Cumulative Carbon and Just Allocation of the Global Carbon Commons

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Abstract

Recent research has shown that the effect of human activities on climate can be characterized by a single statistic, called cumulative carbon. This statistic is the aggregate amount of carbon emitted in the form of carbon dioxide by activities such as fossil fuel burning and deforestation over the entire time such activities persist. In this paper, the concept is used to address the question of fair allocation of carbon emissions amongst nations or other emitting units. It is concluded that even if emissions prior to the year 2000 are left out of the accounting, North America would have a just obligation to cease emissions completely in thirteen years, even if the emissions rate were frozen at its current level. China, India, and other developing nations could continue emissions for much longer before exhausting their fair share of the Carbon Commons. If historical emissions are fully taken into account, North America exceeded its fair share of usage in 1970, and has been in carbon overdraft ever since, whereas none of the major nations of the developing world have yet exceeded their fair shares. It is concluded that, based on principles of human equality, North America, and in particular the US, has a strong moral obligation to take the lead in actions that will ultimately reduce global carbon emissions. Western Europe has similar obligations, but has begun measures to take on a fair share of responsibility for emissions reduction, whereas such action has been largely absent in North America.

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I. INTRODUCTION

In the climate problem, there is a clear goal for a theory of justice: first to reduce the growth rate of global carbon dioxide emissions, and ultimately to bring them to zero before they commit the Earth to an unacceptable degree of climate disruption. We are not interested in abstract notions of who may deserve to be punished. There is a job to be done and, while finding a just solution is only a part of the process, it probably does play some role in persuading all parties to act in their mutual interest. Nations will rarely do anything that goes much against perceived self-interest just because it is the right thing to do, but on the other hand, in the absence of military coercion, nations will mightily avoid agreeing to restrictions they perceive (rightly or wrongly) as unjust.

Finding a solution to the threat of global climate change involves distribution of a valuable and scarce resource, the global Carbon Commons. It engages issues of equity between rich and poor (both within nations and across national boundaries), and between present and future generations. We also need to find principles for dealing with past emissions, in order to determine how much of the commons has been "used up," and how the unused portion of the commons should be allocated. These are quintessentially ethical problems. First, we need to clarify the nature of the resource being distributed.

II. THE GLOBAL CARBON COMMONS

When carbon is emitted into the air in the form of carbon dioxide (generally as a result of burning fossil fuels or as a consequence of deforestation), over time it is repartitioned among the atmosphere, the ocean, and the near-surface materials of the land. That portion that remains in the atmosphere causes global warming and other forms of climate disruption, while that portion that enters the ocean causes ocean acidification. Allocation of the global Carbon Commons requires us to know the relation between climate-relevant emissions and climate change.

Other significant greenhouse gases—notably methane—also contribute to global warming, but these do not merit consideration on an equal footing with CO_2 because their persistence in the atmosphere is so short. For example, since methane has an atmospheric lifetime of only twelve years, we can delay methane controls for two centuries if we wish, and still get the full benefit of reduction of methane emissions within a few decades of implementation of controls. The same cannot be said for CO_2, as we shall see shortly. The commonly used practice of aggregating short-lived and long-lived greenhouse gases through their Global Warming Potential leads to highly erroneous policy guidance, and should be abandoned.[1]

Recent research has shown that the magnitude of climate change, as measured by global mean warming, is very well characterized by a simple metric known as cumulative carbon.[2] Cumulative carbon is simply the net carbon emitted globally over the period of time during which human activities continue to contribute a net input of carbon (as CO_2) to the Earth system—more or less the duration of the fossil fuel era. The key results regarding cumulative carbon are as follows:

- The global mean warming is linearly proportional to cumulative carbon.
- The amount of warming at the time emissions cease is nearly independent of the emissions trajectory over which the cumulative carbon is emitted.
- The amount of warming at the time emissions cease persists for about a thousand years, and declines only very gradually over the next ten thousand years, and still more slowly over the following several hundred thousand years.

Cumulative carbon is usually quoted in terms of gigatonnes (billions of metric tonnes) of carbon. The linearity property is very important in thinking about allocation, because the contribution of individual entities to climate damage—be they nations or persons—can be characterized by the amount of cumulative carbon they contribute to the total. To determine the size of the usable Carbon Commons, we must determine (by a process of negotiation) the maximum allowable warming that can be tolerated, and then translate that into a cumulative carbon number. Because climate change is nearly independent of emissions trajectory, there is little point in arguing about details of when an entity chooses to emit its fair allocation of carbon.

The fact that it is the *cumulative* amount of carbon that counts for climate change derives from the very long lifetime of CO_2 in the atmosphere. It accumulates in the atmosphere, rather like mercury in the fat of a fish, and leads

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1 See Susan Solomon, et al, *Atmospheric Composition, Irreversible Climate Change, and Mitigation Policy*, in J. Hurrell and G. Asrar, eds, *Climate Science for Serving Society: Research, Modelling and Prediction Priorities* (Springer 2012).

2 For background on cumulative carbon see, for example, David Archer, *The Long Thaw* (Princeton 2008); Susan Solomon, et al, *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 Proceedings Natl Acad Sci 1704 (2009).

to essentially irreversible changes in the climate.[3] Before proceeding to the question of usage and allocation of the Carbon Commons, we will digress to summarize the basic science leading to the connection between climate change and cumulative carbon.[4]

During the first ten thousand years after emissions, the main sink for anthropogenic CO_2 is uptake by the ocean. In order to store a significant amount of carbon in the ocean, it must be mixed from the surface layers into the deep ocean, and this takes about a thousand years. Moreover, the ocean can only store significant amounts of carbon by converting it from dissolved CO_2 to bicarbonate (the same substance found in baking soda), which involves some chemistry that has nonlinearities in it. The upshot is that the fraction of emitted carbon that stays in the air as CO_2 once the atmosphere-ocean system has come into chemical equilibrium increases with the cumulative carbon emitted. A calculation of the air fraction—based on the very simple equilibrium carbon model in *Principles of Planetary Climate*[5]—is shown in the upper panel of Figure 1, where the amount in the atmosphere is expressed as Gigatonnes Carbon (GtC).[6] It is seen that the atmospheric CO_2 is concave upward as a function of cumulative carbon. However, the radiative forcing that drives climate change is logarithmic, and hence concave downward, as a function of atmospheric CO_2. These two nonlinearities very nearly cancel, leading to a linear relation between temperature increase and cumulative carbon, as shown in the lower panel of Figure 1.

3 Archer, *The Long Thaw* at 122–23 (cited in note 2); Solomon, 106 Proceedings Natl Acad Sci at 1705–06 (cited in note 2).

4 For a more complete review of the subject, see National Research Council, *Climate Stabilization Targets: Emissions, Concentrations and Impacts over Decades to Millennia* 83–97 (National Academies 2011).

5 Raymond T. Pierrehumbert, *Principles of Planetary Climate* 497–597 (Cambridge 2010).

6 To put this in more familiar units, 100 GtC in the atmosphere translates into approximately forty-six parts per million CO_2.

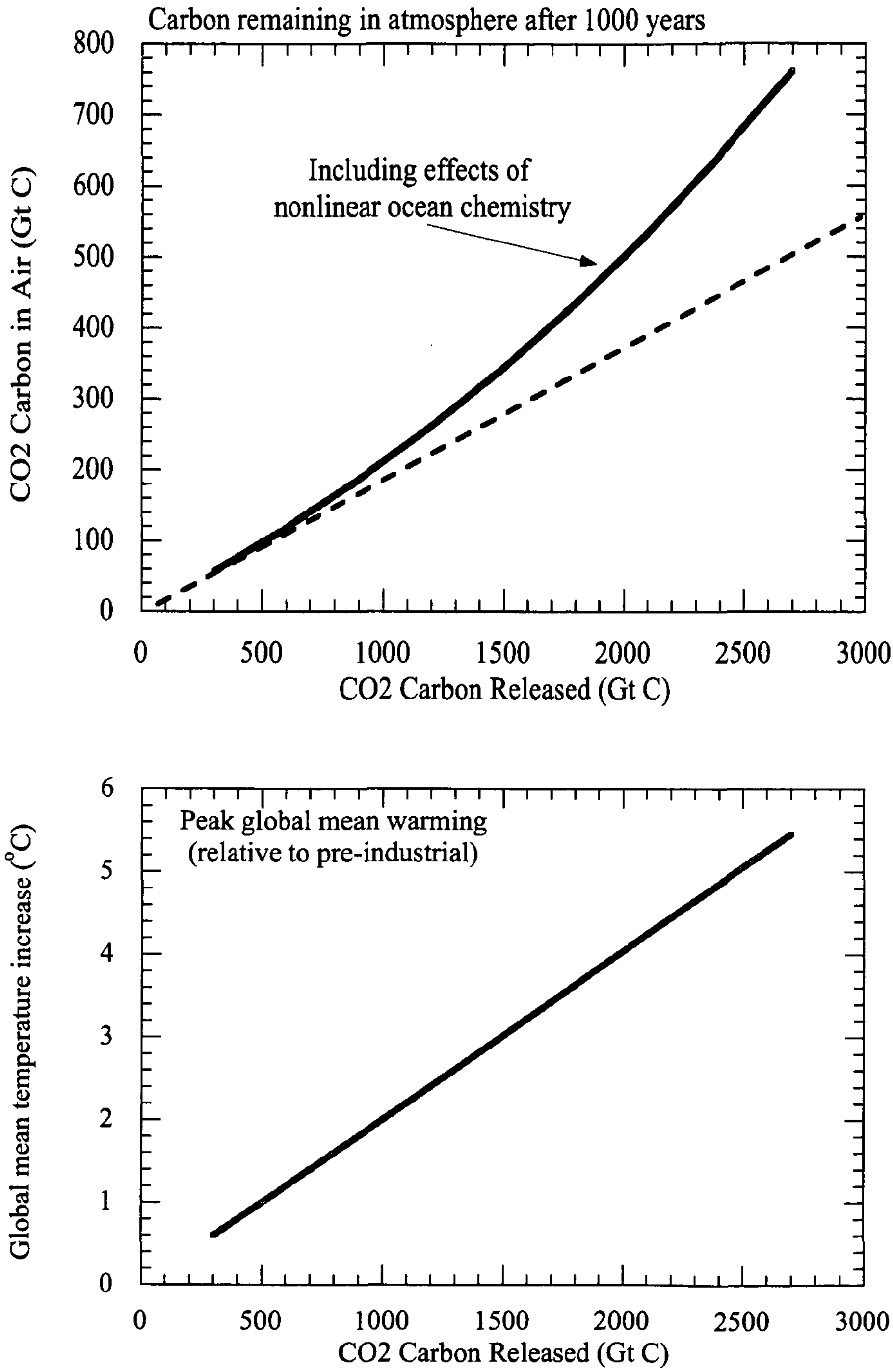
Carbon remaining in atmosphere after 1000 years
CO2 Carbon in Air (Gt C)
800
700
600
500
400
300
200
100
0
Including effects of
nonlinear ocean chemistry
0
500
1000
1500
2000
2500
3000
CO2 Carbon Released (Gt C)
Global mean temperature increase (°C)
6
5
4
3
2
1
0
Peak global mean warming
(relative to pre-industrial)
0
500
1000
1500
2000
2500
3000
CO2 Carbon Released (Gt C)

Figure 1: *Upper panel: GtC in air (as CO_2) versus GtC emitted. Calculation is based on carbon added to a 280ppmv atmospheric pre-industrial baseline, assumed to be in equilibrium with the ocean. The air fraction represents the amount left in the atmosphere after the ocean and atmosphere have equilibrated, but before ocean acidification has been buffered by dissolution of carbonate (limestone) from land and the sea floor. Lower panel: Corresponding peak global mean warming based on a climate sensitivity chosen to match the simulations of Allen et al (2009).*[7] *This sensitivity is approximately equivalent to the median sensitivity in the ensemble of models included in the Intergovernmental Panel on Climate Change Fourth Assessment Report.*[8]

The deep ocean warms and approaches thermal equilibrium on the same one thousand year time scale as it draws down CO_2 following the cessation of emissions. The net result is that atmospheric temperature remains fairly flat over the thousand years following the end of emissions. This is illustrated in Figure 2, where we show the modeled CO_2 and temperature trajectories resulting from releasing 1700 GtC cumulative carbon over an emissions trajectory that brings emissions to zero by the year 2250.[9] The temperature time series would be virtually identical even if all the cumulative carbon were emitted in a pulse over a single year, owing to the thermal smoothing effects of the ocean.[10]

7 Myles R. Allen, et al, *Warming Caused by Cumulative Carbon Emissions Towards the Trillionth Tonne*, 458 Nature 1163, 1163–64 (2009).

8 David A. Randall, et al, *Climate Models and Their Evaluation*, in Susan Solomon, et al, eds, *Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 608–44 (Cambridge 2007), online at http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter8.pdf (visited Nov 16, 2012).

9 The atmospheric CO_2 trajectory is taken from the carbon cycle model discussed in Michael Eby, et al, *Lifetime of Anthropogenic Climate Change: Millennial Time Scales of Potential CO_2 and Surface Temperature Perturbations*, 22 J Climate 2501, 2502–04 (2009). The corresponding temperature is computed using the two-box climate model described in Solomon, et al, *Atmospheric Composition* at 25 (Springer 2012) (cited in note 1).

10 Eby, et al, 22 J Climate at 2510 (cited in note 9).

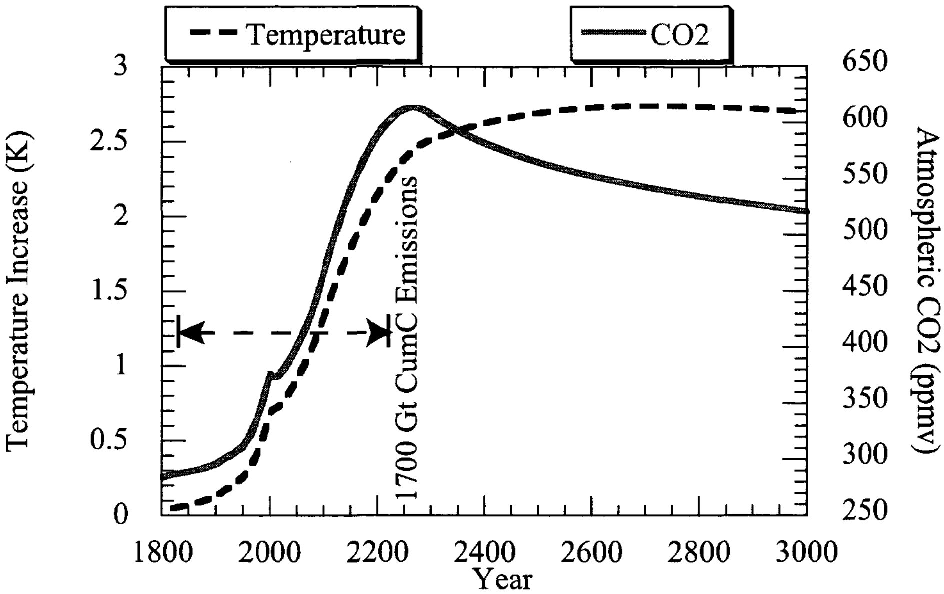

Figure 2: *Time series of atmospheric CO_2 concentration and global mean atmospheric temperature resulting from emission of 1700 GtC up to the year 2250, followed by cessation of emissions.*

Over the next ten thousand years (not shown), carbonate (basically limestone) will dissolve from sediments and wash into the ocean in rivers, buffering the oceans' acidity and allowing a bit more carbon to be taken up, leading to a modest reduction in temperature.[11] Figure 3 shows how the future climate looks as a function of global cumulative carbon emitted, based on the median IPCC climate sensitivity; there is a fifty-fifty chance things would be worse for any given amount of cumulative carbon. If we adopt a 50 percent chance of global mean warming of 2°C or more as our climate target for the sake of discussion, that translates into an allowable total emission of about a trillion tonnes of carbon. This serves as a measure of the size of the Carbon Commons.[12]

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11 National Research Council, *Climate Stabilization Targets* at 75 (cited in note 4).

12 Allen, et al, 458 Nature at 1163 (cited in note 8).

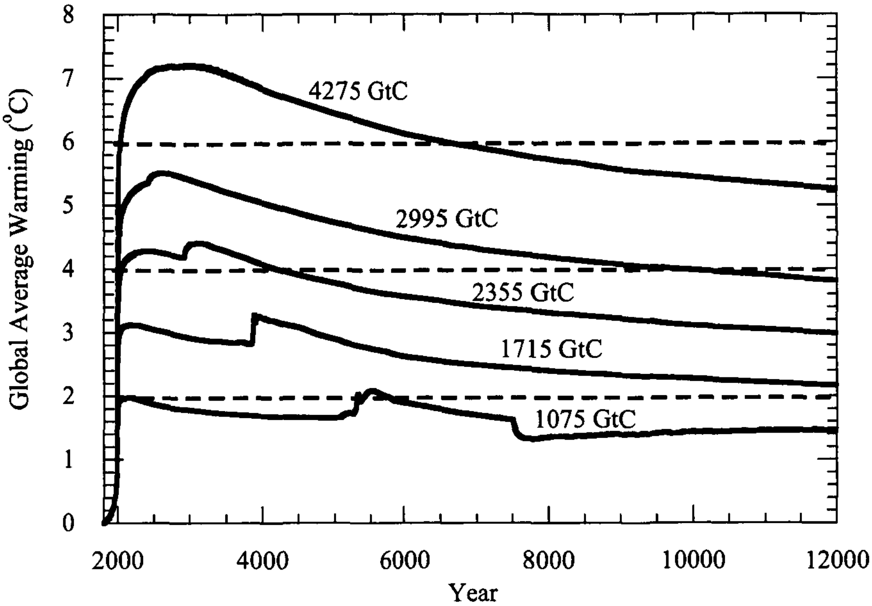

Figure 3: *Global mean temperature out to the year 12000, as a function of cumulative carbon emitted during the period of fossil fuel usage.*

Our discussion of cumulative carbon so far was based only on uptake of CO_2 by the ocean, but terrestrial ecosystems also intercept some of the emitted carbon and store it in living biomass and near-surface soil carbon—between 1 and 3 GtC per year at present.[13] The behavior of this part of the carbon cycle is far less well understood than the oceanic carbon sink, which mostly depends on fairly basic physical and chemical principles. The terrestrial carbon sink is a delicate balance between the increase in carbon uptake by photosynthesis (stimulated by increasing atmospheric CO_2, and by inadvertent and deliberate reforestation or changes in agricultural practices) and a nearly equally large change in the release of CO_2 from decomposition of dead biomass and soil organic carbon. The future of this sink is uncertain; warming tends to enhance decomposition and it takes little change in the balance to turn the net sink into a net source, releasing the carbon we have recently been storing in soils, and

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13 Richard A. Houghton, *Balancing the Global Carbon Budget*, 35 Ann Rev Earth Planetary Sci 313, 316–17 (2007). This estimate excludes the net source due to land use changes such as deforestation or afforestation projects, which are accounted for as part of the net non-fossil fuel anthropogenic source of carbon. It is intended to represent the response of the land biosphere to changed atmospheric conditions.

perhaps even more than that.[14] The carbon cycle models used in Figures 2 and 3 do in fact include a terrestrial carbon module that tends to return to the atmosphere the carbon stored in soils in the first century or so. This part of the carbon cycle needs to be relegated to the domain of known unknowns, and apart from saying that it would be hazardous to rely on continued near-surface storage of carbon that is very subject to oxidation by bacteria that have had two billion years to get good at making use of available organic carbon, there is little that can be said with certainty.

How much of the Carbon Commons has been used up already, and who used it? Figure 4 shows the cumulative emissions for four representative regions (two in the developed world and two in the developing world), together with the net global value.[15] The four regions chosen make up more than half of the world total cumulative emissions. Globally, about a third of the trillion-tonne Carbon Commons has already been used up by fossil fuel burning alone. It is clear that the developed regions (North America and Western Europe plus Germany) have used a far larger share of the Carbon Commons than the developing world regions (centrally planned Asia plus Far East Asia—think China and India). China may have overtaken us as an emitter, with India not far behind, but while the cumulative emissions of both regions are growing rapidly at present rates of growth, they will not overtake North American cumulative emissions until roughly 2040.

14 Eby, et al, 22 J Climate at 2502–04 (cited in note 9).

15 Carbon Dioxide Information Analysis Center, *Fossil-Fuel CO_2 Emissions*, US Department of Energy (Oak Ridge National Laboratory, last updated Sept 26, 2012), online at http://cdiac.ornl.gov/trends/emis/meth_reg.html (visited Oct 14, 2012); all carbon emissions data are derived from the files distributed at http://cdiac.ornl/gov/.

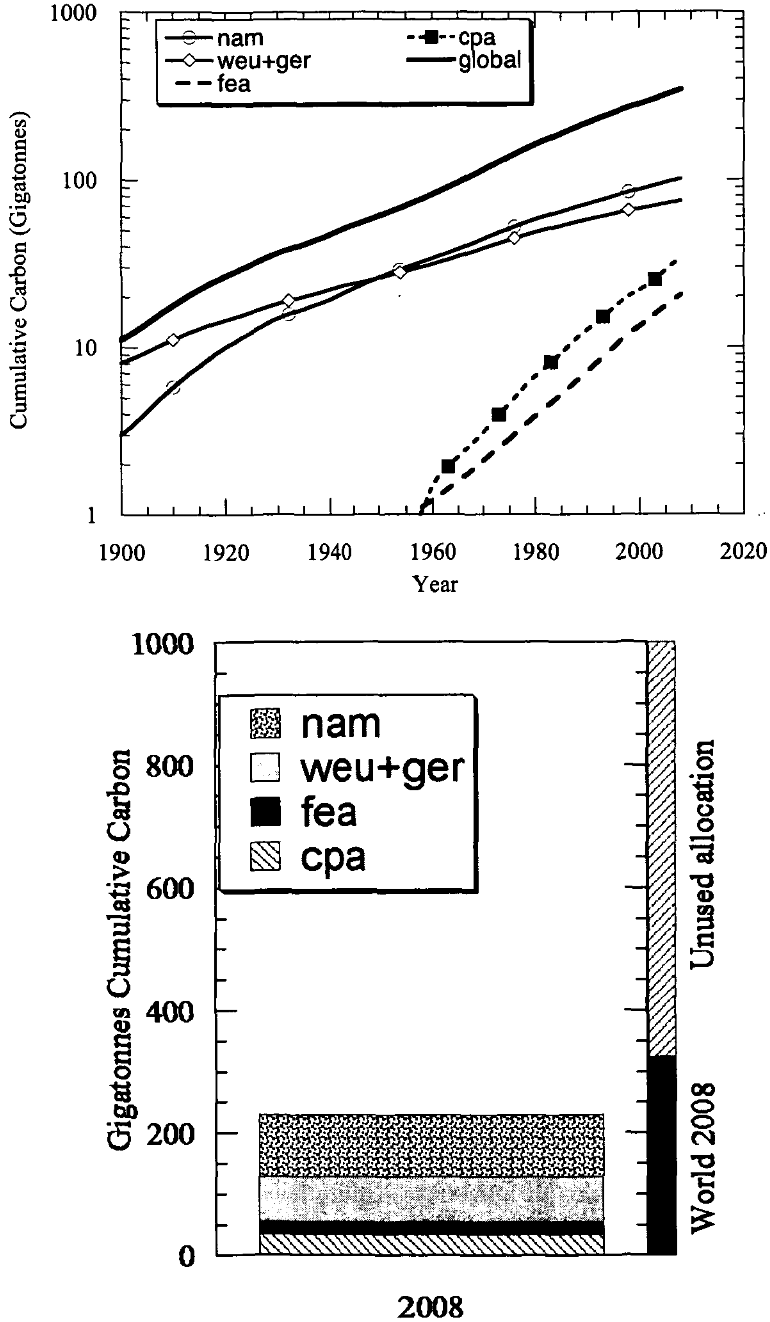

Figure 4: *Global and regional cumulative fossil fuel carbon emissions. Regions defined as follows: nam = North America, weu+ger = Western Europe and Germany, fea = Far East Asia (mostly India and Pakistan; does not include Japan), cpa = centrally planned Asia (mostly China). The bar chart in the lower panel shows year 2008 cumulative emissions on a linear scale, compared with the 1000 GtC cumulative emissions target.*

Land use changes attributable to human activity (mainly deforestation) have also added CO_2 to the atmosphere—approximately 150 GtC as of 2005.[16] This source, however, is not growing as fast as the fossil fuel source, and indeed cannot grow for much longer before we run out of forests to cut down. Including this source in the regional inventory could somewhat shift the contributions of the various regions to cumulative carbon, but we have left it out of the picture in part because historical land use carbon emissions are subject to considerable uncertainty (especially if one wishes to factor in the large source of carbon due to deforestation during the European colonization of North America). Besides that, deforestation creates opportunities for future carbon sinks due to reforestation, provided the land has not become so degraded that it can no longer support forest growth. To the extent that nations avail themselves of this fairly rapid (though limited) carbon sink, the net effects of deforestation are a wash.

The ocean is not a long-term sink of carbon. The carbon added to the system is re-partitioned between an ever-growing air fraction and an oceanic fraction, but so long as emissions exceed the minuscule rate that can be absorbed by the very slow processes, which convert CO_2 to limestone on land, the atmospheric carbon dioxide will continue to grow. Thus, to prevent continued warming, everybody's emission of fossil fuel carbon needs to fall essentially to zero at some point,[17] and before an unacceptable value of cumulative carbon has been reached. The Carbon Commons is not a renewable resource. Allocating it is not like divvying up fishing rights in the world ocean. When it comes to carbon, there is no sustainable catch. If fish were like carbon, everybody would need to give up fishing eventually, and those who caught more fish in the past would have fed themselves at the expense of others.

III. PRINCIPLES FOR JUST ALLOCATION OF THE CARBON COMMONS

As recounted by Judith Shklar, Aristotle saw greed as the basic driver of injustice,[18] and his theory of distributive or normal justice was largely based on the need for an orderly process to keep greed from running rampant. Subsequent thinking may have broadened our understanding of the wellsprings of injustice, but it seems to me that greed, and the need to keep it in check,

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16 Id.

17 H. Damon Matthews and Ken Caldeira, *Stabilizing Climate Requires Near-Zero Emissions*, 35 Geophysical Rsrch Letters 1, 4–5 (2008).

18 Judith N. Shklar, *The Faces of Injustice* 28 (Yale 1990).

serves very nicely as the basis for discussion of just allocation of the Carbon Commons.

The moral philosopher Peter Singer identified three generally recognized principles of justice that could be applied to the allocation of the Carbon Commons, and explained them in terms of an analogy with a series of lakeshore villages all of which dump pollution into a lake they rely on for fish.[19] These principles have a certain affinity with the notion of greed as the root of injustice. I will reformulate them and make them quantitative in terms of cumulative carbon.

The first of the three alternate principles is Polluter Pays, which can be paraphrased as "you broke it, you fix it." In the village analogy, it implies that the village that dumped the most sewage bears a proportionate bulk of the responsibility for cleaning up the mess. In the context of the Carbon Commons, there being no practical way to "fix" the climate by removing a significant proportion of past emissions from the atmosphere, fixing the problem largely means accepting an obligation to pay the costs required to reduce future emissions somewhere in the world. As they occur, new emissions are simply added to past emissions and increase the obligation to pay at a per tonne rate equal to that applied to past emissions. One can think of these payments as going into a fund used for such purposes as paying for replacement of inefficient refrigerators, air conditioners, and furnaces, replacing coal fired power plants with wind, solar, or nuclear energy and the like. Such payments should not be regarded as a fine or penalty, since the purpose is not punitive, but the distinction is fuzzy since—like a fine—the payments make harmful behavior more costly, and thus have value in inhibiting such behavior.

By the Polluter Pays standard, Figure 4 demonstrates that North America has a greater obligation to reduce its emissions rate (or to pay for equivalent reductions elsewhere) than centrally planned Asia. In fact, even if North America instantly reduced its emissions to zero, it would not be until 2030 that centrally planned Asia caught up to an equal degree of obligation, at its present rate of cumulative emissions growth.

Singer's second principle, which we will call Equal Future Shares, is prospective rather than retrospective. Each individual alive in some baseline year is a tabula rasa, free from any responsibility for carbon emitted in the past, and with an equal entitlement to a share of the allowable global future emissions. As Singer notes,[20] it is desirable to base per capita allocations on population in a baseline year, or some other target population number, so as to provide an

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19 Peter Singer, *Ethics and Climate Change: A Commentary on MacCracken, Toman and Gardiner*, 15 Envir Values 415, 418–19 (2006).

20 Peter Singer, *One World: The Ethics of Globalization* 35–36 (Yale 2002).

incentive for measures (hopefully benign) that moderate population growth.[21] Equal Future Shares is usually thought of as allocating blocks of emissions rights to nations in proportion to their baseline population, but if the right kind of global emissions market could be established, there is no real reason not to issue shares directly to individuals. There is much to be said for that, in terms of increasing flexibility and endowing individuals with more freedom to choose how their personal allocation is used, and how much should be left to descendants.

Making allowance for the portion of the Carbon Commons used up by past land use changes (basically deforestation) and dividing up the roughly 500 GtC remaining over the year 2012 world population yields an allocation of about 70 tonnes of carbon per person, which could be augmented to the extent that an individual participates in successful reforestation projects. At the present rate of North American emission, this would be used up in only thirteen years, even without allowing for future growth in the emissions rate. Regardless of where the obligations of North Americans stand relative to the developing world, it is clear that we would need to be doing far more than we currently are in order to bear our fair share of the burden of decarbonizing the world economy. Under Equal Future Shares, centrally planned Asia could continue to emit for several decades at its current annual rate, but would still have considerable incentive to reduce its *emissions growth rate* since the current rate of growth in the emissions rate would exhaust its allocation in not too long a time (roughly thirty years, given a sustained 5 percent annual growth rate, versus fifty-six years if the emissions rate is frozen at its 2008 value).

Neither of the preceding two principles invokes wealth redistribution as a justification. Wealth redistribution from richer to poorer may be a side effect insofar as the countries with greater historical cumulative carbon on the whole tend to be richer and less populous, but the principles would yield the same result even if this were not the case. That brings us to Singer's third principle, which we will call Favor the Poor. Equal Future Shares treats all individuals equally, but Favor the Poor adopts the premise of John Rawls that inequality in treatment of individuals can be accepted to the extent that it benefits the least advantaged individuals. This principle would allocate more emissions rights to poorer individuals, or citizens of poorer nations than would be the case under Equal Future Shares, thus further increasing the responsibility of the developed

21 In accepting an implied population cap for distributing the Carbon Commons, we are deviating from a principle of strict human equality. Any humans born in excess of the cap are given a lower share of the Commons, despite the fact that their so suffering was purely by accident of their circumstances of birth. This should make us uncomfortable, as do many questions touching on population policy.

world to act on carbon mitigation relative to the developing world. It may be objected that what Rawls mostly had in mind is something like the reverse—that to a limited extent it may be acceptable to allow the rich to get richer, if their greater productivity or creativity in use of resources winds up, through subsequent distribution of the fruits of their labors, benefiting the poorest. That objection is neatly taken care of if the carbon allocations are tradable, since the rich would be free to buy emission rights from the poor at a high price, and still profit from the transaction. In order for such transactions to have the intended effect of reducing global emissions, there would need to be a mechanism in place to assure that the funds received by the poor are indeed invested in fulfilling their commitment to forgo the agreed amount of future emissions.

The Rawlsian scheme can also be justified by a Deepest Pockets principle—those who can afford to pay for a shared benefit, with the least suffering to their own well-being, should do so. This is the same principle that justifies progressive tax codes.

The moral underpinnings of Polluter Pays are subtly different from those of Equal Future Shares in that Polluter Pays is neutral with regard to the relative populations of emitting nations or any other unit of aggregation we care to employ. This neutrality is not manifestly absurd, since a tonne of carbon emitted does the same damage to climate whether it is emitted by a large or small group of individuals, or by an individual in a populous or sparsely populated nation. Consider Nation A with a population of 100 million and Nation B with a population of one billion, each of which has emitted 100 GtC. If it cost, for example, $100 to avoid a tonne of future emissions, then each nation is required to pay $10 trillion into the carbon mitigation fund to fully compensate for their past emissions. For Nation A this comes out to $100,000 per person; for Nation B the payment is $10,000 per person and (all other things being equal) would be less burdensome. In that sense, the population issue seems to take care of itself in Polluter Pays. A poor individual might be disproportionately harmed by even the smaller per capita payment in the more populous nation, but that engages the considerations of Deepest Pockets, not Polluter Pays or Equal Future Shares. Polluter Pays even appears sound from a standpoint of human equality, in that each individual is treated equally, and pays a fee for carbon emissions in proportion to the damage caused by those emissions, without any differential in per tonne rates amongst individuals. Polluter Pays is in this sense equivalent to a fixed per tonne carbon tax levied globally without regard to the circumstances of the emitters. Nonetheless, Polluter Pays has different implications from application of some form of an Equal Future Shares principle, and these need to be examined.

The problem with the ethical stance in Polluter Pays is that it fails to recognize that carbon emission is not an incidental activity, but instead is incurred as a result of an attempt to fulfill basic human needs that would tend to require a certain amount of energy expenditure per person. Polluter Pays assigns equal culpability to everybody in proportion to the amount of carbon they have emitted, but this is different from assigning equal rights to a share of the net amount of carbon that can be emitted globally without incurring an unacceptable degree of harm from climate change. For example, if it were assumed that the allowable emissions, when divided equally amongst the citizens of the two nations, were 100 tonnes per person, then the citizens of the populous Nation B would owe nothing to the carbon mitigation fund, whereas the citizens of Nation A would owe $90,000 each (the value of their emissions in excess of the 100 tonne allowance). This is the outcome that would result from applying the principle in Equal Future Shares to historical emissions. It is a very different outcome from Polluter Pays, and is closer to the spirit of treating all humans as endowed with equal rights to a commons that does not intrinsically belong to one nation more than another.

In order to address this issue, I propose a hybrid between Polluter Pays and Equal Future Shares, which I'll call Equal Total Shares. This principle is like Equal Future Shares in being per capita based, but attempts to factor in past carbon emissions. Based on the 2012 world population, the fair individual share of the Carbon Commons is 143 tonnes, some of which has already been used by our forebears. If past carbon emissions were allocated equally to all people alive in the base year, then Equal Total Shares and Equal Future Shares would be identical. However, some individuals have benefited more from past emissions than others, so we can get a more just solution by taking that into account. By way of example, let's do a per capita cumulative carbon accounting in which the historical emissions of North America and centrally planned Asia are assigned to the number of individuals in those regions alive in 2012. The results are shown in Figure 5. By this measure, North Americans used up their fair allocation in 1970, and were 173 tonnes per person into carbon overdraft by 2005. In contrast, centrally planned Asia will not have used its just allocation until 2040. Again, we conclude that it would be just for North America to bear more of the burden of reducing emissions than centrally planned Asia; indeed it would appear that we owe somebody compensation for our overuse of the Carbon Commons.

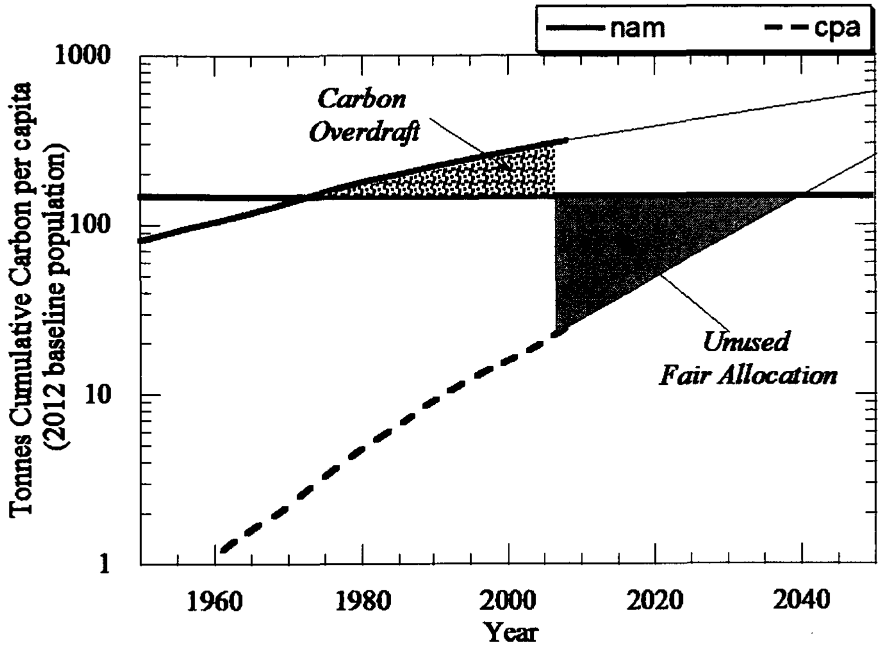

Figure 5: *Per capita cumulative carbon for North America and centrally planned Asia, based on 2012 baseline populations in each region. The horizontal line represents the per capita fair share of the global Carbon Commons.*

The rather extreme principle we have used for attributing past emissions is based on the premise that the prosperity of a nation's citizens today represents the accumulation of the fruits of past energy usage and its associated carbon emissions. It could be argued, with considerable justification, that a person should not be liable for his grandfather's carbon emissions, let alone that of his earlier forebears. Even more so, it could be argued that an immigrant to the US from Africa should not be saddled with a full share of the US carbon overdraft. These are serious issues that any allocation of past emissions must confront. Perhaps there should be a statute of limitations for carbon emission. This cannot be justified on the basis of ignorance of consequences of carbon emissions, since that has been known for well over a century, but one could perhaps find justification to write down some of the past carbon debt on the grounds that the benefits accrued from sufficiently early emissions are dispersed. As the cutoff of the statute of limitations for carbon approaches the present, Equal Total Shares and Equal Future Shares become identical. However, since so much of the carbon has been emitted relatively recently, putting the cutoff date at 1950, which includes the lifetime of the parents of most developed-world persons alive today, that date would still leave the developed world with a considerable carbon overdraft.

None of the principles we have discussed for just allocation of the Carbon Commons invokes retribution as a guiding principle. The aim is not to cause the guilty parties to suffer, so it is perfectly acceptable if the richer villages take care of the problem by investing in pollution reduction in the poorer villages.

Based on Figure 5, at a price of $100 per tonne of carbon, each North American would owe $17,300 for his or her share of the national carbon overdraft. Payment of this debt need not take the form of a direct wealth transfer to nations that have not used their allocation. It could instead be interpreted as the amount we are obligated to invest in developing and implementing technological means to decarbonize our economy, with possible spinoffs to other economies. I have no real expectation that North Americans would agree to taking on an investment of this magnitude any time soon, but one should at least not deceive oneself into thinking that we are declining this responsibility out of any valid sense of injustice, rather than simple unimpeded greed.

It may well be that President George W. Bush was speaking for a majority of the American people when he said, with regard to the Kyoto Protocol, "We will not do anything that harms our economy, because first things first are the people who live in America."[22] Perhaps the American political consciousness is wired in such a way that any international agreement perceived as reducing the growth of American prosperity (no matter how rich it still leaves us) automatically triggers a sense of injustice. Shklar distinguishes between the *sense of injustice* and *actual* injustice, but cautions that all feelings of injustice have a claim to be examined.[23] I do not propose to fathom the source of the peculiarly American sense of injustice (if that is indeed what it is) when asked to do something about climate change. But we must not accord the American sense of injustice any greater claim to be examined than the Chinese sense of injustice, since after all, the Chinese must also be persuaded to sign on to any global carbon emissions protocol if it is to be useful. Why would the Chinese or Indian governments, on behalf of their people, agree to such a manifestly unjust treaty as Posner and Weisbach would seem to wish on them? Stripped of fancy terminology, the proposal of Posner and Weisbach is essentially a Victim Pays model, in which costs of CO_2 abatement are levied according to who suffers the most harm from them, rather than who is responsible for the damage.[24] These costs are levied on the victims even if the victims are predominantly poorer than

22 Singer, 15 Envir Values at 415 (cited in note 19).

23 See discussion in Shklar, *The Faces of Injustice* at 90 (cited in note 18).

24 Eric A. Posner and David Weisbach, *Climate Change Justice* 6–7, 178–81, 183–84 (Princeton 2010). The surplus referred to by Posner and Weisbach includes the value of harms to the victims that are avoided if the victims join in a climate change treaty.

the perpetrators. The victims are supposed to sign on eagerly because they will be even worse off if they do not. Perhaps if the US plays a game of chicken with climate in which China swerves to avoid the crash, we will win. That may be good gamesmanship, but we should not fool ourselves into thinking it has anything to do with justice. There are, moreover, hazards in exploiting victims, even if they are in such a poor bargaining position that the best deal they can get is a manifestly unjust one. Faced with such a choice, maltreated victims may well retaliate by deciding to trash the climate and take everybody down with them, even though that would not be in their own self-interest. The story of Kullervo in the Finnish national epic *Kalevala* provides a sobering reminder of the widespread death and destruction that can ensue from neglecting the needs of a victim by accident of birth.[25] The tragedy that beset the US at the dawn of the twenty-first century likewise reminds us of the global danger posed by failed states, and it takes little imagination to quake at the prospect of nuclear-armed Pakistan and India facing off under the stress of a late twenty-first century crop failure provoked by climate change.

At the same time we acknowledge the essential justice of according more emissions rights to the developing world than to the developed world, we must acknowledge the importance of avoiding purely quixotic actions. If the industrialized world stops emitting carbon but China and India pick up the slack, it will not serve the purpose of protecting the climate. That would be like rearranging the deck chairs on the Titanic. It may satisfy some sense of justice to give the steerage passengers a chance to lounge on the first class deck before the ship goes down, but it would be better to get everybody into lifeboats. Getting the developed world to agree to just emissions caps is only part of the negotiating strategy needed to bring the rest of the world into a controlled-carbon regime.

IV. Discussion and Conclusions

Our analysis confirms and consolidates Singer's conclusion that under a broad range of generally recognized and intuitively appealing principles of justice, the first world—and especially North America—has the greatest obligation to aggressively reduce carbon emissions. This conclusion applies even if we write down all carbon emissions before 2008 and even without factoring wealth redistribution into the equation for social justice. But that does not mean the first world can go it alone, since it is global emissions that count, and the problem cannot be solved without a regime that can persuade the developing world—especially India/Pakistan and China—to bring down their carbon

25 Elias Lönnrot, *The Kalevala: Epic of the Finnish People* 257–62 (Otava 1988) (Eino Friberg, trans).

emissions as well. Developed world citizens are being asked to give up a real benefit in order to serve the goal of climate justice, and giving up this benefit conflicts with a legitimate desire to protect the interests of nation and family—those nearest and dearest. If an agreement is to be reached on the basis of considerations of justice and human equality, there must be the strictest possible assurances that what is given up actually advances the goal of protecting the climate for everybody's future benefit.

Posner and Weisbach's proposal is in essence a Victim Pays model and, in contrast to any of Singer's principles, justifies relatively more inaction by the first world at the expense of the developing world. It could be argued that the moral status of Victim Pays is no more arbitrary than that of Polluter Pays (which rests on a weak presumption of human equality) or Equal Future Shares or Equal Total Shares (which rest on a strong presumption of human equality), and that any of them requires foundational justification. This is a manifestation of the age-old and largely insoluble problem of where morals come from. One can try to derive a given moral position from some more general principles, but in the end, all moral frameworks are quintessentially axiomatic, whether the axioms come from Amartya Sen, Martha Nussbaum, or God (and even in the latter case, one must decide whose God and then which text she speaks through). Morals are sets of axioms to which groups of people agree to be bound, for diverse and sometimes unfathomable reasons. Victim Pays and Equal Total Shares represent opposite poles on the spectrum of respect for human equality, with Polluter Pays somewhere in the middle; from the standpoint of consequences for climate protection, any point on the spectrum will do, provided the major emitters can be persuaded to sign onto the protocol. Presumably, developing world nations would prefer some form of Equal Shares, while the developed world would prefer Victim Pays, at least if they can overcome the moral squeamishness of setting aside all the principles of equality enshrined in the foundational documents of most liberal democracies. One can increase the chances of a global agreement by persuading developed world governments to move more in the direction of Equal Shares, or by persuading the developing world governments to move more in the direction of Victim Pays. I myself feel more comfortable working to persuade developed world governments to adhere to the principles of human equality and dignity they so often profess than I would in trying to persuade the poor to be happy victims.

One way to judge a set of moral principles is to see what kind of actions it could justify, and decide whether we ourselves would wish to be bound by principles that could allow such things to come to pass. Seen in this light, Victim Pays is an affront to most of the principles the civilized world professes to hold dear—indeed the very principles enshrined in our own Declaration of

Independence.[26] Any moral framework that makes us comfortable with Victim Pays also could be used to justify slavery, racial discrimination, stealing land from aboriginal peoples, and any number of other practices whose company decent people would not want to keep. Victim Pays puts us in the company of Nietzsche, while Equal Shares puts us in the company of Goethe. To bring things closer to home, let us suppose that your wealthy neighbor opens an electroplating plant, whose effluent contaminates the well on your property, which is your only source of water, and renders it unusable. He, however, is unaffected, since his water comes from a clear mountain stream higher up. You complain, but his response is that it is *you* who owe him the cost of cleaning up his plant, since you're the one who benefits from being able to use the well. We would not tolerate such an outcome in domestic pollution law, so it is hard to say what moral justification we have in expecting the developing world to acquiesce to the exact analogy in carbon, writ large, when it comes to international negotiations.

But even if we agree on human equality as a foundational principle for just distribution of the Carbon Commons, it must be admitted that deciding just what is meant by "equality" and whether it really demands some form of Equal Shares remains a vexing problem, which I do not propose to solve here. Both the deep appeal, and problematic aspects, of the notion of human equality have been reviewed by Patrick Brennan,[27] who reiterates that humans are manifestly unequal with regard to abilities and any number of other characteristics, and few proponents of equality would wish it upon us that everybody should become identical, or even that all outcomes should be identical. To the contrary, there is in general a celebration of human diversity. So what can it possibly actually mean for humans to be equal? Herbert Spiegelberg,[28] writing poignantly at a time when the Nazi regime was visiting the worst consequences of Nietzschean inequality on the world, arrived at the conclusion nonetheless that not all factual inequalities should be subject to cancellation. What he finds instead is "the need of redress for the unwarranted privileges and handicaps of our unequal stations at birth."[29] Precisely what this redress should entail when the unequal station arises from one individual being born more intelligent than another (and therefore better able to make use of the fruits of a college education) is unclear. Some forms of unequal circumstances at birth (being born black, or female, or poor) are clearly irrelevant to the question of access to something like education or adequate health care, and need unconditional redress. The question of

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26 Decl of Ind.

27 See generally Patrick M. Brennan, *Arguing for Human Equality*, 18 J L & Relig 99 (2002).

28 Herbert Spiegelberg, *A Defense of Human Equality*, 53 Phil Rev 101, 124 (1944).

29 Id.

whether a person should suffer a reduced share of the Carbon Commons simply because she was born African or Indian falls naturally into the same category.

There is another school of thinking about equality, however, which defines equality instead as equal access to certain fundamental *capabilities* (which are themselves axiomatic). This point of view was put forth cogently by Amartya Sen,[30] who finds severe conceptual difficulties in other means of coming to grips with equality. The question then becomes not one of an *equal* share, but rather one of an *adequate* share needed to enable the basic human capabilities. Nussbaum[31] lists one possible (arguably minimal) set of basic human capabilities. Would 100 tonnes of carbon emission per person be enough to provide these capabilities? Is this list comprehensive enough to serve as a basis for international negotiations or should it be expanded? Such considerations could move the default just allocation dictated by Equal Shares, but it would take much further analysis to determine the direction of the adjustment.

Finer points of moral philosophy notwithstanding, anyone arguing that some human beings are intrinsically endowed with a right to a greater share of the Carbon Commons (or any other scarce resource) than others should face a high hurdle in justifying this claim. One could counter that life is unfair and it's not our particular obligation to right all wrongs. Investment bankers are paid more than professors and we tolerate that—after all, we did choose to be professors. But when women and black people are paid less than white men for the very same work, that is, in modern society, considered rank injustice, though in historical times it might have been considered merely a "misfortune" (like the Lisbon Earthquake) to have been born a woman or black—or a slave. Those who argue that the developed world has no particular obligation to take on more of a share of carbon mitigation efforts than the developing world are in essence arguing that it is just a misfortune that the Chinese were born into a nation that did not get to the Carbon Commons as soon as we did. Here, we should pay heed to Shklar's admonition that the rich are very prone to finding ways to reclassify injustice as misfortune.[32] It seems to me that much of the abundant cleverness displayed in Posner and Weisbach's book[33] is deployed to this very end.

Much of my discussion assumes that nations and individuals will have to accept a considerable harm or loss from actions to reduce carbon emissions.

30 Amaryta Sen, *Equality of What?* 217–19 (Tanner Lecture on Human Values, delivered at Stanford University, May 22, 1979), online at http://tannerlectures.utah.edu/lectures/documents/sen80.pdf (visited Oct 12, 2012).

31 Martha C. Nussbaum, *Climate Change: Why Theories of Justice Matter*, 13 Chi J Intl L 469, 487 (2013).

32 Shklar, *The Faces of Injustice* at 68–70 (cited in note 18).

33 Posner and Weisbach, *Climate Change Justice* (cited in note 24).

This is not actually so certain, even in the short term. In the long term one is going to have to adapt to a world without fossil fuels at some point, since they will surely run out—and probably sooner than we think. Prudent measures to decarbonize the economy early and in an orderly fashion could well leave us more prosperous and secure than business as usual.[34] The alternative would confront society with the simultaneous crises of energy scarcity and an irretrievably wrecked climate. Nations and individuals currently seem to have more fear of messing with the economy than of messing with the climate. Perhaps the reason is to be found in Shklar's observation that "[w]e get angry at and on behalf of individuals but are indifferent to wrongs that seem to affect too many people at large."[35] In contrast to the dispersed and somewhat abstract harms from a changing climate, economic impacts may seem very individual. If this cognitive dissonance can be countered, and it becomes recognized that there is a path forward that makes everybody better off and richer, then much of our theorizing about justice based on the premise that avoiding climate change is bitter medicine will be moot.

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34 See generally Amory B. Lovins and Rocky Mountain Institute, *Reinventing Fire: Bold Business Solutions for the New Energy Era* (Chelsea Green 2011).

35 Shklar, *The Faces of Injustice* at 109 (cited in note 18).