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The tragedy of climate change science

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ABSTRACT

The science-society contract is broken. The climate is changing. Science demonstrates why this is occurring, that it is getting worse, the implications for human well-being and social-ecological systems, and substantiates action. Governments agree that the science is settled. The tragedy of climate change science is that at the same time as compelling evidence is gathered, fresh warnings issued, and novel methodologies developed, indicators of adverse global change rise year upon year. Meanwhile, global responses to Covid-19 have shown that even emergent scientific knowledge can bolster radical government action. We explore three options for the climate change science community. We find that two options are untenable and one is unpalatable. Given the urgency and criticality of climate change, we argue the time has come for scientists to agree to a moratorium on climate change research as a means to first expose, then renegotiate, the broken science-society contract.

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Climate change; global change; science-society contract; transformation

Introduction

The science-society contract is broken. Life on Earth is jeopardized by the impacts of human activities, including climate change, biodiversity loss, and unsustainable resource exploitation (IPBES, 2019; IPCC, 2018; IPCC, 2019a; IPCC, 2019b; IPCC, 2021; WWF, 2018). Decades of global change research, and climate change science in particular, is unequivocal: the Earth is in a perilous state, human impacts are pervasive and worsening, a climate emergency is at hand, and urgent action is imperative. Governments agree that the science is settled.

Hope is always, however, at hand. The election of President Biden created new momentum for transformative action. The most recent Intergovernmental Panel on Climate Change (IPCC) reports and COP 26 similarly provide a fresh chance to embed climate change science into national political priorities and policy. Even Covid-19 has provided a window of opportunity to restructure economies and budgets away from reliance on fossil fuels. We argue that while these hopes and discourses are seductive, they are also uncannily similar to previous hopes, which were raised, but which led to disappointment for many: The election of President Obama. Previous IPCC reports and international agreements. The Global Financial Crisis as an opportunity to reset the political economy.

The tragedy of climate change science is that compelling evidence is gathered, fresh warnings issued, new institutions established and novel methodologies developed to redress the problems. Yet, greenhouse gas emissions and, other indicators of adverse climate change, and global change more broadly, rise year upon year. Meanwhile, global responses to Covid-19 have shown that even emergent scientific knowledge can bolster radical government action (Bouman et al., 2021; Ebi et al., 2021; Schipper et al., 2021). It may be because Covid-19 began as an acute problem, while climate change was originally framed as chronic. However, given the urgency and criticality of climate change, we argue the time has come for scientists to agree to a moratorium on climate change research as a means to first expose, then reconfigure, the broken science-society contract.

Governments concur that the science is settled on the reality of global change. Consensus dates back at least to the 1972 Stockholm Conference, was reiterated at the 1992 and 2002 Earth Summits, and in subsequent global agreements, including the United Nations Framework Convention on Climate Change (UNFCCC) 2015 Paris Agreement and Aichi Biodiversity Targets (2011–2020). Yet, the deleterious indicators of adverse global change continue to rise relentlessly. Planetary boundaries are being transgressed (Rockström et al., 2009; Steffen et al., 2015). Vestiges of inevitable scientific uncertainty are being exploited by 'merchants of doubt' (Oreskes & Conway, 2010). This is a tragedy for humanity, for current and future generations, and for life on Earth. It is also a tragedy of and for science, especially climate change science.

There is an unwritten social contract between scientists and society, whereby public investment in science will lead to an improved understanding of our world and help achieve outcomes that are deemed beneficial to society (Lubchenco, 1998). The public health response to Covid-19 is an example of this relationship functioning effectively in some countries (Bouman et al., 2021). However, it is clear that despite scientific success in advancing understanding about various aspects of global change, notably climate change, scientists have been

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spectacularly unsuccessful at bridging the science-policy interface. For climate change, the science-society contract is irrevocably broken. The failure to arrest global warming is an indictment on successive governments and political leaders of all persuasions. It is a breach of the science-society contract. But, as with all contracts, both parties have important roles and responsibilities. Climate change science cannot be absolved of blame.

The tragedy of climate change science

The scientific community has responded effectively to the global change challenges that became increasingly apparent in the second half of the twentieth Century. Taking climate change as an example, scientists rapidly provided foundational knowledge regarding the biogeochemical state of the planet and catalogued the phenomenon and effects of global warming. The scientific endeavour then expanded to understanding the societal drivers of climate change, its impacts and risks, and adaptation and mitigation responses.

New scientific institutions have been established to inform governments. The first Assessment Report of the IPCC, published in 1990, concluded with certainty that human activities were substantially increasing the concentration of greenhouse gases and warming the earth's surface (IPCC, 1990). This led to the UNFCCC which was established in 1992 and designed to stabilize greenhouse gas concentrations to prevent dangerous changes to the climate. Yet, global annual greenhouse gas emissions continue to grow (Friedlingstein et al., 2019; IPCC, 2018; IPCC, 2021). Since the IPCC's first Assessment Report in 1990, global CO^2 emissions have increased a further 67% (Crippa et al., 2020).

Partly in response to governmental inaction, there have been shifts in how climate change research is designed and conducted to better inform policy and practice. Scientists are encouraged to work more closely with citizens, governments and other stakeholders to tackle societal problems through co-creation to bridge local, Indigenous and scientific knowledges, and address societal concerns (Gibbons, 1999). Advances in alternative research approaches, such as post-normal science (Funtowicz & Ravetz, 1993), have similarly sought to identify and reconcile the political and governance issues that may affect the incorporation of science into policy and practice (Jasanoff, 2004). There has also been considerable improvement in climate change science communication (Moser, 2016).

Other strategies aiming to address the failing science-society contract have focused on advocacy and activism. NASA scientist James Hansen's 1988 testimony on climate change to the US Congress garnered international media and public attention. The lack of response to scientific evidence led Hansen and others to turn to public protest and even resulted in his arrest. There are myriad examples of other scientists who have turned to direct action via advocacy and activism. Similarly, there are numerous public exhortations to heed the warnings of climate change science by people like Al Gore and Greta Thunberg. Yet, regardless of the strategy adopted, governments have not yet heeded the calls for urgent climate action (IPCC, 2018; IPCC, 2019a, 2019b, 2021) (Figure 1).

What next for climate change science? Do researchers continue to provide ever more data, novel collaborations and forms of outreach, and participate in more marches and petitions, hoping that governments will respond to the scientific consensus, mounting impacts and growing urgency for action? Most scientists appear to support this strategy, heeding calls to redouble scientific endeavours or to adjust the science-society contract (DeFries et al., 2012; Gibbons, 1999; Lubchenco, 1998). Until recently, we did too. This is the tragedy of climate change science: the compulsion to do ever more research on climate change when the science-society contract is broken. The tragedy is continuing research when the problem is political, diverting attention away from where the problem truly lies, and being gaslighted into crafting new scientific institutions, strategies, collaborations and methodologies.

In their responses to the shock of Covid-19, some governments have shown that they can swiftly enact transformative action, and in doing so held a mirror to the comparable failure to address other crises. Despite a lack of science or uncertainty about the impacts of action versus inaction, governments acted on the warnings of scientists, even when they could only provide partial answers to the pandemic. The shift in focus from public health to economic recovery provides a further opportunity. The scale of emerging fiscal recovery packages will not only shape the nature of the global economy, it will shape the future of socio-ecological systems, and trajectories of climate and global change. Will government responses accelerate or reverse the drivers of environmental change?

Three options for climate change science

So what now for the science-society contract? As members of the scientific community, how should we respond to the mounting evidence of decline and lack of transformational government action? We see three possible options for climate change science.

The first is continuation of climate change science as usual. We carry on. Deliver more science. Collect more evidence of deleterious impacts. This option is founded on hope of action. There are always forthcoming agreements and the possibility of political shifts. There are small policy gains unfolding in different places in different ways. We invest in new ways to better communicate science. We continue with the IPCC assessment process and general positioning, and endeavour to stay politically neutral and avoid being policy prescriptive. However, this option continues the naive demarcation between the practice of science and the politics of policy-making (e.g. Jasanoff, 2004). Given that climate change science is 'settled', and has been for decades, we argue that this course runs counter to our own scientific training of collecting and reflecting upon the evidence. The evidence shows that the science-society contract is broken. The first option is therefore not tenable.

The second option is intensified social science research and advocacy on climate change. It focuses on better understanding why action has not occurred, and how to enable the

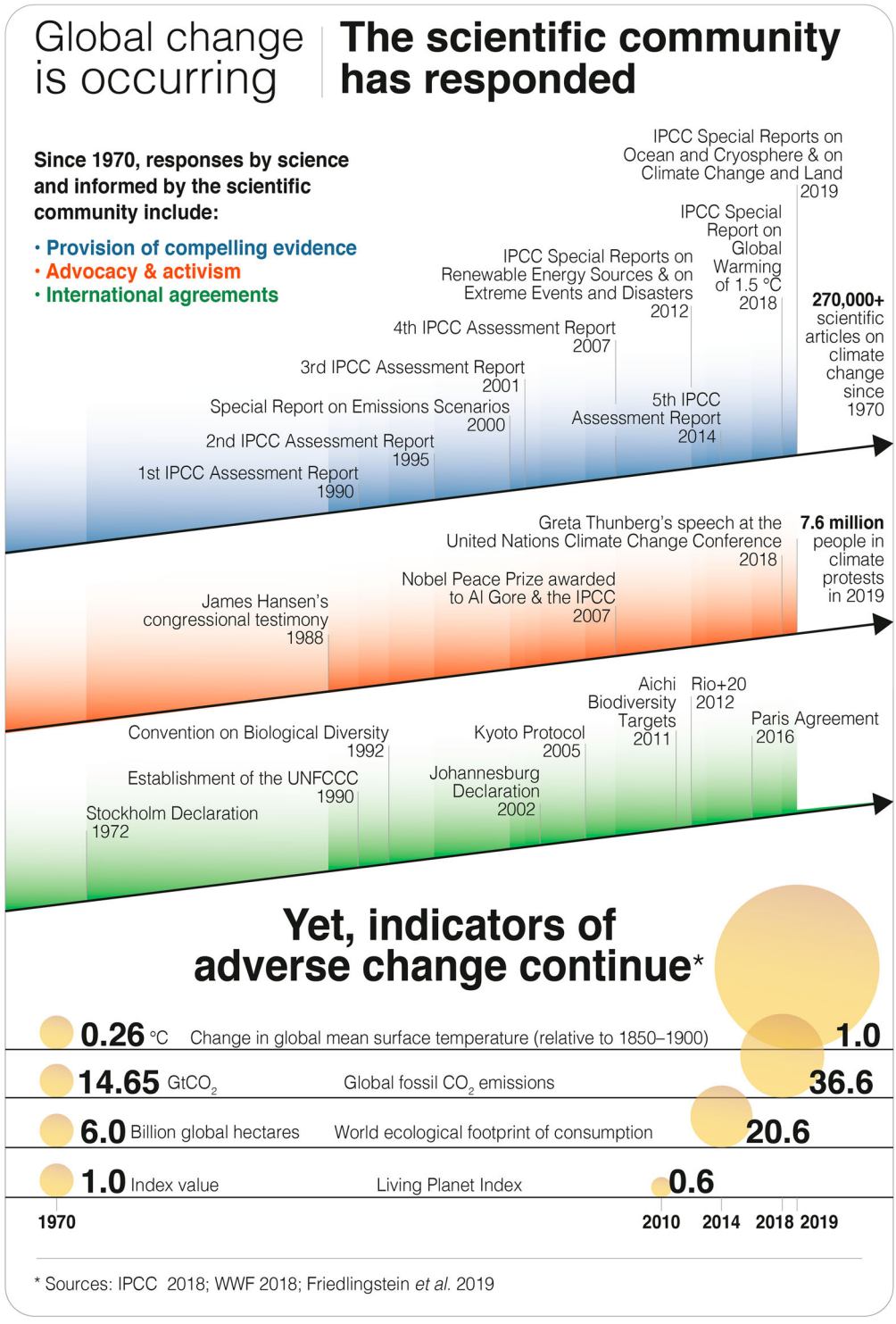

Figure 1. The tragedy of climate change science. Governments concur that climate change is occurring. Yet scientists are compelled to do more research. The tragedy is conducting more climate change research even when the science is settled. Governments need to take action to halt global warming and enable transformational adaptation and climate resilient development.

behavioural and institutional changes required to contain global warming and climate change impacts. To date, funding has been dominated by the natural and technical sciences (Overland & Sovacool, 2020). Concentrated funding and research effort in the social sciences and humanities lies at the heart of this pathway. We recognize that in recent decades much more work is being done in this realm by political scientists, sociologists, economists, human geographers and the like, and this has exposed the powers and vested interests that have impeded climate action (e.g. Supran & Oreskes, 2021). In parallel there has been a recognition among both scientists and the public of the need for increased advocacy by the scientific community (Cologna et al., 2021). However, even with more social science research, scientific advocacy and significant support from civil society, there have been no signs of systemic change in government action. There is no evidence that

more social science research and traditional forms of advocacy will lead to transformative action within the timeframes required to avert dire climate change consequences. The second option is therefore also not tenable.

The third option is much more radical. Climate change science is settled to the point of global consensus. We have fulfilled our responsibility to provide robust knowledge. We now need to stop research in those areas where we are simply documenting global warming and maladaptation, and focus instead on exposing and renegotiating the broken science-society contract. The IPCC's 6th Assessment will be completed in 2022. Will the response to this assessment be any different to the previous five assessments? Nothing indicates that this will be the case. In fact, given the rupture of the science-society contract outlined here, it would be wholly irresponsible for scientists to participate in a 7th IPCC assessment. We therefore call for a halt to further IPCC assessments. We call for a moratorium on climate change research until governments are willing to fulfil their responsibilities in good faith and urgently mobilize coordinated action from the local to global levels. This third option is the only effective way to arrest the tragedy of climate change science.

The three options we set out here are either untenable or unpalatable. Readers may well agree with the nature of the tragedy of climate change science outlined here but disagree with our analysis of viable options. Some may want greater detail on what a moratorium could encompass, or argue for expanding traditional forms of advocacy. Equally, while some may see the third option as damaging the credibility and objectivity of the scientific community, we see this option as a new powerful possibility for scientific advocacy and a further means by which scientists can act in the public interest when all other avenues have failed. The moratorium will be hard, and there will be short-term pain for researchers, with an uncomfortable spotlight on the scientific community. Questions will be raised regarding whether it is our 'duty' to use public funds to continue to improve the state of climate change knowledge, or whether a more radical approach will serve society better? We argue that a critical juncture has now been reached for human and planetary well-being. Given the tragedy of climate change science outlined here, a moratorium offers the only real prospect for restoring the science-society contract. Other options are seductive but offer false hope.

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Author contributions

Each co-author contributed equally to this research.

Data and materials availability

All data is available in the main text or the supplementary materials.

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