The MCCC and MDE have requested that the 2023 report to be concise, easy-to -follow with a few actionable recommendations. Hyperlinks not included but the full link provided for final report.

2023 MCCC Annual Report

Maryland's Climate Pathway. *[This introductory paragraph may be captured earlier in the Annual Report]*

In the development of Action Plans for the Greenhouse Gas Reduction Act, the Maryland Department of the Environment had to rely out-of-state consulting firms to model the effects of various policies and actions on the state's greenhouse gas emissions as it developed the plan to achieve the targeted greenhouse gas emissions reductions, initially 25% by 2020 and then 40% by 2030. With the enactment of the Climate Solutions Now Act in 2022, MDE faces an even steeper challenge in developing a plan that achieves a 69% reduction by 2031 in a way that puts the state on a path to reach net-zero emissions by 2045. This time, MDE turned to Maryland's scientific community and universities to assist in modeling of actions that the state can take to achieve these ambitious new goals. The effort involved experts from the Center for Global Sustainability and the Department of Geographical Sciences at the University of Maryland, College Park, and the Regional Economic Studies Institute at Towson University. Together, the team released the report *Maryland's Climate Pathway* on June 30, 2013, rising to the occasion with lightning speed and impressive result. This analysis is providing critical input to the Action Plan for implementing the Climate Solutions Now Act due later this year. The Pathway report demonstrates how Maryland can meet both the 60% reduction and net-zero emissions goals, all while realizing health and economic benefits for Marylanders, including improved air quality, new jobs, and household cost savings. This effort constitutes a major step forward in building the modeling and assessment capacity needed in Maryland that was recommended by the Scientific and Technical Working Group in the MCCC 2022 Annual Report. Maryland's state agencies and higher education institutions can now build on this momentum by identifying other modeling and assessment needs and ways to meet them with the goal of creating a community of experts that drive innovation and implementation of mitigation and adaptation actions that can be effectively scaled.

2023 Science Update

Globally, July 2023 was the hottest month on record, sea ice was the lowest on record and for the fourth consecutive month, the global ocean surface temperature hit a record high. July was estimated to have been around 1.5°C warmer than the pre-industrial average for 1850-1900, according to the EU Copernicus Climate Change Service, operated by the European Centre for Medium Range Weather Forecasting. July was 0.33°C warmer than the previous warmest month, July 2019.

The UN World Meteorological Organization[1] reiterated that there is a 66 per cent chance that the 1.5ºC threshold above the pre-industrial value will be exceeded in the next five years but this is likely a "temporary" change.

Climate change threats to public health include air quality, extreme heat, extreme weather events, vector- and food-borne illness, food insecurity, sea level rise, and drinking water contamination[2]. The University of Maryland extension weather outlook reports a 30-day outlook for temperatures in September 2023 is 40-50% chance of above normal temperatures for the entire state, with drought conditions persisting.

Global Emissions and Progress toward NDCs

During the 2013-22 decade, global warming reached 1.14 [0.9 to 1.4] °C and 1.26 [1.0 to 1.6] °C in 2022. This rate of warming of 0.2 °C per decade is unprecedented and is caused by a combination of greenhouse gas emissions being at an all-time high of 54 ± 5.3 GtCO2e over the last decade (Figure 1), as well as reductions in the strength of aerosol cooling[3]. There is evidence that increases in greenhouse gas emissions are slowing, and depending on societal choices, this could be the harbinger of a change in human influence on climate and highlights the importance of Maryland's leadership in climate action.
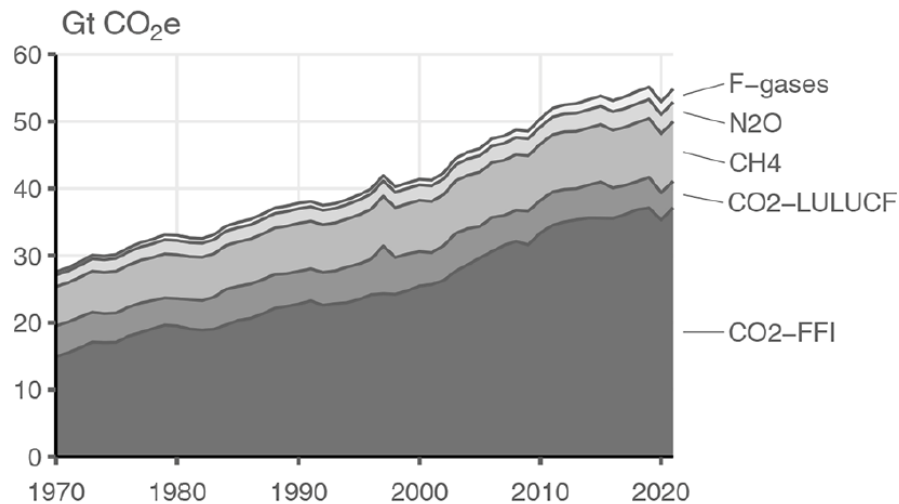

Figure 1: Global Total Greenhouse Gas Emissions. [Source: Forster et al., 2023][3]

Climate Watch monitors the progress of countries toward their Nationally Determined Contributions (NDCs) made in the 2015 Paris Climate Agreement. Climate Watch has reported that 176 countries, representing 93.9% of global emissions, have submitted new or updated NDCs and 107 countries (80.6% of global emissions) have announced total emissions reductions beyond their initial NDC[4]. (www.climatewatchdata.org).

Weather Attribution

2023 has witnessed a further maturing of the nascent field of weather attribution, or the science of directly linking extreme weather events as a consequence of global warming and the unabated increase in greenhouse gas emissions across the world. Attribution science has allowed researchers to determine (with uncertainty quantified) how much climate change is contributing to the severity of weather events[5]. This quantification of human influence is helping communicate risks more effectively and is informing public policy related to adaptation and mitigation.

There are numerous examples relevant to Maryland. The flash flooding of Ellicott City (2016 and 2018) and New York City (September 29, 2023) are reminders of the increasing frequency and intensity of extreme rainfall events. The increasing incidence of wildfires (Figure 2) also pose threats to the forests of Maryland and to human health due to downwinding effects of smoke blown from fires in other regions.
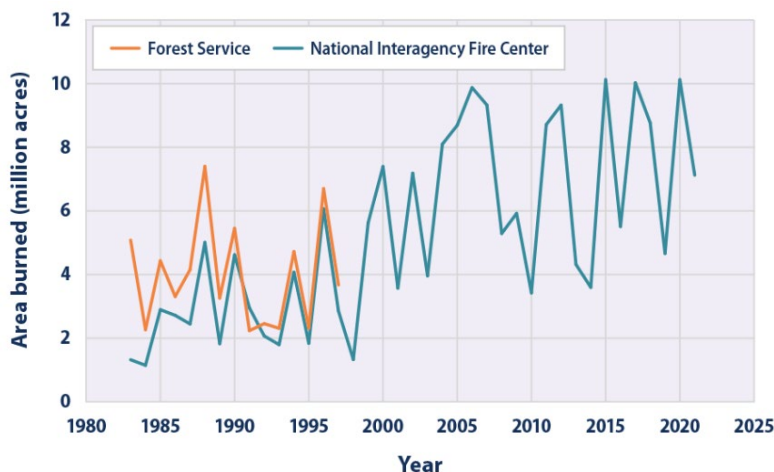

Figure 2: Wildfire Extent in the United States, 1983-2021.
Sources: NIFC (National Interagency Fire Center). 2022. Total wildland fires and acres (1983-2022) and US EPAClimate Indicators (https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires).

In 2023, more than twice as many acres in Canada have burned than the previous record year. Climate change made the dangerous fire weather conditions in Quebec at least twice as likely[6]. (https://www.worldweatherattribution.org/). Prevailing winds pushed the smoke plume through eastern states resulting in the National Weather Service issuing a Code RED Air Quality Alert with some school districts in Maryland and Washington DC closing on June 8-9, 2023.

Weather attribution research is refining the understanding of the types of conditions Maryland can expect to experience in coming decades. It also reinforces the critical importance of the state's progress being made to protect Marylanders and as an example to other states and countries for what is feasible economically and socially. Some recent but not comprehensive scientific findings of relevance to Maryland are maintained on the STWG website. In this summary we focus on heat impact to communities and the 2023 projections of sea-level rise for Maryland.

Heat Impacts

July 2023 was confirmed by NOAA, NASA and the EU Copernicus Climate Change Service as the hottest month on record and likely the highest in the past 120,000 years as well as having the highest-ever ocean surface temperatures since records began.

Goodell[8] summarized how heat-related deaths have been vastly under-counted and this hidden menace will continue to plague communities as heat waves increase in frequency, duration and intensity as was experienced across southern Europe and regions of north America in 2023.

Although Maryland did not experience the same level of extreme heat records as has been experienced in other parts of the US - the risks are clear. In 2023, 4 total heat advisories have been issued as of September 6th, which already exceeds the total of 3 in 2022. From August 29th-September 4th, 312 heat related illness complaints were reported in emergency departments in urgent care in Maryland (Figure 3).
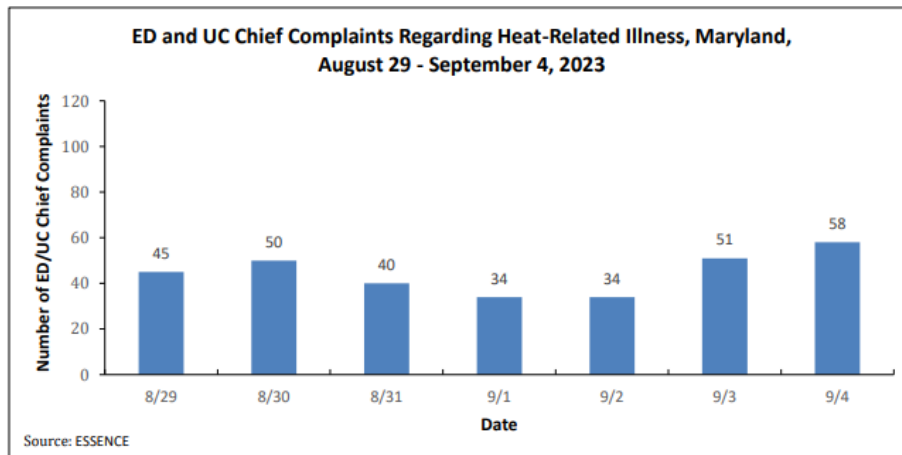

Figure 3: Reported Heat-Related Illness in Maryland During the Heatwave of August 29-September 4, 2023.

Sea-Level Projections for Maryland.

As directed by the Maryland Commission on Climate Change Act, the University of Maryland Center for Environmental Science (UMCES) completed an update of the 2018 projections based on the latest scientific assessments[9]. A 14-member Sea Level Rise Expert Group oversaw the development of the report, acting under the auspices of the MCCC Scientific and Technical Working Group. Liaison with the Adaptation and Response Working Group was maintained throughout the process. The sea-level rise for which Maryland should plan during the latter half of the century and beyond depends on the degree to which global society limits its greenhouse gas emissions. Sea-level projections developed in the IPCC's most recent assessment that assume that only current national commitments for emission reductions would be met are recommended as the primary planning scenario for beyond the next 25 years. These projections were customized for locations in Maryland by factoring in land subsidence, ocean processes and the effects of polar ice sheet melting. For the near-term until 2050, statistical extrapolations of trends from tide gauge and satellite observations provide important guidance. These extrapolations suggest that it is prudent to plan for mean sea-level to rise between 1 and 1.6 feet (relative to the land) from a 2005 starting point. The IPCC "current commitments" projections put the likely range at 2.0 to 3.5 feet by 2100 - two to three times the sea-level rise experienced during the 20th century. Even with unexpectedly rapid polar ice loss, sea-level is very unlikely to exceed 4.9 feet this century. The report suggests ways in which the probability distributions of these projections can be used as reference points in planning for both the natural and build environment.

Monitoring and Modeling GHG Emissions in Maryland

Measurements and numerical models of GHG concentrations and emissions, supported primarily by UMD, NIST, and NOAA, have helped refine inventories and identify local hot spots in GHGs and associated short-lived pollutants – linking climate and environmental justice. These studies confirm the importance of methane in Maryland's climate impact and that traditional inventory methods underestimate methane emissions. MDE's new methane inventories better match research grade determinations, although substantial uncertainty remains especially in emissions from the natural gas delivery system and landfills.

Recent research indicates that methane emissions from Baltimore and Washington have decreased over the past few years although the cause remains unproven. Leak rates were observed to scale with seasonal gas usage producing much higher emissions in winter than summer. The main sources in urban areas are natural gas infrastructure and landfills; on the rural eastern shore wetland emissions play a major role. Out of state sources contributing to methane in Maryland include the Marcellus gas plan and concentrated swine operations in North Carolina.

Measurements from mobile platforms continue to identify leaks and other point sources to refine inventories and suggest targets for remediation. Although replacement of the old natural gas infrastructure is a contentious issue, existing leaks are a hazard in need of immediate attention. Plans to make a Maryland landfill a testbed for methane control are underway. This will provide direct flux determination to refine models and evaluate and then implement control strategies.

The urban heat island effect, and spatially-biased emissions conspire to make many of Maryland's most vulnerable communities hot spots for not only pollution emissions but several environmental problems such as poor air and water quality and heat waves.

Actions taken by Maryland in Response to the 2022 Recommendations

The STWG notes the following actions taken to address 2022 recommendations:

- The 2023 MDE Pathway Report[10] utilized in-state modeling capacity provided by the University of Maryland's Center for Global Sustainability. Utilizing in-state expertise builds the state's workforce trained to support the myriad of climate challeges.
- Governor Moore has committed to filling important vacant positions within the state government, some of which will be critical in the state's ability to address climate change. Further bolstering of agency staffing is critical to the success of the state's climate ambitions but this is an important first step.
- In June of this year, regulations for addressing landfill gas methane emissions were published by MDE[11], and it is estimated a 25-50% reduction[12] in greenhouse gas emissions from affected landfills.

STWG Policy Recommendations

Recommendation 1: Improve public health preparedness for the challenges posed by climate change.

1.1 The state should consider developing a Ready-Set-Go framework for public health adaptation based on early warning systems leveraging subseasonal-to-seasonal (S2S) forecasts. Early health warnings with seasonal lead time should inform contingency planning, and personnel/volunteer training (Ready phase), while sub- seasonal lead time should inform resource allocation, and personnel/volunteer activation (Set phase). Finally, warnings with short range lead time (days) should inform the activation stage, including evacuation, opening of shelters, and distribution of aids (Go phase).

1.2 The state should issue a report on the background, status, and needs associated with the CDC funding for the Climate and Health Program. Additionally, the state should compensate for the loss of CDC funding for the Climate and Health program within the Maryland Department of Health to enhance Maryland's public health preparedness to climate change.

1.3 The Maryland Climate and Health Profile Report, published in 2016, should be updated by the Maryland Department of Health and Mental Hygiene in collaboration with the University of Maryland School of Public Health every five years to accommodate more recent scientific evidence and provide relevant future projections of health burden in Maryland, with a particular emphasis on climate justice by implementing meaningful community engagement.

Recommendation 2: Establish a Climate and Equity Innovation Fund.

Supporting collaborations among industry, private sector, NGOs, government agencies and academia through funding, including initiatives such as seed grants and establishing workforce development programs will be important as novel technologies are sought to meet greenhouse gas emissions targets. To facilitate and incentivize this translation of promising viable technologies that can be scaled, it is recommended that a Climate and Equity Innovation Fund be established. This fund should be commensurate with the magnitude of the challenge (for example, an initial allocation of $30m for the first year. This competitive and peer-reviewed program has the purpose of positioning Maryland as a national leader in climate technologies through partnerships and supporting workforce development programs that focus on creativity, diversity and equity. The program will be managed by existing accelerator programs [Maryland Sea Grant (MDSG)for adaptation and the Maryland Energy Innovation Accelerator previously created by the Maryland legislature that builds on the Maryland Energy Innovation Institute (MEI2) and Maryland Clean Energy Center (MCEC)]. These programs have a long history of managing such competitive programs on behalf of Maryland.

As Maryland moves forward in reaching greenhouse gas emissions goals (60% by 2031) and into achieving net-zero by 2045, carbon capture and sequestration technologies will be

critical. The UN [State of Carbon Dioxide Removal report](#)[13] states that scaling up carbon dioxide removal is an urgent priority, and identified a gap between how much removal is planned and how much removal is needed to meet temperature goals of the Paris Agreement. Effective mitigation <u>and </u>adaptation strategies and technologies that benefit communities are needed.

Recommendation 3: Inclusivity of All Marylanders

Review whether people with disabilities are adequately accounted for in mitigation and adaptation planning as an integral part of the equity and underserved community underpinnings of the 2022 Climate Solutions Now and the State's response to climate change.

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