Next: Work to apply the coastal vulnerability methodology to all tidal counties is underway. When complete, SHA will share the data and findings with those counties. SHA is using this vulnerability data in development of a tool that SHA would use for planning and assessment. It would sort all the locations identified as vulnerable to determine priorities.

SHA also created a new Innovative Planning and Performance Management Division within the Office of Planning and Preliminary Engineering (OPPE) to better integrate vulnerability assessment data with asset management and performance management. Climate change vulnerability studies will be led by this new division. Additionally, SHA is in the midst of developing its federally required Transportation Asset Management Plan (TAMP) and will include vulnerability information in the TAMP development.

Maryland Transportation Authority (MDTA)
MDTA conducted a high-level vulnerability assessment of its nine maintenance facilities for sea level rise, storm surge, precipitation, and temperature for years 2050 and 2100. This vulnerability assessment provided insight on the most vulnerable assets. Overall, this study can provide MDTA with planning level information needed to prioritize and allocate resources.

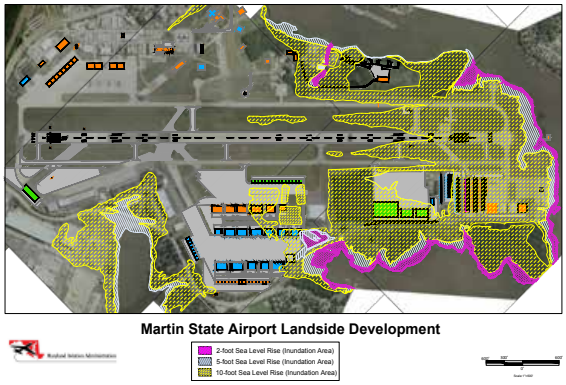
Up Next: MDTA is continuing to develop a framework that creates the process and methodologies to support vulnerability identification, as well as developing adaptation measures for improved infrastructure resiliency. This framework would be used for a variety of climate stressors including sea level rise, storm surge, temperature, precipitation, and extreme weather events.

Maryland Transit Authority (MTA)
MTA Environmental Planning Division (EPD) has completed a draft vulnerability assessment and is continuing to utilize the results in development of adaptation measures and resiliency planning. Once completed, implementation of the adaptation measures will provide security and resilience for MTA assets identified as susceptible to sea level rise, hurricane storm surge and flooding events.

Up Next: Information gained from MTA's Climate Change Vulnerability Assessment shall be used to develop and implement mitigation or adaptation measures at sites identified as posing a high or very high risk to MTA's services. Results of the Climate Change Vulnerability Assessment will be incorporated into MTA's Asset Management Plan and system preservation program as appropriate.

Maryland Port Authority (MPA)
MPA has begun development of a climate change resilience program. This program utilizes the 2010 vulnerability assessment of the port infrastructure and incorporates several Coast Smart best management practices into design engineering for new terminals, structures and dredged material management facilities. BMPs include a two-foot freeboard above the floodplain for all new facilities, movement of terminal functions out of the floodplain and use of non-corrosive, weather resistant materials. MPA has already increased armor at dredge material sites and raised some infrastructure out of vulnerable locations.

Up Next: MPA will implement a resiliency program in 2016. The plan includes installation of additional tie-downs for cranes, installation of future emergency generators above ground level at +10 feet, elevation of berths, wharfs and parking lots, protection from inundation for underground utilities, review of emergency response plans to incorporate updated sea level rise data. Engineering design consideration for future infrastructure development includes corrosion resistant reinforcement; concrete mixes that increase durability; and quality control of production and installation of concrete components.



Martin State Airport Landside Development

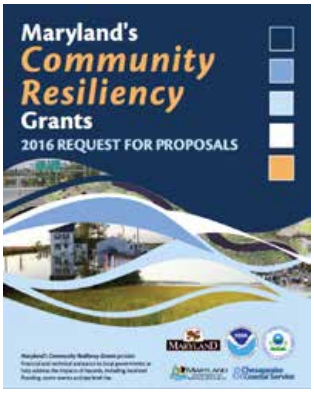
Maryland Aviation Administration

MAA utilized sea level rise/inundation mapping from the Maryland Department of Natural Resources (DNR) and included the 2-foot, 5-foot, and 10-foot projected sea level rise as a layer superimposed on the Airport Layout Plan (ALPs) for Martin State Airport to assist with future planning efforts.

Up Next: MAA is the owner of Martin State Airport and can report that there have been no projects at Martin State Airport that have occurred in areas of projected sea level rise/inundation. MAA will continue to implement Coast Smart Guidelines and utilize the vulnerability assessment to ensure future projects are not located in vulnerable areas.

Community Resiliency Grants Program: The Maryland Department of Natural Resources' Chesapeake and Coastal Service (CCS) Unit will be issuing the first awards under the new Coastal Resiliency Grants Program in 2016. This program is supported by funding from the National Oceanic and Atmospheric Administration and the Environmental Protection Agency and was developed to help Maryland communities become more resilient to impacts from the changing climate. Six projects have been selected for funding, four of which help communities respond to coastal hazards and two of which pursue the use of green infrastructure to address stormwater hazards.

Up Next: The 2016 RFP was released on December 17, 2015. Awards were announced on June 8, 2016. Projects selected through the 2016 RFP are either already in progress or will begin no later than January 1, 2017. Work to prepare the 2017 RFP will begin later this Fall. The RFP will be released on December 15, 2016.



Maryland State Hazard Mitigation Plan: Under the planning requirements of the Disaster Mitigation Act of 2000 (44 CFR 201.4), the 2016 Maryland State Hazard Mitigation Plan Update serves as guide to creating resilient communities for the State of Maryland. The plan is supported by a list of specific actions and strategies for Maryland State government, local governments and organizations that will reduce the loss of life and property damages from natural hazards. The plan features a comprehensive natural hazard identification, risk assessment and vulnerability analysis, that ranks hazard risks across Maryland. MEMA will also provide funding and support for hazard mitigation planning for all County governments. As a component of the State's Hazard Mitigation Plan, exposure and risk to coastal flooding and sea level rise was evaluated by intersecting the MDE and DNR coastal layers with the Maryland critical and State-owned facility geospatial database. Risk to State-owned and critical facilities was evaluated for 6 facility categories.

Community Resilience in Deal Island: Alongside a network of more than 50 community members and organizations, a team of partners (The University of Maryland, Sea Grant Extension; DNR; resource managers and academia; and the Eastern Shore GIS Cooperative) are conducting an Integrated Community Resilience Assessment of the Deal Island Peninsula using both quantitative and qualitative methods to understand and plan for the impacts of flooding now and into the future. This is a phased approach that starts with a flood vulnerability index model that assesses potential of flooding now through 2050; selection of five focus areas for a more in-depth look at vulnerability to flood events; ground truthing and community discussions about options for flood risk reduction. Ultimately, the community and partners will develop realistic options that can be implemented on both the parcel and community scale and identify ways for implementation.

The Flood Vulnerability Index has been completed for the years 2015, 2020, 2030, 2040 and 2050 and assessed the impact of rising sea level and storm events on roads, property and primary structures. The maps have been presented to the community stakeholders through a facilitated workshop. CCS staff is currently working on a StoryMap and refining the maps to be presented on the Deal Island Peninsula Project website. Project staff will meet with Somerset County prior to the release of the maps. Ethnographic data has been collected for 4-5 focus areas to better understand past and current flood events and response. CCS staff in August of 2016, submitted an application to NOAA's National Ocean Service Ecosystem Resiliency Grant. The purpose was to create habitat mitigate erosion and prevent the breach of an interior salt marsh complex on Deal Island. Grants will be awarded in October 2016.

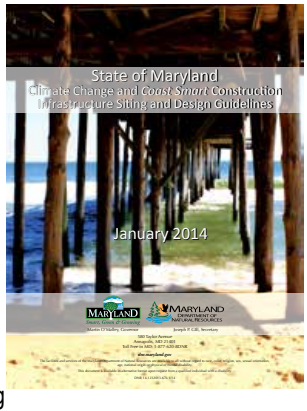
Up Next: Community Field Assessments and Focus Area Characterizations will be ongoing in Fall 2016 and Winter

2017. The maps provided a desk audit of vulnerability and the field assessment will provide a ground level understanding of what's vulnerable and what adaptation measures are already occurring, and identify potential adaptation options based on community conditions and knowledge.

Community Resilience Grants at MHT: Through federal grant funds, financial and technical assistance is provided to local governments seeking to reduce their vulnerability to the effects of coastal hazards, sea level rise and localized flooding caused by increased precipitation events.

Up Next: As these projects are completed, the Maryland Historical Trust will develop case studies so that other jurisdictions can benefit from lessons learned.

Coast Smart Construction Siting and Design Guidelines: The Maryland Department of General Services has advanced work on implementation of the Coast Smart Construction Siting and Design guidelines by modifing the Procedural Manual for Hiring Architects/ Engineers, (Appendix C). Appendix C has been modified to implement Coast Smart requirements for the construction of new projects or any substantial improvements to any existing facility exceeding 50% of market value located within the tidal or non-tidal flood plains as follow:



The structure must meet: First floor elevation bottom cord 2 feet above the 100 year flood; water resistant below the 2-foot free-board; critical infrastructure such as hospitals, police stations, emergency centers, and national security buildings and roads should be 2 feet above the 500 year flood; and exterior walls need to withstand hydrostatic and hydrodynamic pressure from water and be water resistant if below the 100 year flood (focus on basements). Water also needs to flow in and out of basements without damage (minimum of 2 openings with size requirement).

Two recently completed projects were designed to meet the Coast Smart Council Requirements to reduce impacts to the built environment: the Harriet Tubman Museum and Point lookout Lighthouse Improvements (under design).

Coast Smart Construction Siting and Design in Riverine Areas: The Coast Smart Council and the ARWG have worked to address state capital project investments in flood-vulnerable areas and determine how the approaches vary in coastal vs. riverine areas. Based on a review at MDE and DNR, work is underway to determine how to incorporate climate change assessment criteria into the waterway construction requirements for activities proposed by State agencies. MDE is discussing ways to incorporate climate change and "Coast Smart" construction and resiliency techniques into the waterway construction regulatory program in a way that limits additional burden on State agencies and creates a consistent process regardless of whether work is being conducted in coastal or riverine areas.

Up Next: As this work advances, MDE and other partners will evaluate possible requirements for State agencies to design and construct new permanent State structures or to reconstruct or rehabilitate substantially damaged State structures located in Special Flood Hazard Areas in Coast Smart ways and evaluate possible requirements for State agencies to demonstrate that they have conducted an alternatives analysis regarding the location of a structure.

Maryland Department of Planning (Planning): Planning's regional planners assist local governments in developing applications for state and federal grants in support of local climate change adaptation plans, plan elements and projects, and provides planning and other assistance to ensure success with development and implementation of the plans and projects. For example, to help implement the Smith Island Vision Plan, Planning's regional planners, on behalf of Somerset County, applied for and received a $50,000 Green Infrastructure Resiliency Grant from DNR to hire a professional contractor to perform a comprehensive drainage assessment of Smith Island and to recommend drainage improvements, such as green infrastructure techniques, where feasible. The assessment will be completed by July 1, 2017. Planning's regional planners also make local governments aware of state and national adaptation planning resources as they update their comprehensive plans, as early in the process as possible, such as during the 10-year comprehensive plan review.

Planning also works with DBM and other agencies to ensure that State capital investments consider Climate Change Impact Areas during the identification of potential sites and the scope of the work associated with the capital investment. Climate Change Impact Areas include: projected 50-year and 100-year Sea Level Rise Inundation Zones, 50-year Erosion Vulnerable Zones, Category 2 Storm Surge Inundation Zones, Marsh Transition Zones, Temperature Sensitive Streams, Drought Hazard, and Wildfire Risk Areas. The intent of identifying these areas is to ensure that the State and local governments make wise decisions about how to protect our natural resources, and where and how to develop and redevelop in light of climate change induced hazards and risks. Local governments also are educated on how to use the maps and are encouraged to use them in capital improvement planning.

CHALLENGE: NATURAL RESOURCES AND RESOURCE BASED INDUSTRIES

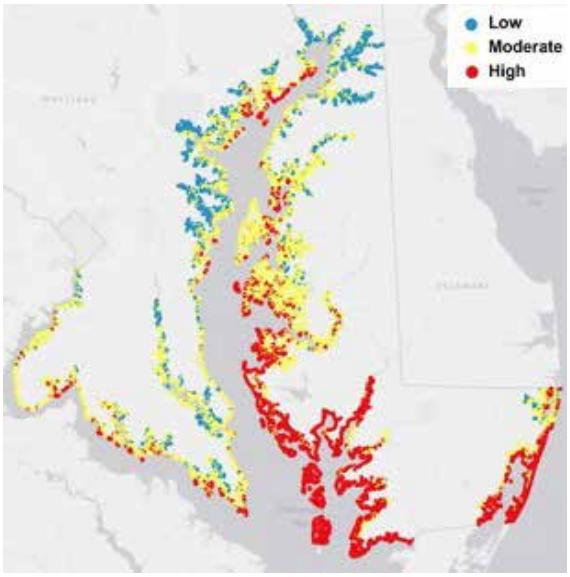
Restoring and protecting Maryland's natural resources and resource-based industries.

Solutions

10	Increase crop diversity, protect against pests and disease, address saltwater intrusion and other climate risks, and intensify water management.
11	Strengthen applied research, risk communication and technical support to improve the relay of climate information and foster stewardship on private lands.
12	Enhance existing best management practices, update targeting protocols and revise land protection and conservation targets for agricultural and resource lands.
13	Advance management approaches and restore critical bay and aquatic habitats to enhance resilience and protection of at-risk species and habitats.

Actions and initiatives

Coastal Resiliency Assessment: In support of MD DNR's 2010 climate change policy and the 2014 Chesapeake Bay Agreement Climate Resiliency Goal (Adaptation Outcome), DNR worked with The Nature Conservancy and other state, federal and non-governmental partners from April 2015–March 2016 to complete a Coastal Resiliency Assessment. The Assessment identified statewide priorities for conservation and restoration where coastal habitats provide risk-reduction to vulnerable communities at risk to flooding and other coastal hazard impacts.



Screen capture of Coastal Resiliency Assessement data.

Program Open Space's GreenPrint Ecological Scorecard has been updated to increase the scores of parcels that are enhancing coastal community resiliency (i.e. parcels that occur along Tier I priority shorelines, or where moderate to highly protective marshes are present). Sensitivity testing is currently underway to ensure scorecard changes do not artificially elevate coastal property scores. CCS staff are conducting outreach to internal programs and external partners to explore other data applications. Additionally, resiliency data was integrated into the State Hazard Mitigation Plan and the Greater Baltimore Wilderness Coalition coastal defense targeting maps to inform future green infrastructure project implementation at a multi-county and state scale.

Up Next: Two trainings will be held in 2017 to share data with local governments on the western and eastern shores. Current conversations with Talbot County and Ocean City about data integration into Hazard Mitigation Plan Updates will be used to inform future trainings tailored for local use. CCS staff will also explore expansion of the analysis to the riverine environment, inclusion of critical infrastructure in priority rankings, and model updates based on user feedback and ground-truthing. Resiliency data will be re-evaluated annually to determine if updates are necessary.

Coastal Erosion Control: In 2016, DNR will continue to work to implement buffer reforestation, wetland restoration, and shoreline practices to enhance ecosystem resilience to sea level rise and coastal erosion impacts. Practices include on-the-ground habitat restoration projects such as stream and shoreline buffer plantings, stream-floodplain reconnection, marsh hydrology restoration, and living shorelines. In conjunction with the on-the-ground restoration, the

Department is working with several federal partners to finalize a set of metrics to assess if restoration projects are achieving resiliency goals and the ways to measure success.

Up Next: The Natural Infrastructure Metrics workgroup (under the Systems Approach to Geomorphic Engineering- SAGE-umbrella) will be finalizing these metrics and releasing it by the end of October.

National Network for Ocean and Climate Change Interpretation (NNOCCI) Strategic Framing, One-day Training Sessions: Staff from the Department of Natural Resources, as trained facilitators of Strategic Framing, have been facilitating one-day workshops in partnership with Maryland Audubon, National Aquarium, and MADECLEAR throughout the region.

In 2016, staff from the Chesapeake Bay National Estuarine Research Reserve-Maryland (CBNERR) conducted five one-day Strategic Framing sessions for the following audiences: CCS staff at DNR, MD Master Naturalists, Leadership Legacy for the Environment (LLiFE), Mid Atlantic Audubon stakeholders (in partnership with MD Audubon), and Salisbury University students and professors in the environmental studies department. In all, approximately 110 individuals were trained in the strategic framing communication tool.

Up Next: A meeting is scheduled for December 1, 2016 to solidify regional efforts to support other NNOCCI trained facilitators, specifically targeting the support for a "bank" of relevant regional solutions to use while framing, and to determine framing support in discussions around sea level rise. In addition, a few one-day NNOCCI trainings are scheduled for 2017.

Visualizing Change: Training and Tools to Support Informal Educators: Visualizing Change is a 3-year grant funded by NOAA's Office of Education to help build capacity in the science education field to more effectively use global data sets to communicate about climate change, its impact on coastal zones and marine life and how people are working to use scientific information to shape our world.

On April 14th the National Aquarium hosted a one day workshop for educators interested on learning to expand their climate change interpretation at their own institutions. Through a grant from NOAA, several institutions around the country have developed and thoroughly tested four storyboards that use visual aides to tell the story. Each storyboard has been developed keeping in mind how to effectively communicate climate change in a positive way that leads the listener to action. CBNERR staff Trystan Sill and Coreen Weilminster attended the training, and will be sharing training materials with CBNERR component staff as climate change interpretation signage and activities are developed. The SLR storyboard is most relevant to the ongoing work for sentinel site science communication.

Monie Bay Sentinel Site: The CBNERR-Maryland Program is working to expand its capacity as a sentinel site for climate change. Currently, the Reserve is focusing on building out its Monie Bay component, located in Somerset County, as a fully functioning sentinel site. On-the-ground data collected here will complement the Reserve's other sentinel site in Jug Bay (Patuxent River) and contribute through data-to-management efforts of the Chesapeake Bay Sentinel Site Cooperative.

Surface elevation tables established at the Jug Bay freshwater tidal marsh to measure sediment elevation. Photo by Jenn Raulin.

Up Next: A sentinel site plan is currently being developed for Monie Bay. Award money from NOAA will be distributed in October 2016 to implement the build out of the sentinel site infrastructure and increase data collection (i.e. water level loggers, elevation measurements) at the site.

Building Local Capacity and Regional Collaboration on the Eastern Shore: With funding from the Town Creek Foundation, the Eastern Shore Land Conservancy (ESLC) and Antioch University's Center for Climate Preparedness and Community Resilience piloted a regional capacity building project for climate resilience on the Eastern Shore. The pilot project successfully launched the Eastern Shore Coastal Resilience Facilitated Community of Practice, which includes participants from five county governments (Caroline, Dorchester, Kent, Queen Anne's, and Talbot), three municipalities (Cambridge, Chestertown, and Oxford), four state agencies (DNR, MDE, MEMA, and the Critical Area Commission), four academic institutions (UMD Sea Grant Extension, UMCES, Washington College, and Chesapeake College), and one nonprofit organization (ESLC).

Up Next: As of October 2016, the Community of Practice is drafting goals and a list of possible collaborative initiatives. Priority work areas will include:

- Assisting communities and expanding capacity for risk

reduction and preparedness
- Facilitating information and knowledge exchange between members
- Promoting education for members, residents, and elected leaders.

Critical Area Commission. With funding from the National Oceanic and Atmospheric Administration (NOAA), through the Maryland Department of Natural Resources Chesapeake and Coastal Service, the Critical Area Commission developed a Coastal Resilience Planning Guide for Municipalities. Commission staff worked with the Town of Oxford as a pilot community to evaluate its local Critical Area program and identify opportunities for enhancing coastal resiliency. In the fall of 2016, the Town will be amending its Critical Area program in order to enhance shorelines and improve stormwater management in the face of coastal impacts due to climate change. The Commission will be making the Planning Guide available for use by other municipalities by the end of 2016.

NEED CAPTION - dont remember where this is from

Invasive Plants Advisory Committee: Since many of the invasive plants that threaten native plant health and biodiversity in both agricultural and natural landscapes in Maryland are imported, bred, distributed and promoted for sale by the landscape and nursery industries, the Maryland General Assembly established the Invasive Plant Advisory Committee (IPAC) in October 2011. The IPAC's primary responsibility is to reduce the risks from invasive plants in Maryland by advising the Secretary of Agriculture on the regulation of invasive plant sales to prevent invasives from entering or spreading further in the state. Using the USDA APHIS Weed Risk Assessment (WRA) tool to not only identify their character and potential for damage, but also document their economic, ecological, and health impacts, invasive plants will be identified under new regulations that became effective on April 11, 2016, as Tier 1 (banned) or Tier 2 (still marketable but with specific caveats and signage). Preliminary lists of plants in the two tiers, as well as WRAs for ten of the invasives, are available online at the Maryland Department of Agriculture's website.

Healthy Soils and Carbon Sequestration: The Adaptation and Response Working Group (ARWG) has proposed partnering with the Mitigation Work Group (MWG) through an initiative to promote the multiple benefits of healthy soils and soil carbon sequestration technologies. Soils already serve as huge stores of carbon, and improved management can make them even bigger. A recent study, published by a group of international scientists, suggests that using "soil-smart" techniques for soil management could sequester as much as four-fifths of the annual emissions released by the burning of fossils fuels. Such "soil-smart" techniques include planting mixed cover crops, especially those with deep roots – that help keep soil intact and encourage the growth of microbial communities that help trap soil carbon, designing stream restoration projects with organic matter dynamics that increase carbon sequestration, adopting continuous no-till farming practices, and using charcoal-based composts. Additionally, healthy soils buffer against the increased erosional forces brought on by climate change, reduce nutrient loss, and lower water, fertilizer, and energy usage.

Up Next: ARWG members have convened a "Health Soils Consortium" group to discuss opportunities for industry and resource management communication and information sharing on this issue. Representatives from public, private and industry organizations are discussing how and when to advance this issue in 2017.

Building Local Capacity and Regional Collaboration on the Eastern Shore: Planning joined ESLC in creating a model Comprehensive Plan Element specifically focusing on coastal resiliency for local governments. The coastal resiliency element was designed to allow each jurisdiction to select from various coastal resiliency actions, to incorporate recommendations and policies into the comprehensive plan. Since development of the model element, DNR (through the Coastal Communities Initiative) has provided a grant to the City of Cambridge that will adopt a Cambridge-specific coastal resiliency element, based on the model element created from the Planning/ESLC collaborative project.

CHALLENGE: FINANCIAL AND ECONOMIC WELL-BEING

Shifting to sustainable investments and avoiding financial and economic impact.

Solutions

5	Develop and implement long-range plans to minimize the economic impacts of climate impacts (e.g. sea level rise, saltwater intrusion) to natural resource based industries.
6	Promote market opportunities related to climate change adaptation and response.

Actions and Initiatives

New Protocol for Wetland Carbon Finance: A new methodology to encourage coastal restoration across the globe has been approved by the Verified Carbon Standard (VCS). The Methodology for Tidal Wetland and Seagrass Restoration (VM0033) is the first globally applicable greenhouse gas accounting methodology for coastal wetland restoration, and will allow salt marsh, seagrass, mangrove, living shoreline and other tidal wetland restoration projects to earn carbon credits. In addition to providing critical fish habitat, improving water quality, and protecting the coastline from storms, coastal wetlands also remove large amounts of carbon dioxide from the atmosphere via photosynthesis. This carbon is then stored in the ground, where it can remain for centuries or more, as long as the habitat is not degraded or destroyed. Carbon credits are purchased by companies or individuals to offset the emissions they cannot reduce. This landmark methodology provides procedures for how to calculate, report and verify greenhouse gas reductions for tidal wetlands (salt marsh, mangroves and seagrass), allowing coastal restoration projects anywhere in the world to generate carbon credits and receive support from carbon finance. Through the purchase of carbon credits, the carbon market can now support coastal habitat projects with a climate benefit.

Up Next: Default carbon sequestration values for the VCS protocol will be evaluated for applicability to determine greenhouse gas benefits for various restoration projects under a range of salinity conditions.

Hazard Mitigation Assistance (HMA): The U.S. Department of Homeland Security, FEMA HMA programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on Federal disaster funds. The HMA programs provide funding for eligible activities that are consistent with the Presidential Policy Directive 8: National Preparedness (PPD-8), and the National Mitigation Framework's Long-term Vulnerability Reduction capability. Hazard mitigation projects submitted to MEMA are reviewed for eligibility by the MEMA staff and the Mitigation Advisory Committee to insure that all State applications are consistent with the recommended Coast Smart Siting and Design Guidelines. The HMA program reduces community vulnerability to disasters and their effects, promotes individual and community safety and resilience, and promotes community vitality.

Resiliency in Working Waterfronts: In February 2016, MD DNR started working with Talbot County and Rock Hall to support the revitalization of existing and historical working waterfront communities and economies. The Working Waterfronts Program is continuing to support the waterfront planning efforts currently underway by Talbot County and Rock Hall. Both grantees have established advisory committees and held public workshops to identify needs, opportunities and constraints along the waterfront, while accounting for the impacts of coastal hazards. These planning projects are scheduled to be completed in February 2017.

Photo by Curtis Brandt

Up Next: Three new communities have been selected to receive Working Waterfronts Enhancement grants. The towns of Oxford, St. Michaels, and Cambridge will begin planning projects in October 2016. Oxford and Cambridge will be developing strategic waterfront plans, while St. Michaels will be working with the Chesapeake Bay Maritime Museum to develop a Master Plan for the Maritime Museum Zone that includes climate adaptation considerations. These projects will be completed in October 2018.

CHALLENGE: HUMAN HEALTH

Enhancing preparedness to protect human health, safety, and welfare.

Solutions

7 Conduct vulnerability assessments to gain a better understanding of risks and inform preventative responses.

8 Integrate impact reduction strategies into State and local planning practices.

9 Streamline and revise data collection and information dissemination channels.

Actions and initiatives

Human and Animal Health and Safety: To maximize the safety and well-being of Maryland's citizens, the Department of Health and Mental Hygiene will work with the Department's of Agriculture and Natural Resources to strengthen the coordination and management across Agencies responsible for human and animal health and safety.

The Department of Health and Mental Hygiene continues to coordinate closely with other State agencies on a variety of initiatives related to human and animal health and safety. These activities include: (1) response to emerging vector-borne diseases such as Zika virus; (2) work with academic partners related to possible changes in foodborne illness patterns due to changes in climate; and (3) exploring opportunities to improve capacity for surveillance, including both human capacity (for example, public health entomologists), and systems capacity (such as geographic information systems capacity to better analyze and display data on geographic and other factors influencing disease patterns).

Climate and Health Profile: The Climate and Health Profile Report was released in Spring, 2016. Subsequently, DHMH applied for and was awarded a new, competitive 5-year cooperative agreement with CDC, the Maryland Climate Change Health Adaptation Program, which started on September 1, 2016.

The Maryland Climate Change Health Adaptation Program (MCCHAP) builds on the previous work of the Maryland Public Health Strategy for Climate Change, and has the overall goal of ensuring that Maryland and its communities successfully develop and implement adaptation interventions for climate change, and of monitoring and demonstrating the impacts of those interventions. The specific objectives of this proposal are to: (1) Develop an overall statewide implementation and monitoring strategy for climate change health adaptation efforts that is integrated with the Maryland Climate Plan; (2) Provide tools and technical assistance to communities and other stakeholders on evidence-based public health interventions for climate adaptation; (3) Institute a DHMH surveillance system for climate interventions and their associated health outcomes as they are implemented; (4) Use surveillance results to further refine and improve state and local interventions; and (5) Measure and communicate the health impacts of those interventions.

Anticipated primary first-year activities for the project include: (1) Identify and strengthen relationships with old and new stakeholders, including representatives from vulnerable populations; (2) Based on the State Climate Action Plan, develop an overall Maryland Implementation and Monitoring Strategy (IMS) for climate change health adaptation efforts; (3) Develop a plan for communicating the IMS to community, leaders, and other relevant stakeholders; and (4) Develop a plan for communicating the IMS to community, leaders, and other relevant stakeholders.

Vector-borne Disease Surveillance and Control: Maryland State officials continue to track the spread of the West Nile (WNV) and Zika viruses and other arboviral activity in vector species, host animals, and humans. This tracking allows for the ongoing enhancement and deployment of effective tools to support surveillance, prevention, and control of WNV, Zika, and other arthropod-borne viruses, including novel or emerging pathogens that threaten the health of Maryland residents. In addition, the Mid-Atlantic Zoonotic and Vector Borne Disease Inter-Agency Workgroup (MAZV), a collaboration between DHMH, DNR, MDA, researchers, practitioners, and federal agency partners, meets regularly to monitor and discuss vector-borne disease activities in Maryland and the surrounding regions. Extensive awareness and prevention information on both WNV and Zika can be found online at the Maryland Department of Agriculture's website. These efforts will continue into 2017 as data, information and science about vector-borne diseases change.

Photo credit and caption

RECOMMENDATIONS

The Adaptation and Response Work Group (ARWG) is chaired by the Secretary of the Maryland Department of Natural Resources with administrative support provided by Department staff. The ARWG advances its work through the active involvement of and leadership from other work group members, agencies and stakeholders. The work group has relied upon and recommends the continued collaboration and conversations with stakeholders to determine when, how and if implementation of adaptation measures move forward. The recommendations set forth in the ARWG 2016 annual report will continue to be guided and informed in this manner as they move forward.

Adaptation efforts are also closely tied to the other work groups. For instance, the Scientific and Technical Working Group (STWG) issues sea level rise projections and updates that are used in a wide variety of ARWG-related vulnerability assessments and future planning activities. Additional engagement with the Mitigation Work Group is being pursued to better understand possible connections between adaptation/resilience and mitigation efforts and also with the Education, Communication and Outreach Work Group to ensure that adaptation efforts are communicated clearly to a wide variety of audiences.

The ARWG outlines the following priorities and recommendations for 2017:

1. Supporting Local Partners – in order to continue to address the four adaptation challenge areas, it will require work not only among state partners and at the state level, but also across local towns, municipalities and counties to ensure that our people, economies and resources are positioned to thrive into the future in a changing climate. The ARWG has made it a priority to strengthen efforts in 2017 to place greater emphasis on supporting adaptation at the local level. This will be done by working or continuing to understand capacity needs, delivering assistance to communities, and highlighting local progress to foster advances across the state.

2. Focus and Accelerate Adaptation Progress on Non-Coastal Impacts - at the same time progress continues on coastal climate impacts such as sea level rise and coastal flooding, the work of the ARWG and its members' - as well as the challenges of different climate impacts - continue to evolve. Following its 2016 quarterly meetings, the ARWG identified an increasing need to focus on adaptation in non-coastal jurisdictions and the wider set of climate impacts outlined in both Phase I and II adaptation strategies. The work group recommends that increasing emphasis be placed on accelerating adaptation progress on non-coastal issues and communicating ongoing progress in these areas in a more tangible way.

3. Expand Partnerships – climate adaptation requires work across sectors and stakeholder groups. The ARWG has identified the need to expand public and private partnerships and work group participation to include business and industry representatives and local, state and federal partners.

Appendix F

Maryland Commission on Climate Change and Working Group Membership

Maryland Commission on Climate Change Membership

Governor Appointed and Standing Members	
Ben Grumbles (Chair of Commission)	Secretary, Maryland Department of the Environment
Nancy K. Kopp	Maryland State Treasurer
Karen Salmon	Superintendent of Maryland Schools
Joseph Bartenfelder	Secretary, Maryland Department of Agriculture
Ellington Churchill	Secretary, Maryland Department of General Services
Mark Belton	Secretary, Maryland Department of Natural Resources
Pete Rahn	Secretary, Maryland Department of Transportation
Wendi Peters	Secretary, Maryland Department of Planning
Mary Beth Tung	Director, Maryland Energy Administration
Donald Boesch	President, University of Maryland Center for Environmental Science
Chuck Fry	Maryland Farm Bureau
Dr. Russell Dickerson	Climate Change Expert representing a University located in Maryland
Dr. Jane Kirschling	Public Health Expert representing a University located in Maryland
Charles Deegan	Chair, Critical Area Commission
Senate President Appointed Members	
Senator Paul G. Pinsky	Senator, Maryland General Assembly
Stuart Clarke (Co-Chair)	Town Creek Foundation
Lori Arguelles	Alice Ferguson Foundation
Jim Strong	Organized Labor Representative
Michael Powell	Business Community Representative
House Speaker Appointed Members	
Delegate Dana Stein	Delegate, Maryland General Assembly
C. Richard D'Amato	Retired Attorney
Mike Tidwell	Chesapeake Climate Action Network
Larry Kasecamp	Organized Labor Representative
Anne Lindner (Co-Chair)	Business Community Representative
Local Government Appointees	
Deni Taveras	Maryland Association of Counties
Jacob Day	Maryland Municipal League

Maryland Commission on Climate Change Steering Committee	
Ben Grumbles (Chair of Commission)	Secretary, Maryland Department of the Environment
George "Tad" Aburn	Maryland Department of the Environment
Stuart Clarke	Town Creek Foundation
Anne Lindner	Constellation Energy
Lori Arguelles	Alice Ferguson Foundation
Joe Bartenfelder	Maryland Department of Agriculture
Mark Belton	Secretary, Maryland Department of Natural Resources
Don Boesch	University of Maryland Center for Environmental Science
C. Richard D'Amato	Retired Attorney
Michael Powell	Business Community Representative
Nancy Kopp	Maryland Treasurer
Mike Tidwell	Climate Change Action Network
Mary Beth Tung	Maryland Energy Administration

Mitigation Working Group Membership

Co-Chairs	
George "Tad" Aburn (Working Group Lead)	Maryland Department of the Environment
Michael Powell	Business Community Representative
Mike Tidwell	Chesapeake Climate Action Network
Private Sector Representatives	
Anne Lindner	Exelon
Mike Remsberg	Trinity Consultants
R. Daniel Wallace	Bith Energy
John Quinn	BGE
Drew Cobbs	American Petroleum Institute
Tom Ballentine	NAIOP – Real Estate Development
Tom Dennison	Southern Maryland Electric Cooperative
Tom Weissinger	Raven Power
Public Sector Representatives	
Jana Davis	Chesapeake Bay Trust
Gerrit Knaap	National Center for Smart Growth Research and Education, UMCP
Arjun Makhijani	Institute for Energy and Environmental Research
Joe Uehlein	Labor Network for Sustainability
Anya Schoolman	Community Power Network
Rebecca Ruggles	Maryland Environmental Health Network
Other Representatives	
Colby Ferguson	Maryland Farm Bureau
Ben Hobbs	Johns Hopkins University
Jim Strong	United Steelworkers
Les Knapp	Maryland Association of Counties
Alice Kennedy	Maryland Municipal League
Government Members	
Colleen Turner	Maryland Department of Transportation
Chris Rice	Maryland Energy Administration
Christine Conn	Maryland Department of Natural Resources
Susan Payne	Maryland Department of Agriculture

Mitigation Working Group Steering Committee	
George "Tad" Aburn (Working Group Lead)	Maryland Department of the Environment
Michael Powell	Business Community Representative
Mike Tidwell	Chesapeake Climate Action Network
Colleen Turner	Maryland Department of Transportation
John Fiastro	Maryland Energy Administration
Christine Conn	Maryland Department of Natural Resources
Susan Payne	Maryland Department of Agriculture

Adaptation and Response Working Group Membership

Chair	
Mark Belton	Secretary, Maryland Department of Natural Resources
Coordinator	
Catherine McCall	Maryland Department of Natural Resources
Maryland Commission on Climate Change Liaisons	
C. Richard D'Amato	Retired Attorney
State Senate Members	
James C. Rosapepe	State Senator
Public Sector Representatives	
Fredrika Moser	Maryland Sea Grant
Brian Ambrett	Eastern Shore Land Conservancy
Eric Myers	Conservation Fund
State-Agency Adaptation Sector Leads	
Catherine McCall	Department of Natural Resources (Sea Level Rise and Coastal Storms)
Clifford Mitchell	Department of Health and Mental Hygiene (Health)
Susan Payne	Department of Agriculture (Agriculture)
Bruce Michael	Department of Natural Resources (Bay and Aquatic)
Don Van Hassent	Department of Natural Resources (Forest and Terrestrial)
Jason Dubow	Department of Planning (Growth and Infrastructure)
Sandy Hertz	Department of Transportation (Growth and Infrastructure)
Gary Setzer	Department of the Environment (Water Resources)
Mark James	Maryland Emergency Management Agency (Emergency Management)

Technical Advisors	
Katherine Charbonneau	Critical Area Commission
Matthew Flemming	Department of Natural Resources
Philip Stafford	Department of Natural Resources
Megan Granato	Department of Natural Resources
Chris Becraft	Department of Natural Resources
Sasha Land	Department of Natural Resources
Vacant	Local Government Representative
Scott Zarcharko	Department of the Environment

Scientific and Technical Working Group Membership

Chair	
Donald Boesch	University of Maryland Center for Environmental Science
Members	
Ghassem Asrar	Joint Global Change Research Institute
Eric A. Davidson	Appalachian Laboratory, University of Maryland Center for Environmental Science
Belay Demoz	Joint Center for Earth Systems Technologies, University of Maryland Baltimore County
Gerrit J. Knaap	National Center for Smart Growth Research and Education, University of Maryland College Park
David A. Vanko	Fisher School of Science, Towson University
Eric D. Wachsman	University of Maryland Energy Research Center, University of Maryland College Park

n.b. Several members pending appointment

Education, Communication and Outreach Working Group Membership

Chair	
Allison Rich	Maryland Environmental Health Network
Commission Liaisons	
Lori Arguelles	Alice Ferguson Foundation
Liz Entwisle	Maryland Department of the Environment
Public Sector Representatives	
Tiffany Hartung	Maryland Climate Coalition
Pat Harcourt	University of Maryland Center for Environmental Science / MADE CLEAR
Kelly Trout	Chesapeake Climate Action Network
Joelle Novey	Interfaith Power and Light
Noah Smock	Baltimore Toolbank
Ashley Pennington	Johns Hopkins Office of Sustainability
Dannielle Lipinski	Maryland League of Conservation Voters
Dan Brellis	Alliance for the Chesapeake Bay
Isaac Hametz	Mahan Rykiel Associates
Kris Hoellen	National Aquarium
Private Sector Representatives	
Vacant	Maryland Chamber of Commerce
Michele Mitch-Peterson	Honeywell
Government Representatives	
Mark Shaffer	Maryland Department of the Environment
Colleen Turner	Maryland Department of Transportation
Vacant	Maryland Energy Administration
Stephen Schatz	Maryland Department of Natural Resources
Julie Oberg	Maryland Department of Agriculture
Sara Luell	Maryland Department of Housing and Community Development

Technical Advisors	
David Costello	IEER
Alex Fries	University of Maryland Center for Environmental Science
Samantha Kappalman	The Hatcher Group
Tad Aburn	Maryland Department of the Environment
Steven Schatz	Maryland Department of Natural Resources
Crystal Romeo Upperman	Maryland Department of Health and Mental Hygiene
Wiley Hall	Maryland Department of Housing and Community Development
John Coleman	Maryland Department of Planning

APPENDIX G

MCCC Legislation (House Bill 514)

LAWRENCE J. HOGAN, JR., Governor

Chapter 429

(House Bill 514)

AN ACT concerning

Maryland Commission on Climate Change

FOR the purpose of establishing the Commission on Climate Change in the Department of the Environment to advise the Governor and General Assembly on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change; establishing the membership of the Commission; ~~requiring certain members to serve as chair and vice chair of the Commission~~; providing for the terms of ~~a~~ *an appointed* member of the Commission; authorizing the Governor to remove a member of the Commission under certain circumstances; prohibiting a member of the Commission from receiving certain compensation, but authorizing a member to be reimbursed for certain expenses; requiring the Commission to establish certain working groups; requiring the Chair of the Commission to appoint working group members who represent certain public and private interests; requiring the Commission to prioritize certain working group actions; requiring the Commission, on or before a certain date each year, to report to the Governor and General Assembly; requiring each State agency to complete a certain review in accordance with certain requirements; requiring each State agency to identify and recommend certain changes to certain programs under certain circumstances; requiring certain State agencies to report annually to the Governor and General Assembly on the status of certain programs; requiring the University of Maryland Center for Environmental Science to establish and update certain sea level rise projections; requiring the sea level rise projections to include certain maps and to be made publicly available on the Internet; providing for the construction of this Act; establishing the intent of the General Assembly; requiring the Commission members and working group members to be appointed and the Commission to be convened ~~and the working group members to be appointed~~ on or before a certain date; providing that nothing in this Act shall preclude the appointment of a certain member to the Commission; requiring each working group to meet and establish a work plan on or before a certain date; and generally relating to the Maryland Commission on Climate Change.

BY adding to

Article – Environment

Section 2–1301 through 2–1306 to be under the new subtitle "Subtitle 13. Maryland Commission on Climate Change"

Annotated Code of Maryland
(2013 Replacement Volume and 2014 Supplement)

Preamble

WHEREAS, As reported by the United Nations Intergovernmental Panel on Climate Change (IPCC) in March 2014, the effects of climate change are already occurring on all continents and across the oceans, and numerous opportunities exist to respond to and mitigate associated risks; and

WHEREAS, Maryland has already experienced some effects of climate change, including sea level rise of more than 1 foot in the last century, increasing water temperatures in the Chesapeake Bay, more rain and flooding in the winter and spring, and less in the summer; and

WHEREAS, Maryland has demonstrated its strong commitment to addressing the drivers and consequences of climate change by passing several laws, including the Healthy Air Act, the Maryland Clean Cars Act of 2007, the Greenhouse Gas Emissions Reduction Act of 2009, the Maryland Offshore Wind Energy Act of 2013, and the Coast Smart Council; and

WHEREAS, Although the Maryland Commission on Climate Change was created by Executive Order 01.01.2007.07 in 2007, and then strengthened by Executive Order 01.01.2014.14 in 2014, there is not a statutory body in the State whose sole purpose is to address climate change impacts and make recommendations to the Governor and General Assembly; now, therefore,

SECTION 1. BE IT ENACTED BY THE GENERAL ASSEMBLY OF MARYLAND, That the Laws of Maryland read as follows:

Article – Environment

SUBTITLE 13. MARYLAND COMMISSION ON CLIMATE CHANGE.

2–1301.

(A) THERE IS A COMMISSION ON CLIMATE CHANGE IN THE DEPARTMENT TO ADVISE THE GOVERNOR AND GENERAL ASSEMBLY ON WAYS TO MITIGATE THE CAUSES OF, PREPARE FOR, AND ADAPT TO THE CONSEQUENCES OF CLIMATE CHANGE.

(B) THE DEPARTMENT AND THE DEPARTMENT OF NATURAL RESOURCES SHALL JOINTLY STAFF THE COMMISSION.

2–1302.

(A) THE COMMISSION'S MEMBERSHIP SHALL CONSIST OF THE FOLLOWING ~~25~~ MEMBERS:

(1) ONE MEMBER OF THE HOUSE OF DELEGATES, APPOINTED BY THE SPEAKER OF THE HOUSE;

(2) ONE MEMBER OF THE SENATE, APPOINTED BY THE PRESIDENT OF THE SENATE;

(3) THE STATE TREASURER, OR THE STATE TREASURER'S DESIGNEE;

(4) THE SECRETARY OF THE ENVIRONMENT, OR THE SECRETARY'S DESIGNEE;

(5) THE SECRETARY OF AGRICULTURE, OR THE SECRETARY'S DESIGNEE;

(6) THE SECRETARY OF NATURAL RESOURCES, OR THE SECRETARY'S DESIGNEE;

(7) THE SECRETARY OF PLANNING, OR THE SECRETARY'S DESIGNEE;

(8) THE STATE SUPERINTENDENT OF SCHOOLS, OR THE STATE SUPERINTENDENT'S DESIGNEE;

(9) THE SECRETARY OF TRANSPORTATION, OR THE SECRETARY'S DESIGNEE;

(10) THE SECRETARY OF GENERAL SERVICES, OR THE SECRETARY'S DESIGNEE;

(11) THE DIRECTOR OF THE MARYLAND ENERGY ADMINISTRATION, OR THE DIRECTOR'S DESIGNEE;

(12) THE PRESIDENT OF THE UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE, OR THE PRESIDENT'S DESIGNEE;

(13) THE CHAIR OF THE CRITICAL AREA COMMISSION FOR THE CHESAPEAKE AND ATLANTIC COASTAL BAYS, OR THE CHAIR'S DESIGNEE;

(14) ONE MEMBER APPOINTED BY THE FARM BUREAU REPRESENTING THE AGRICULTURE COMMUNITY;

~~(13)~~ (15) ONE MEMBER APPOINTED BY THE ~~PRESIDENT OF THE SENATE~~ MARYLAND ASSOCIATION OF COUNTIES AND ONE MEMBER APPOINTED BY

THE ~~SPEAKER OF THE HOUSE OF DELEGATES~~ MARYLAND MUNICIPAL LEAGUE TO REPRESENT LOCAL GOVERNMENTS;

~~(14)~~ (16) ONE MEMBER APPOINTED BY THE PRESIDENT OF THE SENATE AND ONE MEMBER APPOINTED BY THE SPEAKER OF THE HOUSE OF DELEGATES TO REPRESENT THE BUSINESS COMMUNITY;

~~(15)~~ (17) ONE MEMBER APPOINTED BY THE PRESIDENT OF THE SENATE AND ONE MEMBER APPOINTED BY THE SPEAKER OF THE HOUSE OF DELEGATES TO REPRESENT ENVIRONMENTAL NONPROFIT ORGANIZATIONS;

~~(16) THREE REPRESENTATIVES OF PRIVATE PHILANTHROPIC ORGANIZATIONS, ONE EACH APPOINTED BY THE GOVERNOR, PRESIDENT OF THE SENATE, AND SPEAKER OF THE HOUSE OF DELEGATES;~~

(18) ONE MEMBER APPOINTED BY THE PRESIDENT OF THE SENATE AND ONE MEMBER APPOINTED BY THE SPEAKER OF THE HOUSE TO REPRESENT ORGANIZED LABOR ~~IN~~, *ONE OF WHOM SHALL REPRESENT* THE BUILDING OR CONSTRUCTION TRADES *AND ONE OF WHOM SHALL REPRESENT THE MANUFACTURING INDUSTRY*;

(19) ONE MEMBER APPOINTED BY THE PRESIDENT OF THE SENATE AND ONE MEMBER APPOINTED BY THE SPEAKER OF THE HOUSE TO REPRESENT PHILANTHROPIC ORGANIZATIONS;

~~(17)~~ (20) ONE CLIMATE CHANGE EXPERT APPOINTED BY THE GOVERNOR REPRESENTING A UNIVERSITY LOCATED IN MARYLAND; AND

~~(18)~~ (21) ONE PUBLIC HEALTH EXPERT APPOINTED BY THE GOVERNOR REPRESENTING A UNIVERSITY LOCATED IN MARYLAND~~;~~ .

~~(19) ONE REPRESENTATIVE OF ORGANIZED LABOR APPOINTED BY THE GOVERNOR; AND~~

~~(20) ONE REPRESENTATIVE OF THE AGRICULTURAL COMMUNITY APPOINTED BY THE GOVERNOR.~~

(B) ~~(1)~~ THE SECRETARY OF THE ENVIRONMENT OR THE SECRETARY'S DESIGNEE SHALL CHAIR THE COMMISSION.

~~(2) THE GOVERNOR SHALL APPOINT ONE BUSINESS REPRESENTATIVE AND ONE NONPROFIT REPRESENTATIVE FROM AMONG THE COMMISSION MEMBERS TO SERVE AS VICE CHAIRS OF THE COMMISSION.~~

(C) (1) SUBJECT TO PARAGRAPH (2) OF THIS SUBSECTION, THE TERM OF ~~A~~ *AN APPOINTED* MEMBER ~~APPOINTED BY THE GOVERNOR, PRESIDENT OF THE SENATE, OR SPEAKER OF THE HOUSE OF DELEGATES~~ IS 2 YEARS.

(2) THE GOVERNOR, PRESIDENT OF THE SENATE, AND SPEAKER OF THE HOUSE OF DELEGATES SHALL STAGGER THE TERMS OF THE INITIAL APPOINTED MEMBERS.

(3) AT THE END OF A TERM, A MEMBER CONTINUES TO SERVE UNTIL A SUCCESSOR IS APPOINTED AND QUALIFIES.

(4) A MEMBER WHO IS APPOINTED AFTER A TERM HAS BEGUN SERVES ONLY FOR THE REMAINDER OF THAT TERM AND UNTIL A SUCCESSOR IS APPOINTED AND QUALIFIES.

(5) THE GOVERNOR MAY REMOVE AN APPOINTED MEMBER FOR INCOMPETENCE, MISCONDUCT, OR FAILURE TO PERFORM THE DUTIES OF THE POSITION.

(D) A MEMBER OF THE COMMISSION MAY NOT RECEIVE COMPENSATION, BUT IS ENTITLED TO REIMBURSEMENT FOR EXPENSES UNDER THE STANDARD STATE TRAVEL REGULATIONS, AS PROVIDED IN THE STATE BUDGET.

2–1303.

(A) THE COMMISSION SHALL ESTABLISH:

(1) A SCIENTIFIC AND TECHNICAL WORKING GROUP;

(2) A GREENHOUSE GAS MITIGATION WORKING GROUP;

(3) AN ADAPTATION AND RESPONSE WORKING GROUP; AND

(4) AN EDUCATION, COMMUNICATION, AND OUTREACH WORKING GROUP.

(B) THE COMMISSION MAY ESTABLISH OTHER WORKING GROUPS AS NEEDED.

(C) THE CHAIR OF THE COMMISSION SHALL APPOINT WORKING GROUP MEMBERS WHO REPRESENT BOTH PUBLIC AND PRIVATE INTERESTS IN CLIMATE CHANGE, INCLUDING REPRESENTATIVES OF:

(1) ACADEMIC INSTITUTIONS;

(2) RENEWABLE AND TRADITIONAL ENERGY PROVIDERS;

(3) ENVIRONMENTAL ORGANIZATIONS;

(4) GOVERNMENT AGENCIES;

(5) LABOR ORGANIZATIONS; AND

(6) BUSINESS INTERESTS, INCLUDING THE INSURANCE ~~INDUSTRY~~ AND REAL ESTATE INDUSTRIES.

(D) THE COMMISSION SHALL PRIORITIZE WORKING GROUP ACTIONS, INCLUDING:

(1) STRENGTHENING AND MAINTAINING EXISTING STATE CLIMATE ACTION PLANS;

(2) DEVELOPING BROAD PUBLIC AND PRIVATE PARTNERSHIPS WITH LOCAL, STATE, AND FEDERAL AGENCIES;

(3) COMMUNICATING WITH AND EDUCATING CITIZENS ABOUT THE URGENCY OF ACTING TO REDUCE THE IMPACTS OF CLIMATE CHANGE;

(4) MAINTAINING AN INVENTORY OF MARYLAND'S GREENHOUSE GAS EMISSIONS SOURCES AND CARBON SINKS;

(5) ADDRESSING ANY DISPROPORTIONATE IMPACTS OF CLIMATE CHANGE ON LOW–INCOME AND VULNERABLE COMMUNITIES;

(6) ASSESSING THE IMPACTS THAT CLIMATE CHANGE MAY HAVE ON THE STATE'S ECONOMY, REVENUES, AND INVESTMENT DECISIONS;

(7) ASSESSING THE NEEDS FOR UTILITIES AND OTHER PUBLIC AND PRIVATE SERVICE PROVIDERS THROUGHOUT THE STATE TO ADJUST THEIR OPERATING PRACTICES AND INVESTMENT STRATEGIES TO MITIGATE THE IMPACTS OF CLIMATE CHANGE ON THEIR CUSTOMERS AND THE PUBLIC;

~~(7)~~ (8) ASSESSING THE IMPACTS THAT CLIMATE CHANGE MAY HAVE ON AGRICULTURE IN THE STATE;

~~(8)~~ (9) RECOMMENDING SHORT– AND LONG–TERM STRATEGIES AND INITIATIVES TO BETTER MITIGATE, PREPARE FOR, AND ADAPT TO THE CONSEQUENCES OF CLIMATE CHANGE;

~~(9)~~ (10) ASSISTING LOCAL GOVERNMENTS IN SUPPORTING COMMUNITY–SCALE CLIMATE VULNERABILITY ASSESSMENTS AND THE DEVELOPMENT AND INTEGRATION OF SPECIFIC STRATEGIES INTO LOCAL PLANS AND ORDINANCES;

~~(10)~~ (11) ESTABLISHING COMPREHENSIVE AND ACCOUNTABLE ANNUAL WORKING GROUP WORK PLANS THAT SET ANNUAL GOALS AND PERFORMANCE BENCHMARKS AND PRIORITIZE NEW AND EXISTING CLIMATE CHANGE MITIGATION AND PREPAREDNESS ACTIONS AND INITIATIVES;

~~(11)~~ (12) MAINTAINING A COMPREHENSIVE ACTION PLAN, WITH 5–YEAR BENCHMARKS, TO ACHIEVE SCIENCE–BASED REDUCTIONS IN MARYLAND'S GREENHOUSE GAS EMISSIONS ~~OF 80% OF 2006 LEVELS BY 2050~~;

~~(12)~~ (13) CONVENING REGULAR WORKING GROUP AND FULL COMMISSION MEETINGS TO ENSURE THAT SUFFICIENT PROGRESS IS BEING MADE ACROSS ALL SECTORS AND COMMUNITIES IN MARYLAND; AND

~~(13)~~ (14) CONSIDERING OTHER RELATED MATTERS AS THE COMMISSION DETERMINES TO BE NECESSARY.

2–1304.

ON OR BEFORE NOVEMBER 15 OF EACH YEAR, THE COMMISSION SHALL REPORT TO THE GOVERNOR AND GENERAL ASSEMBLY, IN ACCORDANCE WITH § 2–1246 OF THE STATE GOVERNMENT ARTICLE, ON THE STATUS OF THE STATE'S EFFORTS TO MITIGATE THE CAUSES OF, PREPARE FOR, AND ADAPT TO THE CONSEQUENCES OF CLIMATE CHANGE, INCLUDING FUTURE PLANS AND RECOMMENDATIONS FOR LEGISLATION, IF ANY, TO BE CONSIDERED BY THE GENERAL ASSEMBLY.

2–1305.

(A) (1) EACH STATE AGENCY SHALL REVIEW ITS PLANNING, REGULATORY, AND FISCAL PROGRAMS TO IDENTIFY AND RECOMMEND ACTIONS TO MORE FULLY INTEGRATE THE CONSIDERATION OF MARYLAND'S GREENHOUSE GAS REDUCTION GOAL AND THE IMPACTS OF CLIMATE CHANGE.

(2) THE REVIEW SHALL INCLUDE THE CONSIDERATION OF:

(I) SEA LEVEL RISE;

(II) STORM SURGES AND FLOODING;

(III) INCREASED PRECIPITATION AND TEMPERATURE; AND

(IV) EXTREME WEATHER EVENTS.

(B) EACH STATE AGENCY SHALL IDENTIFY AND RECOMMEND SPECIFIC POLICY, PLANNING, REGULATORY, AND FISCAL CHANGES TO EXISTING PROGRAMS THAT DO NOT CURRENTLY SUPPORT THE STATE'S GREENHOUSE GAS REDUCTION EFFORTS OR ADDRESS CLIMATE CHANGE.

(C) (1) THE FOLLOWING STATE AGENCIES SHALL REPORT ANNUALLY ON THE STATUS OF PROGRAMS THAT SUPPORT THE STATE'S GREENHOUSE GAS REDUCTION EFFORTS OR ADDRESS CLIMATE CHANGE, IN ACCORDANCE WITH § 2–1246 OF THE STATE GOVERNMENT ARTICLE, TO THE COMMISSION AND THE GOVERNOR:

(I) THE DEPARTMENT;

(II) THE DEPARTMENT OF AGRICULTURE;

(III) THE DEPARTMENT OF GENERAL SERVICES;

(IV) THE DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT;

(V) THE DEPARTMENT OF NATURAL RESOURCES;

(VI) THE DEPARTMENT OF PLANNING;

(VII) THE DEPARTMENT OF TRANSPORTATION;

(VIII) THE MARYLAND ENERGY ADMINISTRATION;

(IX) THE MARYLAND INSURANCE ADMINISTRATION;

(X) THE PUBLIC SERVICE COMMISSION; AND

(XI) THE UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE.

(2) THE REPORT REQUIRED IN PARAGRAPH (1) OF THIS SUBSECTION SHALL INCLUDE:

(I) PROGRAM DESCRIPTIONS AND OBJECTIVES;

(II) IMPLEMENTATION MILESTONES, WHETHER OR NOT THEY HAVE BEEN MET;

(III) ENHANCEMENT OPPORTUNITIES;

(IV) FUNDING;

(V) CHALLENGES;

(VI) ESTIMATED GREENHOUSE GAS EMISSIONS REDUCTIONS, BY PROGRAM, FOR THE PRIOR CALENDAR YEAR; AND

(VII) ANY OTHER INFORMATION THAT THE AGENCY CONSIDERS RELEVANT.

2–1306.

(A) THE UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE SHALL ESTABLISH SCIENCE–BASED SEA LEVEL RISE PROJECTIONS FOR MARYLAND'S COASTAL AREAS AND UPDATE THEM AT LEAST EVERY 5 YEARS.

(B) THE SCIENCE–BASED SEA LEVEL RISE PROJECTIONS SHALL INCLUDE MAPS THAT INDICATE THE AREAS OF THE STATE THAT MAY BE MOST AFFECTED BY STORM SURGES, FLOODING, AND EXTREME WEATHER EVENTS.

(C) THE SCIENCE–BASED SEA LEVEL RISE PROJECTIONS REQUIRED UNDER THIS SECTION SHALL BE MADE PUBLICLY AVAILABLE ON THE INTERNET.

SECTION 2. AND BE IT FURTHER ENACTED, That, before June 1, 2016, nothing in this Act shall be construed to affect the current membership and duties of the Maryland Commission on Climate Change, established by Executive Order 01.01.2014.14. It is the intent of the General Assembly that the Maryland Commission on Climate Change, established by Executive Order 01.01.2014.14, shall continue to meet and complete its tasks for 1 year following the enactment of this Act and until members are appointed to the Maryland Commission on Climate Change, established by this Act, in accordance with Section 3 of this Act.

SECTION 3. AND BE IT FURTHER ENACTED, That, on or before July 1, 2016, the members and working group members of the Maryland Commission on Climate Change, established in accordance with Section 1 of this Act, shall be appointed and a meeting shall be convened. Nothing in this Act shall preclude the appointment of a member to the Maryland Commission on Climate Change, established in accordance with this Act, who served as a member of the Maryland Commission on Climate Change, established by Executive Order 01.01.2014.14.

SECTION 4. AND BE IT FURTHER ENACTED, That, on or before October 1, 2016, each working group established by Section 1 of this Act shall meet and establish a work plan.

~~SECTION 2. AND BE IT FURTHER ENACTED, That on or before September 1, 2015, the Commission shall be convened and working group members shall be appointed. On or before October 1, 2015, each working group shall meet and establish a work plan.~~

SECTION ~~3.~~ 5. AND BE IT FURTHER ENACTED, That this Act shall take effect June 1, 2015.

Approved by the Governor, May 12, 2015.

Appendix H

Acronyms

ARWG	Adaptation and Response Working Group
CAA	Clean Air Act
CAP	Climate Action Plan
CO_2	Carbon Dioxide
CPP	Clean Power Plan
DHMH	Department of Health and Mental Hygiene
DNR	Maryland Department of Natural Resources
ECO	Education, Communication and Outreach Working Group
EPA	Environmental Protection Agency
GGRA	Greenhouse Gas Emissions Reduction Act
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
MCCC	Maryland Commission on Climate Change
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MEA	Maryland Energy Administration
$MMtCO_2e$	Million Megatons Carbon Dioxide Equivalent
MWG	Mitigation Working Group
NOAA	National Oceanic and Atmospheric Administration
RGGI	Regional Greenhouse Gas Initiative
SEIF	Strategic Energy Investment Fund
SHA	State Highway Administration
STWG	Scientific and Technical Working Group
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture

Appendix I

References

Maryland Climate Change Documents and Reports

The following laws, executive orders, and major reports can be found at:
http://www.mde.state.md.us/programs/Marylander/Pages/MCCCPublications.aspx

Executive Order 01.01.2007.07

Executive Order 01.01.2014.14

Greenhouse Gas Emissions Reduction Act of 2009

Greenhouse Gas Emissions Reduction Act – Reauthorization (2015)

Maryland Department of the Environment, 2008. *Climate Action Plan.*

Maryland Department of the Environment, 2013. *Maryland's Greenhouse Gas Reduction Act Plan.*

Maryland Commission on Climate Change, 2015. *2015 Maryland Commission on Climate Change Report.* (includes Appendix 1, "Reducing Emissions of Greenhouse Gases Beyond 2020")

Maryland Department of the Environment, 2015. *2015 Greenhouse Gas Emissions Reduction Act Plan Update.*

Other Works Cited

Boesch, D.F. (editor), 2008. *Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland.* Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change. University of Maryland Center for Environmental Science, Cambridge, Maryland. http://www.umces.edu/applying-science/maryland-climate-change

Boesch, D.F., L.P. Atkinson, W.C. Boicourt, J.D. Boon, D.R. Cahoon, R.A. Dalrymple, T. Ezer, B.P. Horton, Z.P. Johnson, R.E. Kopp, M. Li, R.H. Moss, A. Parris, C.K. Sommerfield. 2013. *Updating Maryland's Sea-level Rise Projections.* Special Report of the Scientific and Technical Working Group to the Maryland Climate Change Commission, 22 pp. http://www.umces.edu/sea-level

Center for Climate and Energy Solutions, 2015. *Climate Change: Cost of Inaction for Maryland's Economy.* http://www.c2es.org/publications/climate-change-cost-inaction-marylands-economy

Chesapeake Bay Program. "Climate Change". [accessed 24 Oct 2016] http://www.chesapeakebay.net/issues/issue/climate_change

Cook, J., N. Oreskes, P.T. Doran, W.R.L. Anderegg, B. Verheggen, E.W. Maibach, J.S. Carlton, S. Lewandowsky, A.G. Skuce, S.A. Green, D. Nuccitelli, P. Jacobs, M. Richardson, B. Winkler, R. Painting and K. Rice, 2016. Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters* (11) 4. http://iopscience.iop.org/article/10.1088/1748-9326/11/4/048002

Horton, R., G. Yohe, W. Easterling, R. Kates, M. Ruth, E. Sussman, A. Whelchel, D. Wolfe, and F. Lipschultz, 2014. Chapter 16: Northeast, *Climate Change Impacts in the United States* (p. 371-395). http://nca2014.globalchange.gov/report/regions/northeast

Intergovernmental Panel on Climate Change, 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate*

Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. https://www.ipcc.ch/report/ar5/syr/

Kopp, R.E., R.M. Horton, C.M. Little, J.S. Mitrovica, M. Oppenheimer, D.J. Rasmusen, B.H. Strauss, and C.Tebaldj, 2014. Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. *Earth's Future.* http://onlinelibrary.wiley.com/doi/10.1002/2014EF000239/abstract

Loss, Samantha, 24 December 2015. "Balmy December weather keeping trails closed at area ski resorts". Washington's Top News. http://wtop.com/local/2015/12/balmy-december-weather-keeping-trails-closed-area-ski-resorts/slide/1/

Maryland Commission on Climate Change Scientific and Technical Working Group. 2016. *Re-Examining Projected Climate Changes for Maryland.* http://www.mde.state.md.us/programs/Marylander/Documents/STWG/STWGRe-examinCC01252016.pdf

Maryland Commission on Climate Change Scientific and Technical Working Group, 2016. *Scientific Perspectives Related to Methane Emissions in Maryland.* Maryland Climate Change Commission. http://www.mde.state.md.us/programs/Marylander/Documents/STWG/STWGMethaneRept10242016.pdf

Maryland Department of the Environment, 2015. *Maryland 2014 Periodic GHG Emissions Inventory.* http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/GreenhouseGasInventory.aspx

Maryland Department of Natural Resources, "Climate Change in Maryland". [accessed 24 Oct 2016] http://dnr2.maryland.gov/climateresilience/Pages/about_climatechange.aspx

Maryland Department of Natural Resources, "Forestry Facts". [accessed 18 Oct 2016] http://dnr.maryland.gov/forests/Pages/mdfacts.aspx

Maryland Office of Tourism Development, "Official Site of State of Maryland Tourism". [accessed 14 Oct 2016] http://www.visitmaryland.org/

Maryland State Archives, "Maryland at a Glance: Agriculture". [accessed 24 Oct 2016] http://msa.maryland.gov/msa/mdmanual/01glance/html/agri.html

Maryland State Archives, "Maryland at a Glance: Economy". [accessed 24 Oct 2016] http://msa.maryland.gov/msa/mdmanual/01glance/economy/html/economy.html

Maryland Institute for Applied Environmental Health, and University of Maryland School of Public Health College Park, prepared for the Maryland Department of Health and Mental Hygiene, 2016. *Maryland Climate and Health Profile Report.* http://phpa.dhmh.maryland.gov/OEHFP/EH/Pages/about_climate.aspx

Maryland Ocean Acidification Task Force, 2015. *Task Force to Study the Impact of Ocean Acidification on State Waters Report to the Governor and the Maryland General Assembly.* http://dnr.maryland.gov/waters/bay/Pages/MDOATF/OATF_Home.aspx

Maryland Office of Tourism Development, 2015. FY2015 *Tourism Development Annual Report.* http://industry.visitmaryland.org/research/annual-reports/

Maryland State Highway Administration, 2014. *Climate Change Adaptation Plan with Detailed Vulnerability Assessment.* https://www.fhwa.dot.gov/environment/climate_change/adaptation/resilience_pilots/2013-2015_pilots/maryland/final_report/

National Center for Biotechnology Information, U.S. National Library of Medicine. PubChem Database. [accessed 4 Oct 2016] https://pubchem.ncbi.nlm.nih.gov/

NOAA Chesapeake Bay Office, 2011. *Climate Change and the Chesapeake Bay.* http://chesapeakebay.noaa.gov/features/climate

U.S. EPA, "Climate Impacts in the Northeast". [accessed 14 Oct 2016] https://www.epa.gov/climate-impacts/climate-impacts-northeast

U.S. EPA, "Climate Impacts on Energy". [accessed 20 Oct 2016] https://www.epa.gov/climate-impacts/climate-impacts-energy

U.S. EPA, "Hazardous Air Pollutants". [accessed 4 Oct 2016] https://www.epa.gov/haps

U.S. Geological Survey, "Water Use Data for Maryland". [accessed 18 Oct 2016] http://waterdata.usgs.gov/md/nwis/water_use?

United Nations Framework Convention on Climate Change. "The Paris Agreement". [accessed 12 Oct 2016] http://unfccc.int/paris_agreement/items/9485.php

United Nations Framework Convention on Climate Change, 2015. *Paris Agreement.* http://unfccc.int/paris_agreement/items/9485.php

University of Cambridge, 2014. *Climate Change: Implications for Tourism*. https://europeanclimate.org/climate-change-implications-for-tourism/U.S. Global Change Research Program, 2009. Chapter 1: Climate and Health Assessment. *Global Climate Change Impacts in the United States.* https://health2016.globalchange.gov/climate-change-and-human-health

Weather.com, "Wisp Four Seasons Resort, MD". [accessed 31 Oct 2016] https://weather.com/weather/monthly/l/USMD0433:1:US