CLIMATE RESPONSIBILITY

Fair shares?

Climate and carbon debts are one way to identify contributions to climate change. But they must be seen as part of a larger body of research assessing international responsibility.

Jan S. Fuglestvedt and Steffen Kallbekken

Delegates will meet in Paris in December for the latest round of international negotiations aiming to design a new global climate policy framework. Once again, there will be debate over the amount different countries should contribute to the international climate policy effort. Research can play a key role in informing this debate, but should be wary of crossing the fine — and crucial — line between policy-relevant research and political debate.

The UN Framework Convention on Climate Change (UNFCCC) established that countries' actions should be guided by "common but differentiated responsibilities and respective capabilities"[1]. There has been a substantial scientific debate on differentiation (often referred to as 'burden sharing' or 'effort sharing') since the early 1990s. In particular, a 1997 proposal by Brazil to assign mitigation targets (to developed countries) based on historical contributions to climate change triggered a body of research[2–5]. One of the key insights from this work is that, in addition to scientific and data uncertainties, several methodological choices — scientific and policy related — have significant impacts on calculated warming contributions.

In *Nature Climate Change*, Damon Matthews[6] adds to this field[7] by applying the concept of carbon and climate debts (and credits) to a range of countries. Previous studies typically present the contributions to historical warming as shares of total global man-made impact[2–4]. Matthews, however, quantifies contributions using carbon and climate debts, defined as the amount by which contributions have deviated from hypothetical equal per capita shares over time. He focuses on the "over- or under-contribution" of each country to warming relative to this benchmark.

Matthews' measurement implies that if per-capita emissions were equal, there would be no debts or credits. It also implies that any country under-contributing is owed some right (a credit) to emit more or to receive some form of compensation. This ignores the common responsibility that would exist if all countries had equal per capita emissions, as well as different capabilities.

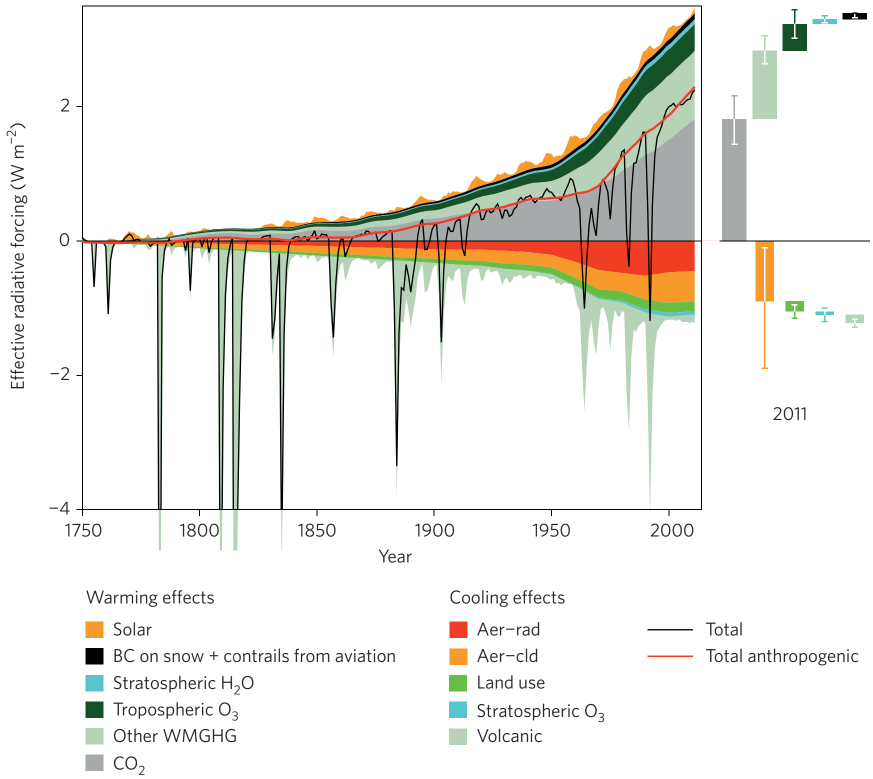

Figure 1 | Evolution of forcing for anthropogenic and natural forcing mechanisms through time. The graph shows that CO_2 is the main driver of anthropogenic climate change, while other GHGs and tropospheric ozone also contribute significantly. In addition to the warming components, human drivers have also caused cooling. Bars with the forcing and 5 to 95% confidence range (whiskers) for 2011 relative to 1750 are given in the right panel of the figure. WMGHG, well-mixed greenhouse gases; BC, black carbon; Aer-rad, aerosol–radiation interaction; Aer-cld, aerosol–cloud interaction. Figure adapted from ref. 9, IPCC.

Matthews argues that the carbon and climate debt concept "offer[s] a new lens with which to examine historical disparities among countries with respect to their contributions to climate warming". However, this magnifies certain disparities, leaving others out of the frame, and focuses on the differentiated responsibilities to the detriment of the common responsibility.

It is also potentially problematic to use calculations of causal contributions directly to infer moral responsibility[8]. In particular, Matthews' perspective that some countries have undercontributed could reignite the political posturing that has blocked progress on earlier occasions.

Calculating historical contributions can be difficult. One crucial choice is how far back in time to include historical emissions, which are used to calculate the warming contributions. This is closely related to the question of when policymakers should have known that climate change is a serious problem.

Furthermore, which year should be chosen for evaluating the climate response, and what indicators of climate impact should be used remain undecided. Although emissions, concentrations and radiative forcing are essential and much used, people are more concerned about changes to temperature, precipitation and sea level, not only as global annual means, but also in terms of regional and temporal variability.

A broad set of components have disturbed the climate[9], short- and long-lived, causing both warming and cooling effects (Fig. 1), and it is not obvious which of these to include in calculations of the contributions of countries. The set of gases regulated by the Kyoto Protocol is one option. But what about SO_2, which causes cooling? Should climate credits be given for air pollution?[2,4] These choices have large impacts on the calculated warming contributions.

Most countries support the principle of common but differentiated responsibilities and respective capabilities. When it comes to putting the principle in policy, however, interpretations diverge — often as a reflection of countries' material interests[10].

Searching for a single formula to define responsibility is therefore unlikely to succeed[11]. The Lima call for climate action instead asks countries to define what they consider to be a fair contribution[12]. In this setting, research to explore the implications of different ways of operationalizing fairness principles, including one based on warming contributions, is useful.

Matthews finds that with a wider range of emissions beyond CO_2, some countries change from creditors to debtors. This illustrates a further challenge in applying calculated warming contributions in a political context: The methodological choices have substantial implications for the calculated warming contributions and potentially also for policy.

Matthews' calculations also focus on short time scales; that is, start dates of 1960 and 1990. These time scales only cover approximately 66 and 36%, respectively, of total accumulated CO_2 emissions from 1750 to 2013[13], thereby omitting a large share of historical drivers of anthropogenic climate change (Fig. 1). Choosing earlier start-dates would have captured the early emissions related to deforestation and the Industrial Revolution, which changes the picture[2,3].

Research has a crucial role to play in informing the policy debate on differentiation of climate policy contributions. Matthews' research represents one of the multiple approaches that can serve this function. However, there are problems with using the concept of carbon and climate debts to inform debates over "who should pay" for the costs of mitigation[6], adaptation or loss and damages in countries with lower historical emissions. Instead, research on warming contributions and capabilities that encompasses a broad set of lenses could better help negotiators reach an agreement in Paris. ❐

Jan S. Fuglestvedt and Steffen Kallbekken are at the Center for International Climate and Environmental Research, Oslo (CICERO), Norway. e-mail: j.s.fuglestvedt@cicero.oslo.no; steffen.kallbekken@cicero.oslo.no

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Published online: 7 September 2015

SOUTH ASIAN MONSOON

Tug of war on rainfall changes

Precipitation associated with the South Asian summer monsoon has decreased by approximately 7% since 1950, but the reasons for this are unclear. Now research suggests that changes in land-cover patterns and increased emissions from human activities have contributed to this weakening, which is expected to continue in the coming decades.

Deepti Singh

The onset of the South Asian monsoon in early June brings with it a burst of life across the region — children playing on the streets, blossoming flora, flowing rivers, and sowing of agricultural lands. The monsoon supplies ~80% of South Asia's annual rainfall, supporting the region's primarily rain-fed agriculture and recharging rivers, aquifers and reservoirs that provide water to over one-fifth of the global population. Since the 1950s, the monsoon has weakened[1] and become more erratic, with increased occurrence of extreme rainfall events[2]. This has led to crop failures and water shortages with severe socio-economic and humanitarian impacts across South Asia. Writing in *Climate Dynamics,* R. Krishnan and colleagues[3] suggest that anthropogenic greenhouse gas (GHG) emissions, aerosol emissions and agricultural land-cover changes are responsible for the observed changes in rainfall patterns. They predict that the monsoon weakening will continue through the twenty-first century, threatening the livelihoods and resources of over 1.6 billion people in the region.

Simplistically, the South Asian monsoon can be viewed as a system of moisture-carrying winds driven by the land–ocean thermal contrast that develops as the land heats up faster than the ocean in the summer and by the contrast in sea surface temperatures between the northern and southern Indian Ocean (Fig. 1). As the land heats, the warm, moist air rises over the Indian subcontinent. Heat released from condensing moisture further warms the atmosphere, feeding the monsoon. Increasing emissions from fossil fuel combustion, which include GHGs (such as carbon dioxide) and aerosols (such as sulphates, black carbon and nitrates), can affect the monsoon by modifying these thermal contrasts as well as moisture availability. Relative atmospheric warming near the equator due to GHG emissions reduces these temperature differences, weakening the thermally driven monsoon circulation[4] (Fig. 1). But near-surface warming over the oceans increases the