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"Assessing the Homeland Security Impacts of a Changing Climate"

House Committee on Homeland Security,
Subcommittee on Emergency Preparedness, Response, and Recovery

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Chairman Payne, Ranking Member King, and Members of the Subcommittee, thank you for providing me the opportunity to testify here today on climate change science. I am a Senior Climate Scientist at the Union of Concerned Scientists and in that capacity, I am here to talk about climate science itself, and climate change impacts. I hope you find this testimony valuable to your efforts around Emergency Preparedness, Response, and Recovery

I will start my testimony by calling your attention to the fact that eighteen of the nineteen warmest years since record keeping began have occurred since 2001, meaning high school graduates from the class of 2019 have lived their whole lives in a world of record-breaking temperatures. Furthermore, the last five years have been the five hottest of all[1]. These are all well-recorded data from various sources around the globe and assessed by NOAA and NASA. Global warming is happening right now and has been happening for many decades (Figure 1). The trend is clear and is slated to continue unless we start putting all our might into reducing heat-trapping emissions.

Global warming is caused mainly by the accumulation of carbon dioxide emissions from the burning of fossil fuels such as coal, oil, and natural gas. In addition to warming, this is causing changes in countless natural and human systems that rely on and in turn influence climate. For instance, among other changes, glaciers are shrinking, Arctic sea ice is decreasing, sea level is rising, and oceans are getting warmer and more acidic. Global warming and climate change are two separate – but deeply interconnected – phenomena.

[1] NOAA 2018 https://www.noaa.gov/news/2018-was-4th-hottest-year-on-record-for-globe

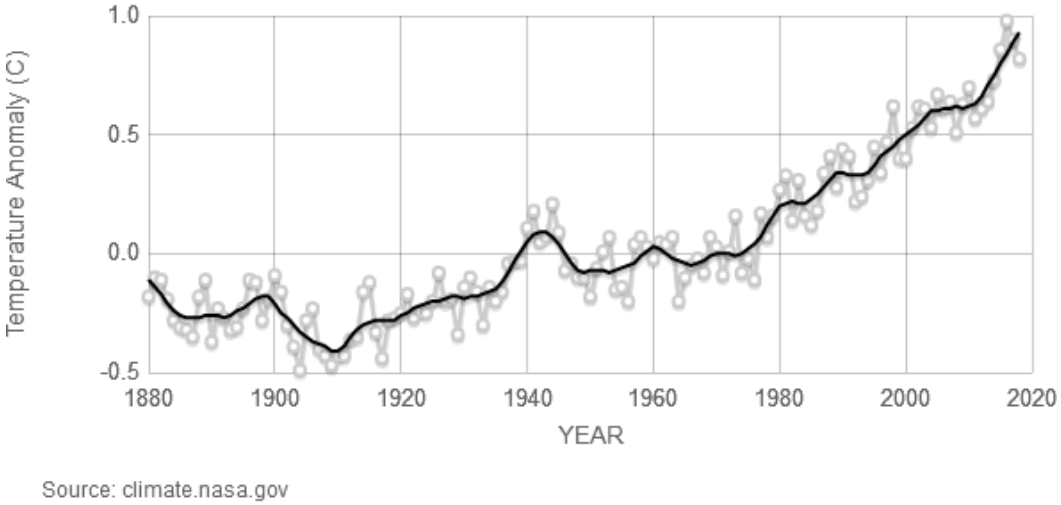

Figure 1: Global land-ocean temperature index[2]

The science of climate change is very well established. Recently, two important scientific assessment reports were released that describe the current and projected impacts of climate change: the Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5C (IPCC 1.5)[3] and the U.S. Fourth National Climate Assessment (NCA4)[4], mandated by the U.S. Government to be produced every 4 years. Climate assessments provide the public and policy makers with the most scientifically sound summary and evaluation of the most recent policy-relevant research. It is worth noting that each of these reports is the product of hundreds of national and international experts from a range of sectors.

The IPCC 1.5 states that "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C," and the NCA4 states that "Earth's climate is now changing faster than at any point in modern civilization. […] These changes are primarily the result of human activities, the evidence of which is overwhelming and continues to strengthen." It also states that climate change presents growing challenges to: (1) the economy and infrastructure, (2) the natural environment and the services ecosystems provide to society, and (3) human health and quality of life.[5]

There is strong consensus among the scientific community (as shown in the conclusions of the reports, based on thousands of scientific research publications) that climate change is happening now, is caused by humans, and that the need for

[2] https://climate.nasa.gov/vital-signs/global-temperature/
[3] https://www.ipcc.ch/sr15/
[4] https://www.globalchange.gov/nca4
[5] https://www.globalchange.gov/nca4

emissions reductions is urgent in order to avoid the worst consequences. The NCA4 also quantifies climate change impacts in economic terms, providing an indication of the potential for reducing risks through mitigation actions. The report concludes that these climate-related impacts will only get worse and their costs will mount dramatically if carbon emissions continue unabated. Annual losses in some sectors are projected to exceed $100 billion by the end of the century and surpass the gross domestic product of many states.

Both reports state that millions of people are already being affected on their everyday lives by worsened heat, drought, wildfires, flooding from both extreme precipitation and sea level rise, stronger hurricanes, and more. The economic impacts and costs of these disasters are staggering. The past three years have been 3 of the 4 costliest years for climate-related disasters here in the US (Figure 2). 2018 was the 4th highest year for both the number and costs of declared disasters. Hurricanes Harvey, Irma, Maria, and the California wildfires created unprecedented demand for federal disaster help in 2017. The federal government has provided at least $120 billion in supplemental funding for these disasters, as well as help with response and recovery[6].

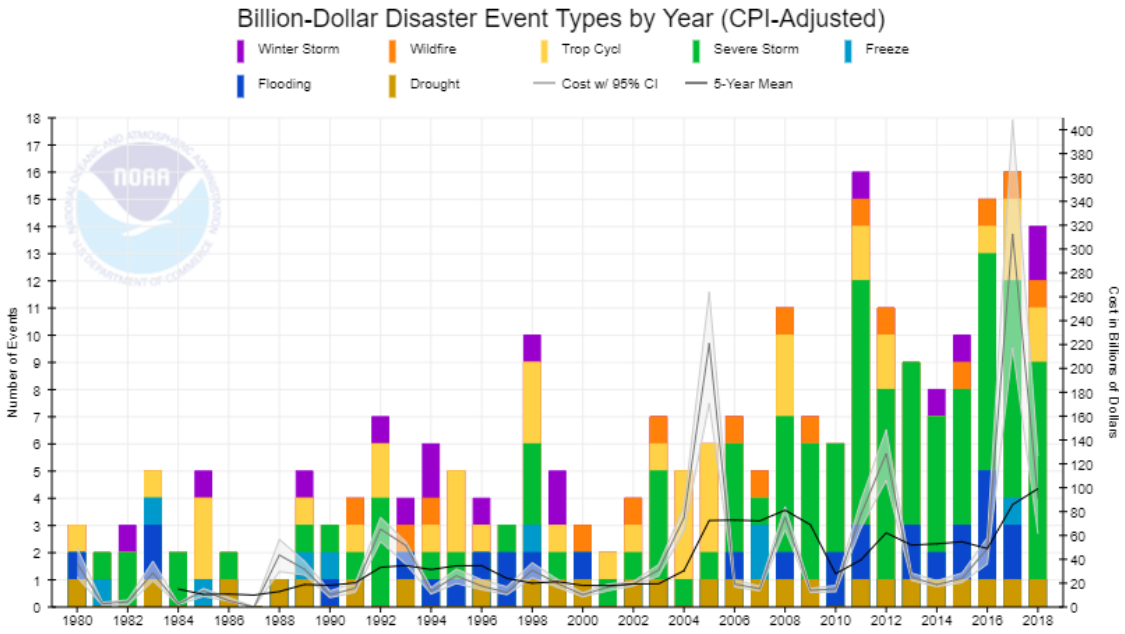

Figure 2: Costs of disasters in the U.S. (Image from NOAA)

As the Government Accountability Office points out[7], in light of growing extreme weather and climate-related disaster costs, the federal government must invest

[6] https://www.gao.gov/products/GAO-18-472

[7] https://www.gao.gov/highrisk/limiting_federal_government_fiscal_exposure/why_did_study

ahead of time to help communities prepare instead of just in recovery after disasters strike. A recent study[8] shows the nation can save $6 in future disaster costs, for every $1 spent on pre-hazard mitigation. Investing in climate resilience would help reduce future costs of climate impacts and cutting global warming emissions would help limit the magnitude of those impacts.

In the past few years the science has advanced to a point where the proportion of climate change that contributed to the severity and probability of individual extreme events is now possible[9]. The science of attribution tells us that certain types of extreme events have been made more intense and/or more likely by climate change (Figure 3). There is strong evidence suggesting that extreme precipitation (including rain from hurricanes), coastal flooding (from high tides and storm surge), and heat waves are influenced by climate change. We will look at some examples.

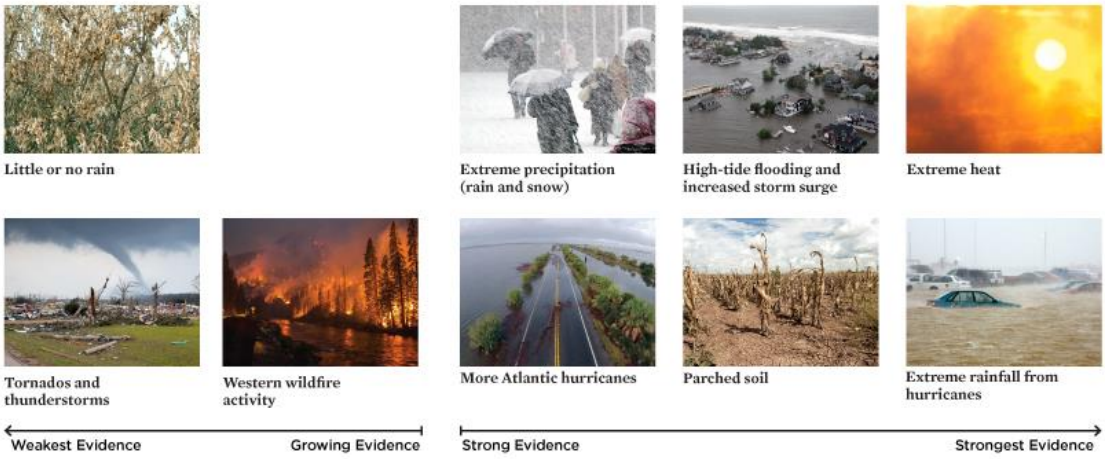

Figure 3: Scientific evidence for connections between extreme weather events and climate change[10]

Extreme rainfall

Studies have shown that extreme precipitation events have become more frequent and more intense in many parts of the United States since the early to mid-1900s, with the eastern half of the country seeing increases of 50 percent or more in extreme rainfall event frequency and the western half seeing smaller increases or even decreases. The amount of rain falling in the heaviest events is also increasing,

[8] https://www.nibs.org/page/mitigationsaves
[9] NAS, 2016: Attribution of Extreme Weather Events in the Context of Climate Change. The National Academies Press, 186 pp.
[10] https://www.ucsusa.org/our-work/global-warming/science-and-impacts/climate-attribution-science

especially in the Northeast (Figure 4). Warmer air holds more moisture (in the form of water vapor), and more moisture means more water can fall as rain. This is one reason, all else being equal, a storm occurring in very hot air can bring more precipitation than the exact same storm would in cooler air.

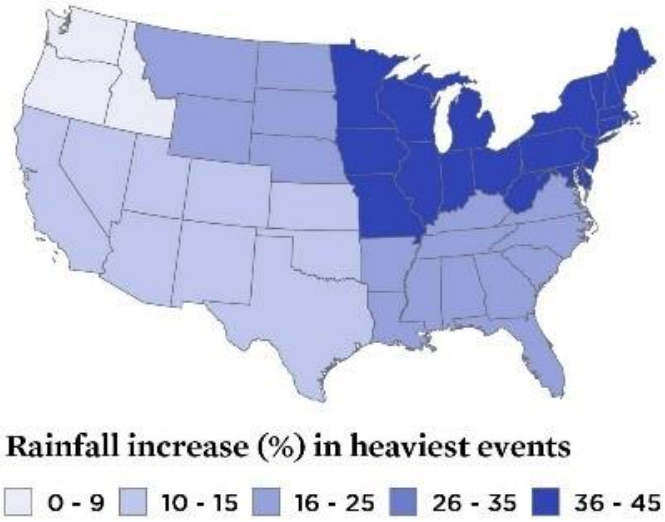

Figure 4: Percent increase in the amount of rain falling during the heaviest 1% of events per region in the continental United States between 1958 and 2016[11]

Rain events once considered rare are now occurring more often than historical records would lead us to expect. For example, the US National Weather Service recorded 13 rare rain events (not including hurricanes) between May 2015 and June 2018 even though such events had a 0.2% probability of occurring in any one year[12]. All of these events led to flooding.

Analyses of specific rain events are bringing to light the connection between human-induced warming and extreme precipitation. Human-caused climate change made the record-breaking rainfall during Hurricane Harvey in 2017 about three times more likely and 15-38 percent more intense[13,14], and a study of the devastating rains in Louisiana in 2016—in which more than two feet of rain fell in a two-day period—concluded that such downpours are expected to occur 40 percent more often and be

[11] https://www.ucsusa.org/global-warming/global-warming-impacts/floods; https://www.globalchange.gov/nca4
[12] https://www.nws.noaa.gov/oh/hdsc/aep_storm_analysis/
[13] van Oldenborgh, G.J., K. van der Wiel, A. Sebastian, R. Singh, J. Arrighi, F. Otto, K. Haustein, S. Li, G. Vecchi, and H. Cullen. 2017a. Attribution of extreme rainfall from Hurricane Harvey, August 2017. Environmental Research Letters 12(12):1–11. doi:10.1088/1748-9326/aa9ef2.
[14] Risser, M.D., and M.F. Wehner. 2017. Attributable human-induced changes in the likelihood and magnitude of the observed extreme precipitation during Hurricane Harvey. Geophysical Research Letters 44(24):12457–12464. doi:10.1002/2017GL075888.

10 percent more intense now than they were before the Industrial Revolution and global warming[15].

Flooding

More volume of rainfall falling in the heaviest events for a region typically leads to flooding. Data from gauges in rivers and streams consistently show that flood frequency has increased in the Mississippi River valley and across the Midwest over the last century. Similarly, parts of the Northeast—eastern Pennsylvania, New York, and New Jersey in particular—has experienced an increase in flood frequency over the last 50 years (Figure 5). These regions are mostly seeing more floods, not necessarily more severe floods, although some increase in moderate and major flood frequency risk has occurred, especially in the Midwest.

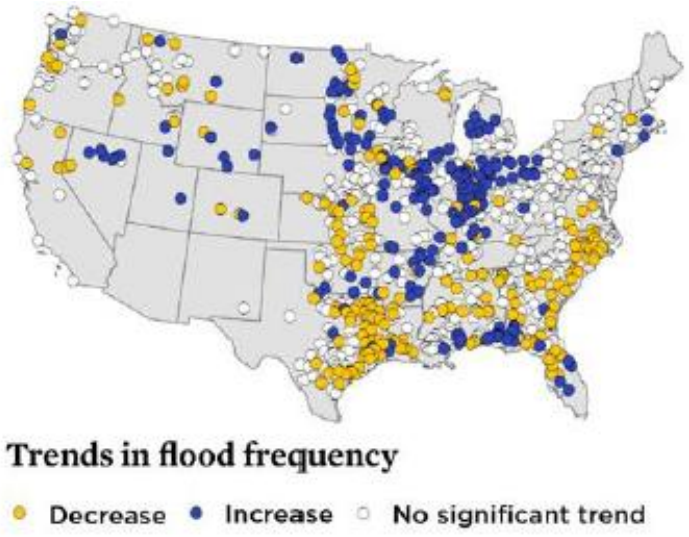

Figure 5: Trends in flood frequency[16]

Hurricanes

Recent research suggests that there has been an increase in intense hurricane activity in the North Atlantic since the 1970s. With global warming, there will likely be more intense hurricanes, whose impacts are likely to be exacerbated by sea level rise. Increases in population density along the coast also increases the destructive

[15] van der Wiel, K., S.B. Kapnick, G.J. van Oldenborgh, K. Whan, S. Philip, G.A. Vecchi, R.K. Singh, J. Arrighi, and H. Cullen. 2017. Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change. Hydrology and Earth System Sciences 21(2):897–921. doi:10.5194/hess-21-897-2017.

[16] https://www.ucsusa.org/global-warming/global-warming-impacts/floods; Slater, L.J., and G. Villarini. 2016. Recent trends in US flood risk. *Geophysical Research Letters* 43(24):12428–12436. doi:10.1002/2016GL071199.

potential of hurricanes. The Congressional Budget Office, in a report on potential increase in hurricane damage, stated that between 2000 and 2010 the population of counties susceptible to hurricane damage grew 22 percent faster than the overall U.S. population.[17]

Hurricanes can form when surface ocean temperatures exceed about 79°F (26°C). The rising of warm, moist air from the ocean helps to power the storm. Oceans absorb most of the warming in the atmosphere, and since 1970, sea surface temperatures worldwide have warmed by about an average of 0.1°C per decade, which provides additional fuel to hurricanes. Hurricanes also require high humidity, and since warmer air can hold more water vapor, that also helps fuel hurricanes – and increase the amount of rain they bring (see Figure 6).

The impact of a hurricane's storm surge can be worse now than in the late 19th century, because sea level has risen by eight inches since then, mainly due to global warming. In fact, the area flooded by hurricane Sandy in 2012 was about 27 square miles larger than it would have been if the hurricane hit in 1880, mainly because of sea level rise[18].

Figure 6: Hurricanes in a warmer world

[17] https://www.cbo.gov/publication/51518

[18] Miller, K.G., R.E. Kopp, B.P. Horton, J.V. Browning, and A.C. Kemp. 2013. A geological perspective on sea-level rise and its impacts along the US mid-Atlantic coast. Earth's Future 1(1):3–18. doi:10.1002/2013EF000135.

Extreme Heat

With global warming, heat records are being broken much faster than cold records[19]. On average, hot days are getting hotter and cold days are also getting hotter globally. In the U.S., California experienced record-breaking heat waves in 2017 and 2018, in addition to several others since the then record-breaking wave of 2006.

Extreme heat is one type of extreme weather for which the evidence of climate change's influence is strong (see Figure 3), and all over the world heat waves are occurring more frequently. A study has found that global warming has contributed to the severity and probability of about 80 percent of record-hot days globally over the 1961-2010 period.[20]

Wildfires

Warming temperatures and drier soils, important factors in wildfires, have contributed to increases in area burned, number of large wildfires, and wildfire season length. Other factors such as wind, land use, and forest management also play roles in determining wildfire risk.

More frequent and extensive wildfires pose threats to lives, critical infrastructure, and property. According to the NCA4, the area burned in the Western U.S. between 1984 and 2015 was twice what it would have been without climate change[21] (Figure 7). In October 2017, more than a dozen fires burned through northern California, killing dozens of people and leaving thousands more homeless. The poor air quality as smoke plumes darkened skies caused the cancellation of school and other activities across the region. The Tubbs Fire, which burned parts of Napa, Sonoma, and Lake counties, was the second most destructive in California's history, with an estimated $1.2 billion in damages, including the destruction of over 5,000 structures. The Camp Fire of 2018 surpassed it in number of structures and acreage burned, and in number of deaths[22].

[19] https://science2017.globalchange.gov/

[20] Diffenbaugh, N. S. et al. 2017. Influence of global warming on extreme events. Proceedings of the National Academy of Sciences, 114 (19) 4881-4886; DOI: 10.1073/pnas.1618082114

[21] https://nca2018.globalchange.gov/chapter/25/

[22] http://calfire.ca.gov/communications/downloads/fact_sheets/Top20_Deadliest.pdf

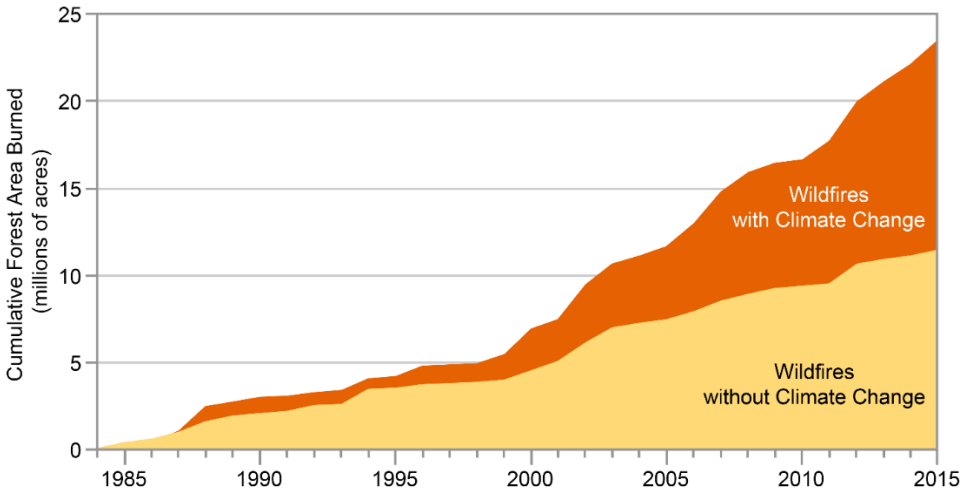

Figure 7: Cumulative area burned by wildfires in the Western U.S.[23]

Drought

Droughts have always occurred, but they are now occurring at higher temperatures, causing massive die off of forest species in the 4-corners region (trees that were centuries old and experienced droughts before). California is suffering massive losses in its agricultural system due to a multi-year drought, and the flow of the Colorado river has been reduced due to higher temperatures.

According to the NCA4, during 2010–2015, a regional drought impacted agriculture in the Southern Great Plains, with soybeans fields in Texas severely affected due to the reduction of irrigation water released for farmers on the Texas coastal plains.

Equity Considerations

Climate change can exacerbate historical inequities, environmental injustice, and environmental racism. Disadvantaged segments of the population already face big challenges recovering from disasters, due to lack of resources and historical disenfranchising, and disasters make these challenges worse. A recent analysis of U.S. government recovery programs showed that "white Americans and those with more wealth often receive more federal dollars after a disaster than do minorities and those with less wealth."[24] Also, a recent study showed that “natural hazard damages and how relief is provided afterward [in the U.S.] exacerbate the growing gap between white and black wealth.”[25]

[23] https://nca2018.globalchange.gov/chapter/25/#fig-25-4
[24] https://www.npr.org/2019/03/05/688786177/how-federal-disaster-money-favors-the-rich
[25] Howell, J., & Elliott, J. R. (2018). As Disaster Costs Rise, So Does Inequality. Socius. https://doi.org/10.1177/2378023118816795

Children, older adults, people of color, and fixed and low-income communities are often at greater risk. The latter are often located in riskier areas that may be more prone to flooding, such as the Lower Ninth Ward in New Orleans, which flooded heavily during Hurricane Katrina, or have fewer public services and resources necessary for recovery from disasters. In Puerto Rico, when hurricane Maria hit, almost 3,000 residents died, the majority for lack of access to medical services.[26]

Extra attention must be paid to ensure that the vulnerabilities of these frontline communities are identified and addressed.

Action is Needed on both Adaptation and Mitigation

Ignoring climate change will not make it go away or lessen its impacts. Only action on both adaptation (reducing and preparing for the risks) and mitigation (reducing heat trapping emissions) can make it less damaging to our lives, our health, our economy, and our planet.

Thank you for this opportunity to speak with you today. I look forward to your questions.

[26] https://publichealth.gwu.edu/sites/default/files/downloads/projects/PRstudy/Acertainment of the Estimated Excess Mortality from Hurricane Maria in Puerto Rico.pdf