United States House of Representatives
Select Committee on the Climate Crisis

Hearing on May 23, 2019
"Creating a Climate Resilient America"

Questions for the Record

Dr. Noah Diffenbaugh
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The Honorable Kathy Castor

1. **China's increasing emissions were raised in the hearing. Can you provide additional perspective on China's emissions and what impact they should or should not have on U.S. climate policies?**

ANSWER: While it is true that China's emissions have been increasing (along with those of many other countries, and the global total), there are a number of important aspects to consider as Congress deliberates US climate policies. Many of the relevant datasets are provided by the Global Carbon Project. In addition to the information below, I refer you to their most recent *Global Carbon Budget*.[1]

We know from the fundamental physics of Earth's energy balance that the warming of the planet is approximately proportional to the total cumulative greenhouse gas emissions.[2] As a result, stabilizing the global temperature – and thus the global climate system – very likely requires reaching net-zero emissions.[3,4] As the figures on the following page illustrate, the US has contributed the largest share (25%) of the world's total cumulative fossil fuel emissions, meaning that we are the largest contributor to the global warming that has already occurred. (And, as I articulated during my testimony on May 23, 2019, US citizens are already experiencing acute impacts from that global warming.)

In addition to being the largest historical emitter, according to the Global Carbon Project the US remains the largest emitter per capita, with annual per capita emissions that are more than twice as large as China or the EU, and almost 10 times as high as India.[1] Further, it is also important to consider that, in addition to having much larger per capita emissions than China, the US also

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[1] Global Carbon Project, *2018 Global Carbon Budget*: https://www.globalcarbonproject.org/carbonbudget/18/presentation.htm

[2] Matthews, H.D., Gillett, N.P., Stott, P.A. and Zickfeld, K., 2009. The proportionality of global warming to cumulative carbon emissions. Nature, 459(7248), 829-832.

[3] Matthews, H.D. and Caldeira, K., 2008. Stabilizing climate requires near-zero emissions. *Geophysical research letters*, *35*(4), https://doi.org/10.1029/2007GL032388.

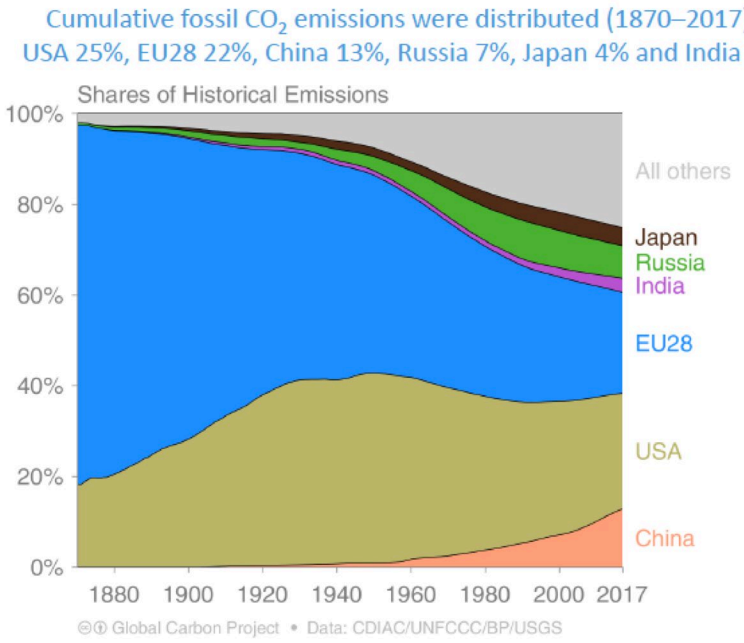
[4] Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M., 2013. Climate Change 2013: The physical science basis. Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

consumes products that are produced in China, and in other countries around the world. When the emissions that are embodied in these products are also considered, the total emissions associated with consumption in the US (and in the EU) are even greater than the respective territorial emissions, while the total emissions associated with consumption in China (and in India) are lower than the respective territorial emissions.

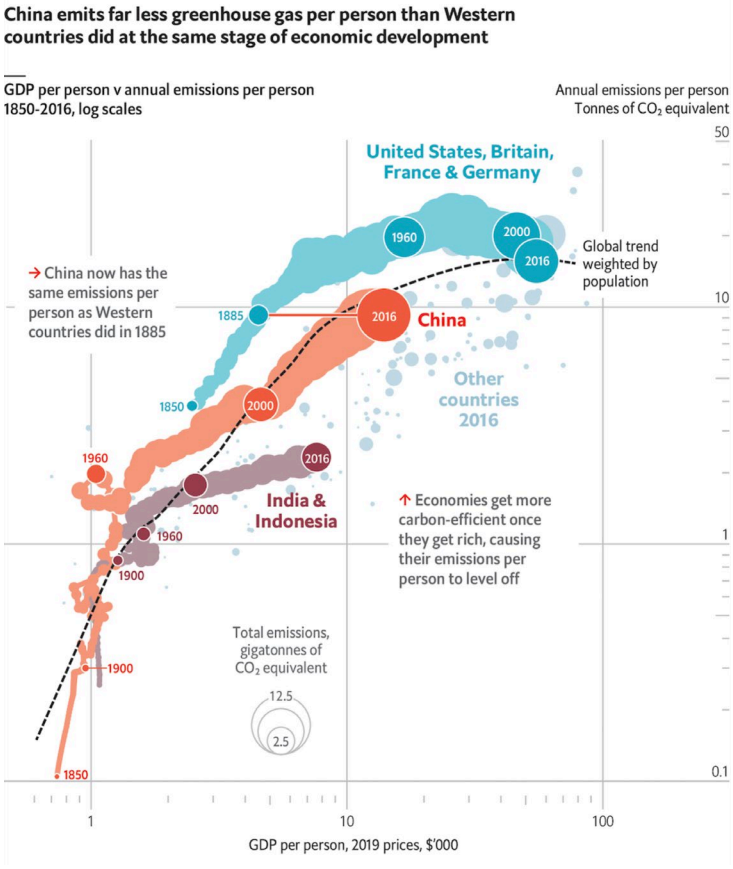
Further, it is also important to consider the emissions intensity of the economy of each country. As is illustrated in the chart published by *The Economist* in May 2019 (reproduced below), China – and India and Indonesia – are curbing their emissions much earlier in their respective economic developments than the US and other OECD countries. For example, as the chart shows, China's per capita GDP is currently similar to the per capita GDP of the US and large European economies during the mid-20th century. However, China's emissions are currently approximately half of what the emissions of the US and large European economies were during the mid-20th century. As a result, in addition to having lower per capita emissions, China is much more economically efficient in its emissions than the US, and is in fact curbing its emissions much earlier in its long-term economic trajectory.

A final point of context is that, because greenhouse gases are well-mixed throughout the global atmosphere, they affect the global energy balance, and thus climate around the world. As a result, US citizens are exposed to the climate change caused by all global emissions. As stated above, the US has accounted for 25% of the total global emissions to date, and we remain the largest per capita emitter. The future trajectory of US emissions will thus contribute very strongly to the climate risks that Americans experience in the future, with greater US emissions contributing to greater risks. (For a summary of these risks, please refer to my testimony on May 23, 2019.) Further, in addition to being exposed to the climate change caused by future US emissions, Americans are also exposed to the climate change caused by the emissions of all other countries. Put simply, the greater the total global emissions, the greater the climate change that will occur in the US, and the greater the risks to US citizens.[5] As a result, even if one views the Chairwoman's question of US climate policies only from the perspective of risks in the US, there is clear evidence that policies that reduce the total global emissions will reduce the future risks to Americans.

[5] Diffenbaugh, N.S., 2013. Human well-being, the global emissions debt, and climate change commitment. *Sustainability Science*, *8*(1), pp.135-141.



Historical cumulative emissions for different economic regions of the world. The US has been responsible for a quarter of all of the historical emissions, which is almost double China's cumulative total. (Global Carbon Project 2018 Carbon Budget)



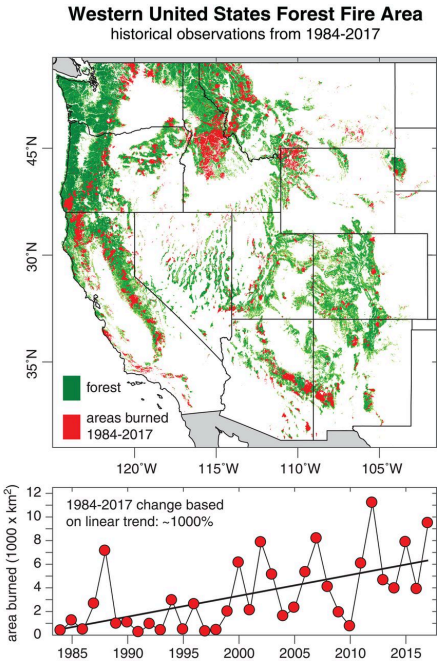
Level of emissions at different stages of economic development. China emits less per person than the US, and also emits less than the US did at a similar level of per capita GDP. (*The Economist*, May 25, 2019*)*

The Honorable Suzanne Bonamici

1. **Like California, Oregon has faced horrific wildfires over the last few years and, unfortunately, it is becoming the norm. Last summer, our region known for its damp and green landscapes was suppressed by an orange blanket of haze. Surrounded by plumes of smoke moving south from British Columbia, north from Southern Oregon and California, and east from the Cascades, air quality in the Portland metropolitan area was recorded at levels unhealthier than Mumbai, Jakarta, and every major industrial city in China.**

   Dr. Diffenbaugh, what are the economic and health consequences of wildfires?

ANSWER: During my testimony on May 23, 2019, I summarized results of a recent review that my colleagues and I conducted evaluating the scientific evidence underpinning the EPA's "Endangerment Finding" for greenhouse gases.[6] As is summarized in that peer-reviewed paper, the area burned in the western United States has increased approximately tenfold since the mid-1980s (see attached figure). Further, evidence shows that "human-caused climate change caused over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984."[7]



Area burned by wildfires in the western United States since the mid-1980s. (From Duffy, Field, Diffenbaugh, et al., *Science*, Vol. 363, Issue 6427, eaat5982, 2019.)

These wildfires have proved very costly. For example, according to the National Oceanic and Atmospheric Administration (NOAA), the 2018 western wildfires had a CPI-adjusted cost of $24.5 billion, while the 2017 western wildfires had a CPI-adjusted cost of $18.7 billion.[8]

In addition to the high financial losses caused by of catastrophic wildfires, we also know that the historical increases in area burned have been accompanied by rising costs of fire suppression. For example, as reported in the National Climate Assessment, both the total US burned area and federal spending on fire suppression have increased fourfold over the past 30 years, with suppression costs rising reaching approximately $2 billion/year in recent years (see attached figure).[9]

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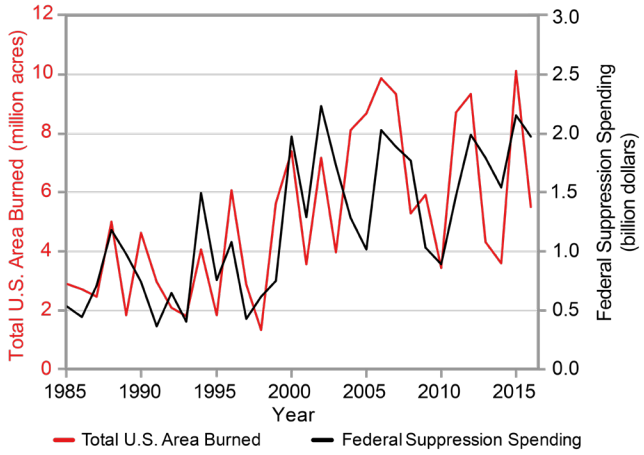
[6] Duffy, P.B., Field, C.B., Diffenbaugh, N.S., et al., 2019. Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases. *Science*, *363*(6427), eaat5982.

[7] Abatzoglou, J.T. and Williams, A.P., 2016. Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, *113*(42), pp.11770-11775.

[8] *NOAA Billion Dollar Weather and Climate Disasters*, Table of Events: https://www.ncdc.noaa.gov/billions/events/US/1980-2019

[9] *Fourth National Climate Assessment*, Chapter 6 "Forests": https://nca2018.globalchange.gov/chapter/6#fig-6-4

Beyond the direct financial costs, it is also clear that wildfires have substantial health consequences. A recent review concluded that, "Consistent evidence from a large number of studies indicates that wildfire smoke exposure is associated with respiratory morbidity with growing evidence supporting an association with all-cause mortality."[10] This finding confirms what so many US citizens have experienced first-hand in recent years: that wildfires can have far-reaching health consequences beyond the geographic area where the fires occur. In addition, of relevance for decisions about the management of wildfire risks, evidence is now emerging that health impacts of wildfires are greater than health impacts of prescribed burns.[11]



Historical federal suppression spending (constant 2016 dollars) and total US area burned. (From the Fourth National Climate Assessment)

Although further research is needed to quantify and project the full costs of rising wildfire frequency in different areas of the US, we already have very strong evidence that wildfires are increasing, and anthropogenic climate change is contributing to that increase, and that costs associated with wildfires are increasing.

[10] Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. 2016. Critical review of health impacts of wildfire smoke exposure. *Environmental Health Perspectives* 124:1334–1343; http://dx.doi.org/10.1289/ehp.1409277

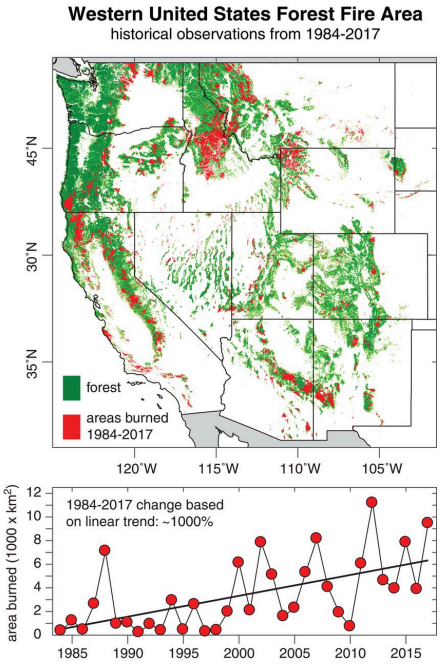
[11] Prunicki, M., Kelsey, R., Lee, J., Zhou, X., Smith, E., Haddad, F., Wu, J. and Nadeau, K., 2019. The impact of prescribed fire versus wildfire on the immune and cardiovascular systems of children. *Allergy*. DOI: 10.1111/all.13825

The Honorable Mike Levin

1. **Dr. Diffenbaugh, you responded to Representative Brownley saying that recently half the wildfire area burned in California is due to the rising temperature, and you expect this trend to continue.**

   Many Members on this committee are concerned about the cost of inaction on climate, and I believe it is important to understand the degree to which wildfire costs should be included in that cost of inaction. Have you or your colleagues quantified the financial costs associated with the greater burned area driven by climate change?

ANSWER: During my testimony on May 23, 2019, I summarized results of a recent review that my colleagues and I conducted evaluating the scientific evidence underpinning the EPA's "Endangerment Finding" for greenhouse gases.[12] As is summarized in that peer-reviewed paper, the area burned in the western United States has increased approximately tenfold since the mid-1980s (see attached figure). Further, evidence shows that "human-caused climate change caused over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984."[13]



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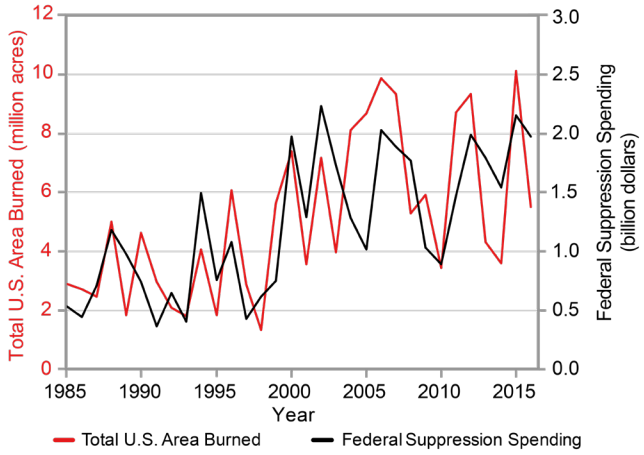

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2. **During the hearing, Rep. Levin asked the following question: "What types of projects and programs would you like to see in a discussion of a climate change resilient infrastructure bill?" You responded: "I would point you to the California Climate Safe Infrastructure Working Group, AB 2800, and our report that was released last summer." Please provide that report.**

ANSWER: The reference for the report is:

Climate-Safe Infrastructure Working Group (CSIWG). 2018. Paying it forward: The Path Toward Climate-Safe Infrastructure in California. Report of the Climate-Safe Infrastructure Working Group to the California State Legislature and the Strategic Growth Council. Sacramento, CA: CNRA, Publication number: CNRA-CCA4-CSI-001.

The report is available from the California Natural Resources Agency at this website: http://resources.ca.gov/climate/climate-safe-infrastructure-working-group/

[16] Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. 2016. Critical review of health impacts of wildfire smoke exposure. *Environmental Health Perspectives* 124:1334–1343; http://dx.doi.org/10.1289/ehp.1409277

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