

Utilitarianism and Climate Change

John Broome

Guest essays represent only the views of the author(s).

Table of Contents

1. The focus on emissions
2. The social cost of carbon
 - Monetary measurement
 - Uncertainty
 - Comparing the well-beings of different people
 - Well-being of non-human animals
 - Persistence of carbon dioxide
 - Deaths
 - Births
3. Life lost
4. Utilitarianism and private morality
5. Utilitarianism and public morality
6. References

The focus on emissions

How does utilitarianism tell us to respond to climate change? This is a question about the actions of individuals and also the actions of governments and the international community. At every level, how should we act?

This question is simplified by the fact that the causal process of climate change passes almost entirely through a single channel: the global emissions of greenhouse gas. This means that, in applying utilitarian moral theory to climate change, we can focus our attention principally on the causes and effects of global emissions. In this essay, I start with the effects and examine what are the benefits of reducing emissions. With this information in hand, I turn to the causes and consider what we ought to do to reduce emissions.

Our response to climate change cannot be aimed solely at this single causal channel through emissions. We also need to make adaptations, which reduce the bad effects of emissions without reducing the emissions themselves. For example, it may be possible to build a sea wall around low-lying areas of land, to save them from flooding. Now that very harmful climate change is becoming progressively more inevitable, adaptation is becoming a more essential part of the right response to it. Nevertheless, this essay focuses on reducing emissions.

Even this focus is not completely sharp. There is not just one quantity of emissions to focus on, because not all emissions are equal in their effects. Emissions at different *places* are pretty much equal, because greenhouse gas stays in the atmosphere long enough to become thoroughly mixed around the globe. But emissions at different *times* are not equal. Empirical evidence from modelling tells us that the timing of emissions makes little difference to the degree of global warming that will eventually be reached, but it does make a difference to the date when it will be reached, and that is morally significant. Also, emissions of different *sorts* of greenhouse gas have very different effects. Some gases are much more powerful heat-traps than others, and some persist in the atmosphere much longer than others.

I shall concentrate on the current emissions of carbon dioxide. Carbon dioxide is the most abundant and most important greenhouse gas apart from water vapour, whose abundance is not directly affected by human beings. Moreover, conclusions about carbon dioxide can be partially extended to other gases by assigning each gas a ‘carbon dioxide equivalent’. The equivalence cannot be exact, because of the gases’ different lifetimes in the atmosphere, but it provides a useful approximation.

The social cost of carbon

I start with the effects of carbon dioxide emissions. We need to know how much benefit—measured in utilitarian terms—is to be gained by reducing these emissions. We can ask specifically how much a one-tonne reduction in emissions would add to the total [well-being](#) of the world.

It will be useful to have a concrete, quantitative answer to this question. Only that way can we compare action on climate change with other actions from a utilitarian point of view, to [determine their relative priorities](#). Given the state of our empirical knowledge, a quantitative answer can at best be very rough. But we do at least have a place to start from. For some decades, economists have been trying to answer the question, and we can benefit from their work.

Economists call the quantity we are looking for ‘the social cost of carbon’. This term refers to the harm done by increasing emissions rather than the benefit gained by reducing emissions, but that is the same thing. Technically it is ‘the social cost of carbon dioxide’ but the briefer term is common. The economists’ approach to working it out is to predict how climate change will develop as a result of emissions, and to predict the consequences for people and societies, using models that integrate physics, biology and economics. Then they set a value on the predicted consequences.

Are these economists really thinking in utilitarian terms? Is the social cost of carbon really meant to be the cost in terms of lost well-being, as utilitarianism requires it to be? Economists use the words ‘welfare’ or ‘utility’ more often

than 'well-being'. Nevertheless, many of them are broadly utilitarian; they want to make people better off. The damage done to well-being by climate change is what many economists would like to measure, though they generally recognize that existing estimates of the social cost of carbon are far from measuring it accurately.

Various difficulties stand in the way of measuring the damage done to well-being, and of treating existing estimates of the social cost of carbon as measuring it. I shall mention some of them.¹

Monetary measurement

The social cost of carbon is measured in money: a number of US dollars. You might think that dollars are simply not a measure of well-being. But a measurement has to be expressed in terms of some unit, and dollars are not a bad one. In a sense, people buy well-being with dollars. Very often, the price a person is willing to pay for some commodity indicates how much she expects the commodity to contribute to her well-being. Since the price a person is willing to pay is often easily observable from the price she actually does pay, dollar prices are a reasonable starting point for measuring well-being. They also have the advantage of measuring the benefit of reducing emissions on the same scale as the cost of reducing emissions, which is often naturally measured in money. So this is more a point to be noted than a real difficulty

Still, economists' use of dollars does indicate that they think of the social cost of carbon as primarily an economic cost. They are concerned with well-being, but primarily well-being that arises from economic sources. Their work generally starts by estimating the effect of emissions on gross domestic product.

Uncertainty

Carbon dioxide stays in the air for centuries, and continues to affect the weather while it does so. But the weather is extremely unpredictable even after

a few days. It is absolutely unpredictable what will be the effect of reducing emissions today on the weather years ahead. Moreover, the effect of the weather on people's well-being depends on the details of how society develops, which are equally unpredictable over a span of centuries.

Suppose you were to reduce emissions by one tonne today, say by cancelling a planned trip. Your act might be extremely beneficial; perhaps you might prevent a hurricane that would otherwise have swept through a city in a hundred years. It might even be extremely harmful, perhaps diverting a hurricane on to a more devastating track. Or it might bring about good or bad results of any degree in between. It is [absolutely impossible to predict your effect](#), and even with hindsight it will be impossible in the future to know what it has been.

Fortunately, the climate, which is weather averaged over an extended period, is much more predictable than the weather. Repeated computer simulations of possible future weather, run for a century or more, allow us to map out the relation between present emissions of carbon dioxide and the future climate. They make it plain that decreasing emissions now will lead to decreased average temperatures in the future. Models also predict the effect that changes in future climate will have on aspects of human well-being such as health and economic development. So we have some basis for predicting the average benefit that would result from reducing present emissions. This is the basis of the social cost of carbon. It is an average figure: an expected value.

This is as it should be. When we are deciding on an action, and are uncertain what will be its actual effect, there is good reason to switch attention to its average effect—more precisely to the mathematical expectation of its benefit. Given uncertainty, utilitarianism tells us that we should [promote the expectation of the total of people's well-being](#).² So it is appropriate to make the social cost of carbon an expected value. Uncertainty does not stand in the way of interpreting the social cost of carbon in utilitarian terms.

However, one feature of the uncertainty surrounding climate change is a real difficulty. Climate change may be [catastrophic](#). There is a small chance it will destroy human civilization and even the human species. A proper estimate of expected value needs to take this chance into account, which involves setting [a value on a possible catastrophe](#). Economics does not have an adequate means of doing this. Even though some economists attach great importance to the possibility of catastrophe,³ in estimates of the social cost of carbon it is ignored.

Comparing the well-beings of different people

A person's willingness to pay for something can be a useful indication of how much she expects it to contribute to her well-being. This provides a basis for comparing the potential well-being an individual can derive from different sources. But it gives no basis for comparing and aggregating together the well-beings of different people.

Money has different value to different people. It has less value to the rich than to the poor. A particular sum of money spent by a rich person contributes less to her well-being than the same sum spent by a poor person. The poor person will spend her money on more pressing needs, and [derive greater benefit from doing so](#). The rich person already has her pressing needs satisfied and will spend her money on less urgent things.

For utilitarian purposes we have to [add together](#) the well-beings of different people. In calculating the social cost of carbon, the monetary value of costs falling on different people is added up. But because money has different value to different people, adding up monetary values does not properly represent adding up well-being.

In principle this problem can be fixed by adjusting monetary values before adding them up. This is to apply 'distributional weights' — as economists call them — to different people's monetary values. The Intergovernmental Panel on Climate Change recommends this practice.⁴ But it is complicated to

implement compared with simply adding up unweighted quantities of money, and it is rarely used in calculating the social cost of carbon. This is a serious difficulty.

Well-being of non-human animals

Utilitarians [include the well-being of non-human animals](#) within the total of well-being. But the social cost of carbon includes human well-being only. It cannot include animal well-being because non-human animals do not participate in markets where dollar values are formed. This is a large omission.

Persistence of carbon dioxide

Carbon dioxide is a stable molecule. Once carbon is released from the Earth's geology and sent into the air in the form of carbon dioxide, it takes millions of years before it is naturally returned to the geology. In the meantime most of the carbon dioxide is absorbed into the oceans and into terrestrial sinks, but about a fifth of it persists in the air for centuries, millennia or longer.

Potentially it goes on doing harm for all that time.

On the face of it, this could make the social cost of carbon extremely high. But the effect is very much moderated in the practice of economics by [discounting future goods](#). Future economic goods are given less value than present goods of the same sort. Goods coming more than two hundred years ahead count for almost nothing.

The practice of discounting can be justified by assuming that people in the future will be richer than we are. Because richer people already have more goods, extra goods coming to them are less valuable than they are to us, the present people. However, in the context of climate change we cannot be confident that future people will be richer than us; climate change may make them poorer. Moreover, some of the goods that will be cut off by climate change are just as valuable to rich people as to poor people. The principal example is saving lives. Climate change will kill people. Losing your life is just

as bad for a rich person as for a poor one. If climate change goes on killing for many centuries, this bad consequence cannot justifiably be diminished by discounting. Calculations of the social cost of carbon, which are moderated by discounting, will be far too low.

This is a serious difficulty. However, there is an answer to it. Suppose global warming eventually stops—temperatures do not fall but they stop rising. Thereafter, people will gradually adapt to the temperature that then prevails, whatever it is. Humanity can tolerate a wide range of temperatures: we inhabit the globe from the tropics to the polar regions. Given time, people adapt to the temperature that is average for where they live. When the temperature in a region departs significantly from the local average, death rates rise,⁵ but the average temperature does not kill people. In the long run, once people are adapted to the new warmer temperature of the Earth, we can assume that this temperature will no longer continue to kill.

So provided global warming eventually stops, adaptation sets a bound on the harm it does in the long run. The practice of discounting may even be an acceptable approximation.

Deaths

Climate change will kill many people. It will kill directly through dangerous weather such as hurricanes and floods. It will kill through droughts and famines, and by extending the ranges of tropical diseases. This is one of the worst harms it will do.⁶ It is incorporated into the social cost of carbon. But the way it is incorporated is generally poor.

First, most theories of value, including versions of utilitarianism, imply that, the greater the length of life a person's death takes away from her, the worse the death is. But estimates of the social cost of carbon generally take no account of the amount of life lost.⁷ This is a failing.

A more important failing is that they generally assign less value to deaths in poor countries than in rich ones.⁸ The reason is that they generally base the value of deaths on what people are willing to pay to reduce their chances of dying. People in poor countries are willing to pay less for this benefit than are people in rich countries. But this is no justification for assigning less value to their lives. Poor people are willing to pay less money because money is more valuable to them, not because their lives are less valuable. If monetary values were corrected for the differing value of money to rich and poor, as the IPCC recommends, this differential value assigned to deaths would vanish.

Correcting this unjustifiable discounting of lives in poor countries would probably greatly increase the social cost of carbon. The loss of life is a large part of this social cost, and most of the loss of life caused by climate change will be in poor countries.

Births

Existing calculations of the social cost of carbon ignore [population ethics](#). Implicitly they assume the process of climate change makes no difference to which people get born and what times they get born at. They implicitly assume climate change affects deaths but not births. This is not a plausible assumption.

Policy to limit climate change is bound to affect who gets born. For example, a carbon tax will affect how much people travel. It will influence who meets whom and who has babies with whom. It will change the identities of the people who live in the future. For a utilitarian, this non-identity effect is not a problem. A utilitarian [cares about the well-being of future people](#) but not about their identity. When I mention harms and benefits done by climate change and by climate policies, I do not necessarily refer to harms and benefits of particular people. I refer to the goodness of future people's lives compared with what the goodness of future people's lives would otherwise have been. If they would have been different future people, no matter.

However, climate change and policy to limit climate change are also very likely to alter the numbers of people who live in the future, and not just their identities. [Numbers do matter to a utilitarian](#). A calculation of the social cost of carbon cannot correctly ignore population ethics.

Life lost

All these difficulties imply that the social cost of carbon is far from an accurate measure of the well-being that can be gained by reducing emissions. Most of the difficulties point in the same direction, so that estimates of the social cost are probably serious underestimates. Many factors are left out of them. On the other hand, economists have been working to overcome some of the difficulties. Recent estimates have been improving and getting bigger. A notable recent estimate from Resources For the Future puts the social cost of carbon at \$185 per tonne of carbon dioxide.⁹

There remain many reasons to be dubious of this figure. About half of it stems from the increased mortality caused by global warming,¹⁰ and this is particularly dubious because it is valued by willingness to pay, uncorrected for the different values of money to rich and poor people. It is therefore worth taking separate account of the quantity of death that will be caused by global warming, separated from its monetary valuation. Let us ask how much life people lose as a result of a one-tonne emission of carbon dioxide.

An accurate answer to this question has not been published, so far as I know. A recent study investigated the 'mortality costs' of climate change in great detail.¹¹ But, although in the course of their work the authors calculated the quantity of life-years lost, they published only their monetary value. I have therefore done my best to extract this quantity by reverse engineering from their published results.¹² This work of mine is inevitably crude compared with the immense sophistication of the original authors' work. The result is very rough, but I think it provides some worthwhile information.

Assuming a plausible scenario for the future development of climate change, I get that a one-tonne emission of carbon dioxide on average shortens people's lives by about 4 hours. This does not mean that, when you emit one tonne, you shorten some particular person's life by that much. The 4 hours is an aggregate over everybody in the world, and it is only an average. Just possibly your action will cause a tragedy and kill many people. Or it may do no harm at all. If you emit 560 tonnes in your lifetime—which is a typical amount for a European—you will shorten lives by three months on average.

If we accept the \$185 figure for the social cost of carbon, you will cause over \$100,000 worth of harm altogether. These are not small numbers. Some moral philosophers suggest that we do only a tiny amount of harm through climate change by our individual actions, or even no harm at all.¹³ That is not so. Our harms are indeed only a tiny fraction of the total harm of climate change, but this total is so huge that even a tiny fraction is big. None of us would want to shorten lives by three months, or harm people to the extent of \$100,000.

Utilitarianism and private morality

Now we have done what we can to evaluate the consequences of emissions, we can turn to their causes and to what we should do about them. I start with what we as individuals should do, and then come to governments.

We have estimates of the benefit of reducing emissions. They need to be balanced against the cost to an individual of doing so. There are many means of reducing emissions: eating less meat (which also [reduces animal suffering](#)), insulating your house, planting trees, travelling less and so on. Each has its own cost, and the costs vary greatly between different means and between people's different circumstances. However, all of us have a means available that is at present remarkably cheap, and that is buying offsets.

To buy an offset is to pay a company to reduce emissions on your behalf. Generally it will do so in developing countries, where there are the most and the cheapest opportunities. For example, some companies supply efficient

cooking stoves to people in African countries. A lot of wood is burned for cooking, and using it efficiently is a good way of reducing emissions. Some offsets reduce emissions less reliably than others, but the more reliable ones are supported by certification schemes.

Offsetting is the practice of buying offsets in order to cancel out the buyer's own emissions. Utilitarianism does not recommend this practice. However, buying offsets is a means of reducing the global emissions of greenhouse gas, whether or not it is done for the purpose of actual offsetting. You can buy reliable offsets for a price of around \$10 per tonne,¹⁴ and this shows that emissions can be reduced at about this cost. This price will increase dramatically in future years as more and more of the cheap opportunities for reducing emissions are used up. But at present, each tonne of emissions, which does harm that is very conservatively evaluated at \$185, could be prevented at a cost of \$10. This is the extraordinary situation we are in with climate change.

You might think that, with such a gain to be made, you should put all the resources you can spare into reducing your emissions. But for a utilitarian that would be a mistake. According to utilitarianism, you should do the best of the alternative acts available to you, and it turns out that there are other things you can do with your resources that are even more beneficial. The charity evaluator [GiveWell](#) lists several charities that it reckons save people's lives at a cost of \$5,000 each or less. Charities that protect people from malaria are among them. Let us assume that saving a person's life from malaria on average extends her life by 30 years. This is 262,800 hours. \$10 then extends life by more than 500 hours. This is two orders of magnitude more than the life extension that the same money can achieve by reducing carbon dioxide emissions. Reducing emissions has other benefits besides extending life, but they cannot possibly be enough to make up this difference.

	Donating \$10 to certified carbon offsets	Donating \$10 to a malaria charity recommended by GiveWell
Assumptions	(i) it costs \$10 to avoid one tonne of carbon (ii) avoiding one tonne of carbon saves 4 hours of life	(i) it costs <\$5,000 to save a life from malaria (ii) 'Saving a life' saves 30 years of life (=262,800 hours)
Lifetime saved	~4 hours	>500 hours

I conclude that reducing carbon emissions is very beneficial but much less beneficial than other ways you can use your resources for doing good. Consequently, it seems utilitarianism does not require you to reduce your emissions except to the extent that you can do so almost costlessly. I shall qualify this conclusion in section 5. And to be sure, utilitarianism does imply that, if you do not use your resources in any of the more beneficial ways available, then you should use them to reduce your emissions.

You might choose to reduce your emissions for a different reason. They harm other people, and it is a widely recognized moral principle that we should not harm others. This is a reason to reduce your emissions to zero, which you could achieve by means of offsetting. But it is not a utilitarian reason. Utilitarianism does not object to your harming other people so long as there is a greater benefit to be gained by doing so.

Utilitarianism and public morality

Now I turn to what governments should do. The costs and benefits of reducing emissions are the same for a government as for an individual. I have said that utilitarianism does not require an individual to reduce her emissions (if she spends her resources to help people in more effective ways). Why should the conclusion be any different for a government?

Because a government controls vastly more resources than an individual. It has the coercive means through taxation and regulation to mobilize the resources of all its citizens. The costs and benefits I described of reducing emissions are *marginal*. That is to say, they are the costs and benefits of reducing emissions by a further tonne, given the existing level of emissions. I explained that the marginal benefit of reducing emissions is much less than the marginal benefit of spending on malaria. For that reason, if an individual has \$10 to spend on doing good, she should spend it on malaria and not climate change. A government, too, should spend its first \$10 on malaria. But it has billions to spend. The more it spends on malaria, the less will be the benefit of extra spending on malaria. The marginal benefit will fall, until it becomes worthwhile to spend on other causes too. In the end it will be worthwhile to spend on climate change.

Remember that, although climate change spending is initially much less beneficial than malaria spending, it is nevertheless extremely beneficial. \$10 spent on reducing emissions brings a return conservatively valued at \$185, and four hours of life. It is certainly worth using resources on. A government should spend on malaria, other highly urgent causes, *and* on climate change. If it chooses not to spend on malaria and other highly urgent causes, *still* it should spend on climate change.

Moreover, climate change demands a much larger response. Malaria is a more urgent problem, but climate change is a much bigger one. A few hundreds of billions of dollars would be enough to eradicate malaria. Climate change demands tens of trillions at least.

Given that this is what governments ought to do, a further responsibility falls on individuals. A country's citizens have a moral responsibility to try and get their government to act as it should. Voting and political activism are ways for a citizen to discharge this responsibility. Another is for her to reduce her own emissions. This has the symbolic benefit of showing that she cares, and it may help to move her government. These political responsibilities are recognized

by utilitarianism, because they offer a prospect of improving people's well-being. On this basis, utilitarianism can require an individual to reduce her emissions of carbon dioxide, despite the calculations set out in section 4.

Governments should invest very large amounts of resources in reducing emissions. How much, exactly? One utilitarian answer is this. Imagine progressively increasing the government's investment at a particular time. As it increases, it will first use up the less expensive ways of reducing emissions, so that further reductions will become progressively more expensive. This means the marginal cost of reducing emissions will increase. Meanwhile the marginal benefit of reducing emissions—the social cost of carbon—will decline. At some level of investment, the marginal cost and the marginal benefit will become equal. That is the utilitarian optimum. Investment at each time should be at a level that makes the marginal cost and the marginal benefit of further investment the same.

To achieve this optimum, no one needs to calculate what it is. The economy's price mechanism can achieve it, provided a carbon price is set on emissions that is equal to the social cost of carbon. But to set this price, the social cost of carbon does need to be calculated, and that is a problem of valuation that has proved intractable. In section 2 I described some of its difficulties. Until they are solved, we cannot achieve an optimum by this means. In any case, setting a price on carbon has proved politically impossible in many countries.

The international community does not follow this route in trying to determine how much effort should go into controlling climate change. It has adopted a very different process, which is not based on valuation but on physical quantities. First a target maximum temperature is set politically; the present official target is 'well below 2 degrees' above pre-industrial levels.¹⁵ Then scientists estimate a 'carbon budget', which is the total amount of carbon dioxide that can be emitted without temperatures' exceeding the target. The effort required is whatever it takes to stay within the carbon budget.

This process is very far from a utilitarian calculation. Moreover it will not achieve the utilitarian optimum I described, because there is no real basis for the chosen target temperature. It is officially supposed to be ‘a level that would prevent dangerous anthropogenic interference with the climate system’,¹⁶ but there is no distinct temperature at which climate change becomes dangerous. The danger increases steadily with increasing temperature. The target has simply emerged from the arcane operation of international politics.

Nevertheless, utilitarianism might approve this process. Even though world emissions are still growing, it has had some success in limiting them. It led to the [Paris Agreement](#) in 2015, and some countries have reduced their emissions as a result. The notion of a carbon budget conveys a sense of urgency and has succeeded in motivating some action. Utilitarianism requires us to adopt a process that in practice offers the greatest expectation of well-being, and this may be it. It certainly appears to have better prospects than trying to calculate a social cost of carbon through valuation.

About the Author

Credit: Keiko Ikeuchi

[John Broome](#) is Emeritus White’s Professor of Moral Philosophy at the University of Oxford, and an Honorary Professor of the Australian National University. At one time he was Professor of Economics at the University of Bristol. He was a Lead Author of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. His books include [Weighing Goods: Equality, Uncertainty and Time](#) (1991), [Counting the Cost of Global Warming](#) (1992), [Weighing Lives](#) (2004), [Climate Matters: Ethics in a Warming World](#) (2012), and [Rationality Through Reasoning](#) (2013).

How to Cite This Page

Broome, J. (2023). Utilitarianism and Climate Change. In R.Y. Chappell, D. Meissner, and W. MacAskill (eds.), <<https://www.utilitarianism.net/guest-essays/utilitarianism-and-climate-change>>, accessed 3/19/2024.

References

- Barry, Christian, and Garrett Cullity, 'Offsetting and risk imposition', *Ethics*, 132 (2022), pp. 352–81.
- Broome, John, 'How much harm does each of us do?', in *Philosophy and Climate Change*, edited by Mark Budolfson, David Plunkett, and Tristram McPherson, Oxford University Press, 2021, pp. 281–91.
- Broome, John, *Weighing Goods: Equality, Uncertainty and Time*, Blackwell, 1991.
- Carleton, Tamma, *et al*, 'Valuing the global mortality consequences', *Quarterly Journal of Economics*, (2022).
- Fleurbaey, Marc, *et al*, 'The social cost of carbon', *The Monist*, 102 (2019), pp. 84–109.
- Intergovernmental Panel on Climate Change, Working Group 3, *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Cambridge University Press, 1996.
- Intergovernmental Panel on Climate Change, Working Group 3, *Climate Change 2014: Mitigation of Climate Change*, Summary for Policymakers.
- Rennert, Kevin, *et al*, 'Comprehensive evidence implies a higher social cost of CO₂', *Nature*, 610 (2022), pp. 687–92.
- Sinnott-Armstrong, Walter, 'It's not *my* fault: global warming and individual moral obligations', in *Perspectives on Climate Change*, Volume 5, edited by Walter Sinnott-Armstrong and R. B. Howarth, Elsevier, 2005, pp. 293–315.
- United Nations, *Framework Agreement on Climate Change*, 1992.

- United Nations, *Paris Agreement*, 2015.
 - Weitzman, Martin L., 'On modeling and interpreting the economics of catastrophic climate change', *Review of Economics and Statistics*, 91 (2009), pp. 1–19.
-

1. Many of these points and others are set out in more detail in Marc Fleurbaey *et al*, 'The social cost of carbon'. ↩
2. This claim is not uncontroversial, particularly because it seems plausible that we should be risk-averse about well-being. But it is supported by the axioms of expected utility theory, combined with other arguments set out in my *Weighing Goods*, chapter 10. ↩
3. Weitzman, 'On modeling'. ↩
4. IPCC, *Climate Change 2014*, Summary for Policymakers, p. 5. ↩
5. See Carleton *et al* 'Valuing the global mortality consequences'. ↩
6. Rennert *et al*, 'Comprehensive evidence' p. 690. ↩
7. For example, Rennert *et al*, 'Comprehensive evidence'. ↩
8. This practice was recommended in the early report of the IPCC, Working Group 3, *Climate Change 1995*, pp. 195–8, and it continues today for instance in Rennert *et al*, 'Comprehensive evidence', online content: Methods. ↩
9. Rennert *et al*, 'Comprehensive evidence'. ↩
10. Rennert *et al*, 'Comprehensive evidence', p. 690. ↩
11. Carleton *et al*, 'Valuing the global mortality consequences'. ↩

12. My calculations are shown in my paper ‘How much harm does each of us do?’. The data I used appear in Table H3 in the on-line Appendix of the published version. ↩

13. For example, Sinnott-Armstrong in ‘It’s not *my* fault’. ↩

14. For example from [Climate Impact Partners](#). ↩

15. *Paris Agreement*, Article 2 Section 1A. ↩

16. UNFCCC, Article 2. ↩