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# Greenhouse Development Rights: towards an equitable framework for global climate policy

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**Abstract** *The assignment of obligations to pay for mitigation of greenhouse gas emissions and for adaptation to unavoidable climate change is a critical and controversial component of international negotiations under the United Nations Framework Convention on Climate Change. In this article we present a new framework called 'Greenhouse Development Rights' (GDRs): a formula for the calculation of national obligations on the basis of quantified capacity (wealth) and responsibility (contribution to climate change). GDRs seek to preserve the 'right to development' by exempting from obligation any income and emissions under a 'development threshold'. By taking into account the distribution of income and emissions within countries, and calculating national obligations as if they were the aggregated obligations of individuals, the framework treats every global citizen identically, and allocates obligations even to poor countries that are proportional to their actual middle-class and wealthy populations. When coupled to a trajectory of rapid emissions reductions (for example, 80 per cent reduction below 1990 levels by 2050), the framework results in larger reduction obligations for both rich and poor countries than they currently seem prepared to accept. However, the formula may be 'fair enough' to break the impasse that currently separates rich and poor countries in the negotiations.*

## Introduction

Since the 1992 adoption of the United Nations Framework Convention on Climate Change (UNFCCC), whose core mandate is to 'prevent dangerous anthropogenic interference with the climate system', the concentration of atmospheric carbon dioxide ($CO_2$) has risen dramatically and the *rate* at which the concentration is rising has accelerated in recent years (Canadell et al 2007). During the same time

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period evidence has mounted that the measured increase in global average temperature over the last century—caused substantially by $CO_2$ and other greenhouse gases (GHGs) added to the atmosphere since the Industrial Revolution—is resulting in adverse effects to ecosystems, precipitating glacier melt in most mountainous regions and beginning to disintegrate the ice cover at both poles.[2] Scientific evidence strongly supports the case not only for GHG emissions cuts, but for *deep* cuts in a matter of decades;[3] the interests to be protected here are not just those of future generations, but those of people now living.

The Kyoto Protocol to the Convention, which came into effect in 2005, required obligated countries to make only modest emissions cuts. It has failed even to significantly reduce the rate at which global emissions are rising—nor is it expected to do so even if all ratifying parties meet their obligations under the Protocol by the end of the commitment period in 2012. This is because the Protocol, though an important first step in addressing the UNFCCC mandate because it includes binding reduction commitments, lacks some essential features. First, although it calls for reductions on the part of 'Annex I' (industrialized) signatories below an emission baseline set in 1990, the Protocol does not include scientifically informed specific temperature targets or corresponding atmospheric carbon concentration targets: in other words, it does not include any criteria for what might be called 'climate adequacy', by which we mean emissions cuts that are calibrated to some defined threshold of 'dangerous climate change'.

Second, the Protocol was crafted in accord with the UNFCCC division of the world into Annex I (obligated industrial countries) and non-Annex I (developing, nonobligated countries). This division operationalizes the UNFCCC requirement that commitments be reflective of unequal national responsibilities and capabilities, and represents a crucial recognition of global inequality. But the Protocol's criteria have been criticized as arbitrary, and the binary division inadequate to take account of what is actually a vast range of difference in national circumstances. Moreover, because non-Annex I countries are exempt from mitigation commitments, the Protocol does not directly address the large and growing aggregate emissions (albeit still small in comparative per capita terms) of rapidly industrializing countries such as China and India. The exemption of these large aggregate emitters under Kyoto has contributed substantially to the political deadlock evident at Kyoto and in subsequent negotiations, since it has been used by the United States (US), the largest aggregate emitter up to the present, to justify its refusal to ratify Kyoto or undertake *any* binding international mitigation commitment.

Our primary purpose in this article is to present Greenhouse Development Rights (GDRs) as a principled equitable framework by which a precautionary

[2] The scientific literature on impacts through roughly 2005 was summarized by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (see for example the Synthesis Report; IPCC 2007a) but worrisome new reports continue to appear regularly (see, for example, *Science Daily* 2007).

[3] Advocates of precautionary climate policy have long cited 2°C above the preindustrial mean as a threshold for 'dangerous climate change' to be avoided; even a 50 per cent chance of staying below this level requires emissions to peak by 2020 and drop to at least 50 per cent below 1990 levels by 2050 (IPCC 2007b, 15–16). Evidence of significant harm from the current temperature increase of 0.8°C now suggests that even the 2°C threshold may be unacceptably high—see for example, Hansen (2007) and Spratt and Sutton (2008).

emissions budget (total allowable emissions over a given time period) might be divided, and which suggests how the costs of mitigation and of adaptation to climate-induced changes that cannot be avoided might be fairly shared. A just distribution of emissions cuts, their costs and the costs of adaptation, we argue, would impose the greatest burden on wealthy people and countries, while preserving for poor people and poor countries the means to achieve 'sufficiency' (Page 2006, 85–93). We believe such a distribution of costs to be equitable. Without the right to the majority of the world's remaining emissions budget and substantial financial assistance for low-carbon development, the world's majority population will likely find its opportunity to enjoy a decent standard of living foreclosed because of the well-documented historical relationship between prosperity and per capita energy use.

A principled and transparent division of mitigation obligations and costs has been called for by a number of developing country parties to the UNFCCC. At the 2007 UNFCCC meeting in Bali, representatives from Africa, South Asia, and Central America underlined the need to take account of particular national circumstances (UNFCCC 2008a, 15). We believe that a principled and transparent approach to 'burden sharing'—or, as some call it, 'differentiation of commitments'—offers the best chance to bring high aggregate-emissions developing countries such as China and India into a post-Kyoto climate regime. These countries must be on board if the world is to achieve a precautionary emissions target within the necessary time frame. A framework that explicitly guarantees the right to development—that is, atmospheric space, the financial and technological means to provide energy services, and time to grow without Draconian restrictions —is thus an evident political necessity.

The GDRs framework is conceived as a design that can satisfy the 'adequacy and equity imperatives' that were enshrined although not specified in the UNFCCC. Sovereign states claim to seek an adequate and equitable solution to the climate problem; the GDRs framework suggests what such a solution might look like, and provides a transparent formula and set of criteria through which the obligations of states can be quantified. Thus GDRs are not a mere thought experiment: the imperatives have been officially recognized and agreed to. The first part of our article therefore lays out precautionary criteria for adequacy, quantifies the conditions that would enable the satisfaction of the equity imperative and explains the formula from which we derive the suggested obligations of states. A unique, and indeed, central feature of the GDRs framework is that the distribution of income *within* states is used as one of the bases upon which their obligations are calculated. This is a novel and potentially controversial feature, but it reflects much more accurately the actual global income distribution (and thus capacity to pay) than any framework that divides obligations among rich and poor *countries.*

Second, we suggest ways that the framework might be relevant to the present negotiations for the second and subsequent commitment periods of the Kyoto Protocol,[4] and more generally to the coming decades of international

[4] The quantified obligations of the Kyoto Protocol govern the so-called 'First Commitment Period' from 2008 to 2012. A second commitment period would thus presumably begin in 2013 but its end date would be negotiated.

climate policy. As we will show, the GDRs framework offers a way to rectify the deficiencies in the binary (Annex I/non-Annex I) differentiation of commitments in the Kyoto Protocol, and to calculate mitigation obligations appropriate to the continuum of countries in terms of their capacity and responsibility. However, a transition to a full global cap-and-trade or equivalent scheme may not immediately be feasible regardless of the allocation principles; thus we address the potential role of GDRs in an incremental evolution of the Kyoto and UNFCCC architectures.

## The Greenhouse Development Rights framework



The GDRs framework is a global climate policy architecture for the allocation of costs—a *burden-sharing* framework, in the policy jargon. It offers a transparent and defensibly fair method for allocating costs, whether for mitigation or adaptation, based on principles of *capacity* and *responsibility*, both of which are widely acknowledged ethical criteria and both of which are regularly invoked by parties to international climate negotiations.[5] Crucially, the framework quantifies national obligations on the basis of the income distribution within countries, so that conceptually a person with the same income and historical emissions would bear the same proportional share of global obligations, regardless of the country in which he or she lives. We believe this is an appropriate ethical principle for the allocation of obligations in a global community, that it embodies a notion of 'fairness' that is understandable and transparent, and is therefore politically defensible.

Although the GDRs framework is in some sense independent of the particular goal that is set for a precautionary global emissions budget, it is motivated in large part by the recognition that the urgency of the climate crisis requires global emissions to fall rapidly long before today's poor countries become 'developed'. In this context, in the absence of a true technological miracle, we see only three possibilities: the climate regime severely limits the growth in energy use of the world's poor; the rich pay to subsidize low-carbon development globally; or we abandon the possibility of rapid emissions reductions that can hope to stabilize the climate. The dilemma is illustrated by Figure 1, which shows a global 'emergency pathway' emissions trajectory that peaks in 2013 and falls at about 5.5 per cent annually to 80 per cent below 1990 levels by 2050, and which *still* has a roughly 14 to 32 per cent chance of leading to temperature increase of more than 2°C above the preindustrial mean.[6] Against this we show an 'optimistic' pathway for the current Annex I countries (bottom line), in which their emissions drop to

[5] Indeed, the UNFCCC itself states that countries should 'protect the climate system . . . on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities' (UNFCCC 1992, article 3 paragraph 1).

[6] The likelihood that any emissions pathway will lead to temperature increase over, for example, 2°C is not an objective probability (like the probability of rolling a six on a fair die). Estimates of these kinds are necessarily *subjective probabilities* and, given the complexity of the system and our ignorance about its mechanisms, reasonable people will disagree. Thus these kinds of risk estimates can only be reported as 'ranges of reasonable probabilities'. These ranges here were calculated with the Monte Carlo Climate Model ($MC^2$), calibrated to results of GCMs published in the scientific literature; calculations based on different models would presumably overlap the ranges reported here. See Baer and Mastrandrea (2006).

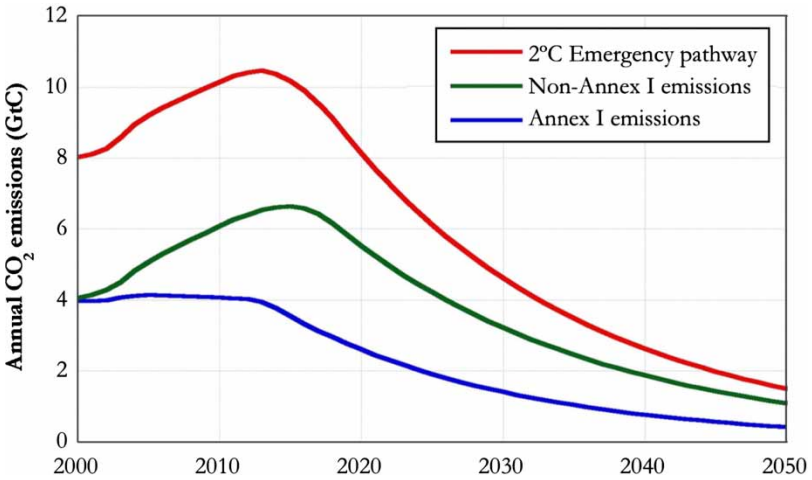


**Figure 1.** Hypothetical $CO_2$ budgets for Annex I and non-Annex I countries under global 'emergency pathway' (see main text)

90 per cent below 1990 levels by 2050. What is left by subtraction is the available carbon budget for the non-Annex I countries, which is represented by the line in the middle. What Figure 1 demonstrates is that emissions in non-Annex I countries must begin to fall shortly after the global peak (2015 in this calculation) and must soon thereafter fall at almost the same rate as global emissions.

What Figure 1 does *not* show is the development status of the non-Annex I countries at the time their emissions must peak and drop. Although such projections are obviously speculative, the fact that the non-Annex I peak must occur within a decade clarifies the situation: even at 5 per cent annual growth in per capita incomes,[7] the average income in the non-Annex I countries in 2018 would still be less than $7,500, adjusted by Purchasing Power Parity (PPP).[8] Furthermore, on projected growth rates, per capita *emissions* in the developing countries would be only about 1.1tC (ton of carbon) per annum, compared to current levels in the Annex I countries of over 3tC. In this context, the idea that developing countries would agree to pay to mitigate at the same rate as developed countries seems, to say the least, far fetched.

Yet, these *average* projected incomes and emissions in the developing countries mask enormous differences of income between them—as well as unequal income distributions *within* them (we leave aside for now the parallel issue in developed countries). At least ten non-Annex I countries have per capita incomes over

[7] For comparison, the countries classified as 'low income' by the World Bank, with roughly 35 per cent of global population, have seen real per capita income growth (in PPP terms) averaging 4.6 per cent annually over the last five years and 3.2 per cent annually over the last 20 years; the lower-middle income group, with roughly the same population (and including China) has had growth of 5.8 per cent annually over the last five years and 5.0 per cent over the last 20 years.

[8] This translates the purchasing power of various national currencies into purchasing power in US dollars. Because a PPP-adjusted figure shows what local incomes *actually buy* in dollar terms, PPP adjustments facilitate more accurate comparisons between countries than conversion using market exchange rates.

$20,000 annually—it is a stretch to still call them 'developing'.[9] And across all of non-Annex I, our estimate suggests that there are already about 750 million people whose incomes exceed $7,500 per capita (PPP adjusted), a level roughly equal to the poverty line in industrialized countries, and which we define for reasons we give below as an individual 'development threshold'. Indeed, it is precisely because there is already this substantial population of developing country citizens—who, although (mostly) not wealthy, are not poor—that we consider it necessary to look within countries to properly estimate the 'capacity' to pay for climate policy (mitigation and adaptation).

In the remainder of this section we will describe in some detail the method that we use to calculate capacity and responsibility, and the way we combine them into a single 'Responsibility and Capacity Indicator', or RCI. Behind all the technical detail, however, it is important to understand that the guiding principle is simple: those who have more capacity to pay, and those who have more responsibility for creating the problem, should contribute more to solve it. This, we maintain is the ethical consensus that underlies the UNFCCC's recognition of 'common but differentiated responsibilities and respective capabilities'. What we have tried to do is to quantify and combine them in a way that adequately protects the poorest and least responsible from bearing the costs of climate policy; this is ultimately what we mean by the 'right to development'.



### Defining and combining capacity and responsibility

We offer a very simple definition of capacity: for an individual, capacity is the income a person has over a specified (PPP adjusted) 'development threshold'. We leap over a stunning amount of complexity here, but the point is that there is a commonly held view of the difference between 'necessities' and 'luxuries'.[10] Capacity in this context is simply the ability to reduce one's consumption without sacrificing necessities. Thus it is a necessarily moral concept, and one that is useful despite the difficulty of specifying a necessity/luxury dividing line with precision; therefore our threshold figure should be understood as a first approximation for purposes of illustration. Nonetheless, there is plenty of evidence supporting the distinction (such as the continued support for progressive taxation).

We have picked for our 'central case' a development threshold of $7,500 per capita, in PPP adjusted dollars. This is obviously much higher than the $1 or $2/day threshold that typically defines 'absolute' poverty; rather, it resembles a poverty threshold in an industrialized country.[11] Keep in mind that, to the extent that PPP adjustments achieve their goal, this figure represents the purchasing power of $7,500 in the US, which is not very much. In terms of energy use, food

[9] Note that we do not intend to imply by this that 'development' is *simply* a matter of economic growth and high per capita incomes, but that discussion would take us far afield.

[10] Developing-country negotiators reference this distinction in speaking of 'luxury emissions' versus 'subsistence emissions' at international climate talks (Embassy of the People's Republic of China in Australia 2007), following Agarwal and Narain (1991) who first coined the expression.

[11] Pritchett (2006) argues that a global poverty line—as opposed to an extreme poverty line—should be on the order of $6,000 PPP adjusted; our $7,500 figure is roughly 125 per cent of this level.

**Table 1.** Sensitivity of covered population and measured capacity to alternative definitions of 'development threshold' (see main text)

| | *Population over threshold* | | *Capacity* | |
|---|---|---|---|---|
| *Development threshold ($PPP adjusted, 2005)* | *Total (billions)* | *Percentage of global* | *Total ($ trillion, $PPP adjusted, 2006)* | *Percentage of gross world product (GWP)* |
| 6,000 | 2.1 | 33% | 40.4 | 62 |
| 7,500 | 1.8 | 28% | 37.1 | 57 |
| 9,000 | 1.6 | 25% | 34.3 | 53 |



consumption, medical care and so forth, it goes only slightly beyond bare necessities. Indeed, in the industrialized countries, persons earning this amount or less are not only typically exempted from income taxes, but are eligible for subsidies of various sorts from the national treasury.[12]

Our point, however, is not that this threshold or any other is 'correct'. In Table 1, we show for our $7,500 threshold, and for slightly lower and higher figures, what fraction of the world's population falls above or below the threshold, and what fraction of the world's capacity is held by those above or below it.[13] It shows that the capacity of the 1.8 billion persons (roughly 28 per cent of the world's population) with incomes over $7,500 amounts to about 57 per cent of gross world product (GWP). Lowering the development threshold to $6,000 would increase the number of people above the threshold from 1.8 to 2.1 billion (a 17 per cent increase) but only increase the measured capacity from 57 per cent to 62 per cent of total GWP (a nine per cent increase). If, for example, one were trying to raise a sum equal to one per cent of GWP (about $590 billion in 2006) by an equal percentage tax on those with capacity, this would mean—for a $7,500 threshold—a tax rate of about 1.6 per cent on all income over $7,500, whereas for a $6,000 threshold, one could have a tax rate of 1.45 per cent on all income over $6,000. With the lower

[12] It is important to keep in view that $7,500 is an individual, not a family, threshold. Thus, threshold income for a family of four in the US would be a more realistic $30,000. However, since the poverty line for a family of four is not the same as four times the poverty level for an individual, no individual threshold can precisely capture the 'capacity' of differently-sized households. Furthermore, national plans could (and should, in our view) be designed so that the *actually taxed* threshold income is considerably higher than the *global* threshold we use to calculate countries' aggregate obligations. For instance, people with over a million dollars' annual income could certainly assume some of the obligations of individuals with incomes between $7,500 and, say, $50,000.

[13] We have used countries' per capita income and their Gini coefficients, which are widely accepted indicators of income inequality, to calculate countries' above-threshold income. We assume that national income can be modelled as a lognormal distribution, which (compared to the bell-curve shape of the well-known 'normal' distribution), is 'pushed to the left' and has a long right-hand 'tail' (see Kemp-Benedict 2001). Using this model, one can estimate how many people in each country are in each 'income bracket', and from this calculate capacity. Inequality matters because in a country with (say) a per capita income of $5,000, if that income were distributed perfectly evenly, the country would (by our definition) have no capacity; as rising inequality shifts income towards those whose individual income is over the threshold, the country's measured capacity rises.

threshold someone earning $7,500 per year would now pay around $20 instead of nothing, and someone earning $50,000 would pay about $640 instead of $670. Of course, whether this is desirable is a value judgement, but what is ultimately at issue is simply that if the income threshold is lowered, poor people must pay more for mitigation and adaptation so that rich people can pay less.

The way in which we calculate obligation on the basis of the distribution of income and emissions *within* countries means that setting the threshold in one place or another doesn't affect whether countries *as a whole* are above or below it; a country will always have obligation proportional to the capacity and responsibility of the fraction of its population, however large or small, that is above the line. This, we suggest, is a key political requirement of a viable and politically acceptable global climate regime. At present, Kyoto's complete exemption of non-Annex I countries from all cost-bearing obligations means that economic elites in poor countries can hide behind their own poor (Baer et al 2007, 66).



The second component that enters into the calculation of obligations in the GDRs framework is 'responsibility', defined broadly as 'contribution to the problem of climate change'. Allocation of burdens on this basis is thus an implementation of the widely endorsed 'polluter pays' principle. There are several ways to convert this general definition into a specific formula; one could count contributions to total GHG emissions, contribution to the remaining stock of GHGs in the atmosphere, or contribution to current or future temperature change, and one could also include or exclude various global sinks, such as forests. One could also choose different gases, different sources or different time periods. Thus any single definition has an element of arbitrariness, and countries could be expected to advocate definitions that reduce their relative responsibility. We choose *per capita emissions of $CO_2$ from fossil fuel consumption since 1990*,[14] a definition that gives greater responsibility to the developing countries relative to longer time periods, but gives greater responsibility to the developed countries than they would have if emissions from deforestation had been included. As a matter of necessary simplification, we assume that historical emissions are distributed in exact proportion to income; thus a fraction of emissions corresponding to 'below the threshold' income is excluded from our accounting.

Finally, to calculate the 'Responsibility and Capacity Indicator' (RCI) that we ultimately use to define a country's share of global obligations, we combine the measures of responsibility and capacity using the formula $RCI = R^a \bullet C^b$ with the restriction that $a + b = 1$. In our base case we set $a = 0.4$ and $b = 0.6$, which weights capacity somewhat more than responsibility. These could be weighted differently, but because some high emitters are poor we have assigned a greater weight to capacity here in the belief that it is fairer for rich countries with low emissions to pay more. Again, C (capacity) is 'income over the threshold,' and R (responsibility) is cumulative per capita emissions from fossil fuels, starting in 1990.

[14] Because the First Assessment Report of the IPCC was published in 1990, it is commonly argued that policy-makers have been informed of the climate change problem—and thus nations have moral responsibility—dating from that year.

**Results**

Table 2 shows, for selected countries and groups of countries, the results of our calculations. We include all of the 'plus 5' developing countries but not all of the G8.[15] We also include the Least Developed Countries (LDCs) and the Annex I and non-Annex I countries.

For each country or group we show, in percentage terms, its share of global population, global income (PPP adjusted), 'capacity' as we defined it above, cumulative fossil fuel emissions from 1990, 'responsibility' as we defined it above, and the combined RCI. Data is projected to 2010 using growth estimates from the International Energy Agency (2007) to reflect more accurately the distribution of income and emissions relevant for post-2012 burden sharing. Table 2 shows that, for all of the limits to the Annex I/non-Annex I distinction, Annex I still includes most (around 75 per cent) of the aggregate capacity and responsibility, despite comprising a small fraction (19 per cent) of the world's population. Together the US and the EU account for more than 55 per cent of calculated global obligations, as measured by the RCI, with the US alone accounting for 32 per cent. By contrast all non-Annex I countries, with 81 per cent of global population, account for only 25 per cent of global obligations. This is not a trivial share, however, as asking for it to be waived would significantly raise everyone else's 'bill'; with literally hundreds of billions of dollars a year at stake, 25 per cent is, as they say, 'real money' and represents a significant obligation for the wealthy in developing countries.

It is useful to go a little further and to consider the application of the GDRs 'obligation formula' to stylized models of fund-based and cap-and-allocate[16]-based implementation. Firstly, as we suggested above, we consider the possibility that the 'costs' of climate change policy (both mitigation and adaptation) could easily be one per cent of GWP—roughly $700 billion in PPP terms in our 2010 projection—which could hypothetically be paid by allocating that amount as a 'tax' on countries in proportion to their RCI. We show in Table 3, in addition to the total 'bill' a country would receive under this allocation, the percentage of people in each country who are over the 'threshold' per capita income. Then, using this fraction, we show the 'per taxpayer' bill on the assumption that only those over the threshold actually pay the tax.

Of course the GDRs framework could not mandate how a country's bill was to be allocated and collected internally, but certainly the political intent is to ensure that the international system lends legitimacy to the demands of poor people to fair treatment in their national policies.

Table 3 presents the results of a highly stylized model of a global assignment of obligations, yet it is intended to be the basis for evaluating concrete proposals. We offer here a defensibly fair allocation of a dollar-denominated global funding requirement, in national and per capita terms, and those who find our arguments

[15] The G8+5 group was formed in 2005 when Tony Blair invited the heads of state of five of the largest developing countries (Brazil, China, India, Mexico and South Africa) to the G8 meeting in Gleneagles, Scotland, in part to address climate change.

[16] We use the term 'cap and allocate' rather than 'cap and trade' to emphasize that, although (theoretically) economic efficiency is achieved by trading, the allocation of permits is what determines the fairness of the system and is a primary, not secondary, consideration.

**Table 2.** Key data and indicators for selected countries and groups of countries, based on 2006 data projected to 2010 (see main text; note that all numbers are in percentage terms)

| | *Per cent share (projected to 2010)* | | | | | |
|---|---|---|---|---|---|---|
| | *Global population* | *Global income* | *Global capacity* | *Cumulative emissions since 1990* | *Global responsibility* | *Global RCI* |
| US | 4.6 | 20.7 | 29.7 | 23.3 | 33.9 | 31.8 |
| EU (27) | 7.2 | 21.6 | 27.9 | 15.9 | 20.5 | 24.8 |
| Russia | 2.0 | 3.2 | 2.9 | 6.3 | 5.9 | 3.9 |
| Brazil | 2.9 | 2.8 | 2.3 | 1.4 | 1.2 | 1.8 |
| China | 19.7 | 12.5 | 5.9 | 15.7 | 7.5 | 6.6 |
| India | 17.2 | 5.2 | 0.8 | 4.2 | 0.7 | 0.8 |
| Mexico | 1.6 | 2.0 | 1.8 | 1.5 | 1.4 | 1.7 |
| South Africa | 0.7 | 0.7 | 0.6 | 1.6 | 1.4 | 0.9 |
| LDCs | 12.5 | 1.5 | 0.1 | 0.6 | 0.0 | 0.1 |
| Annex 1 | 18.8 | 57.2 | 75.1 | 56.5 | 73.4 | 74.6 |
| Non-Annex 1 | 81.2 | 42.8 | 24.9 | 43.5 | 26.7 | 25.4 |

**Table 3.** Characteristics of a fund-based system in which one per cent of GWP is raised by an equal percentage tax on the income of all persons over the $7,500 'development threshold' (see main text)

| | *Total income (billion $ PPP projected 2010)* | *Total capacity (billion $ PPP projected 2010)* | *Percentage of global RCI* | *Bill at 1% of GWP ($ billion PPP)* | *Per 'taxpayer' bill at 1% of GWP ($PPP)* |
|---|---|---|---|---|---|
| US | 14,226 | 11,909 | 31.8 | 219 | 733 |
| EU (27) | 14,845 | 11,192 | 24.8 | 171 | 412 |
| Russia | 2,173 | 1,166 | 3.9 | 27 | 228 |
| Brazil | 1,891 | 926 | 1.8 | 12 | 166 |
| China | 8,567 | 2,345 | 6.6 | 45 | 124 |
| India | 3,541 | 321 | 0.8 | 5.2 | 65 |
| Mexico | 1,368 | 730 | 1.7 | 11.5 | 199 |
| South Africa | 502 | 257 | 0.9 | 6.2 | 320 |
| LDCs | 1,018 | 36 | 0.07 | 0.4 | 57 |
| Annex 1 | 39,357 | 30,112 | 74.6 | 513 | 447 |
| Non Annex 1 | 29,400 | 9,973 | 25.4 | 175 | 169 |
| World | 68,757 | 40,085 | 100.0 | 688 | 315 |

plausible can compare these numbers[17] to those derived from other proposals to address the inevitable needs for some international funding of mitigation and adaptation. Of course, if total obligations turned out to be 0.1 per cent or five per cent of GWP, our formulas could still be applied; we picked the one per cent example in part because it's easy to multiply, not because it is necessarily our best estimate of the total 'bill' to be paid.

[17] Note that by 'these numbers' we don't mean narrowly the results in this particular table, but those that are derived from plausible variations in key parameters like the development threshold and the weighting of responsibility and capacity.

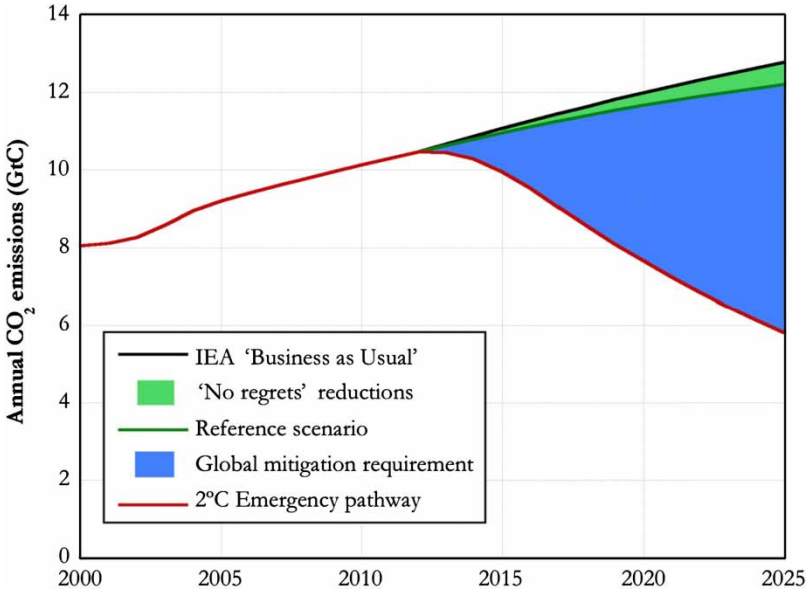


**Figure 2.** Global $CO_2$ emissions trajectory showing 'no regrets' reductions (small wedge) and the global 'mitigation gap' (large wedge) associated with a global 'emergency pathway'

Next we consider the implications of using the RCI as the basis of a cap-and-allocate system, in which hypothetically each country is allocated tradable emissions permits consistent with a precautionary global emissions trajectory. Figure 2 shows the global mitigation requirement or 'mitigation gap' between a hypothetical baseline and the precautionary 'emergency pathway' shown in Figure 1. We show two different baselines, an upper 'Business as Usual' (BAU) baseline and a lower 'reference scenario' baseline which takes into account negative and zero-cost 'no regrets' mitigation options. The larger wedge represents the emissions reductions that must be paid for by someone; the 'no regrets' wedge represents reductions that are presumed profitable or of no net cost to the country that makes them, and thus don't represent costs to be allocated.[18]

Figure 3 shows the 'mitigation gap' from Figure 2, divided into wedges proportional to the RCI for the indicated country or group of countries. This is analogous to the 'technology wedges' defined by Pacala and Socolow (2004), except that it shows the share of reductions to be accounted for by a country, rather than a technology. In this regard, it resembles the way in which the so-called 'Brazilian proposal' would have allocated global reductions, by dividing a mitigation objective in proportion to a single indicator of national 'shares'.[19]

[18] The 'Business as Usual' baseline is derived from projections of the International Energy Agency (2007), modified for emissions reductions through 2012. 'No regrets' reductions are based on the estimates of McKinsey and Company (Enkvist et al 2007) and the IPCC (2007b, Table TS 15).

[19] The Brazilian Proposal of 1997 allocated shares of emissions reductions in proportion to countries' contributions to global temperature change, and took account of capacity by excluding non-Annex I countries from such shares. Otherwise it is perhaps the closest relative of the GDRs approach (Meira Filho et al undated).

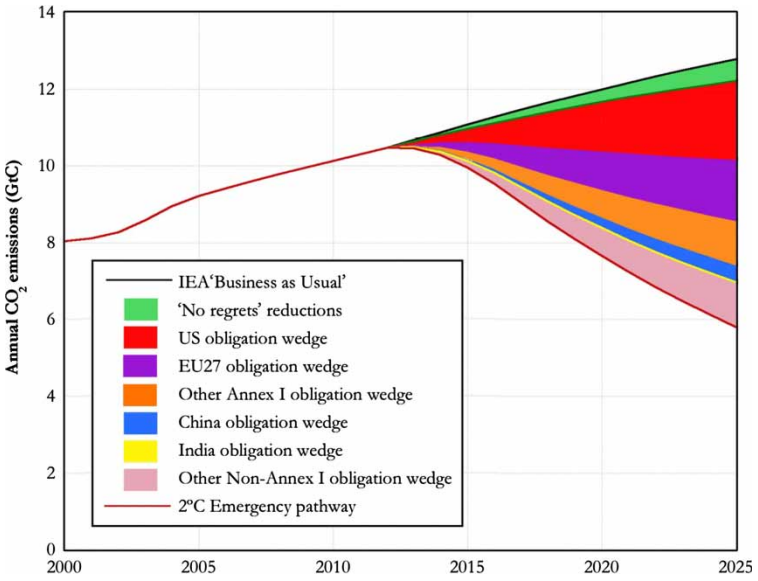


**Figure 3.** National 'reduction obligation wedges' carved out of global 'mitigation gap' in proportion to national (or regional) RCI. *Note*: the legend is in the same order as the wedges, and the 'India' wedge is effectively a line

In order to translate the 'obligation wedges' shown in Figure 3 into an actual allocation of emissions permits, one needs additionally to estimate the national baseline emissions trajectory; a country's obligation is then calculated by subtracting its percentage share of the global mitigation requirement from its baseline. We show such a calculation for the US in Figure 4, and for China in Figure 5. Again, the BAU baseline and 'no regrets' reductions should be taken as merely indicative; the key assumption is simply that a country's baseline

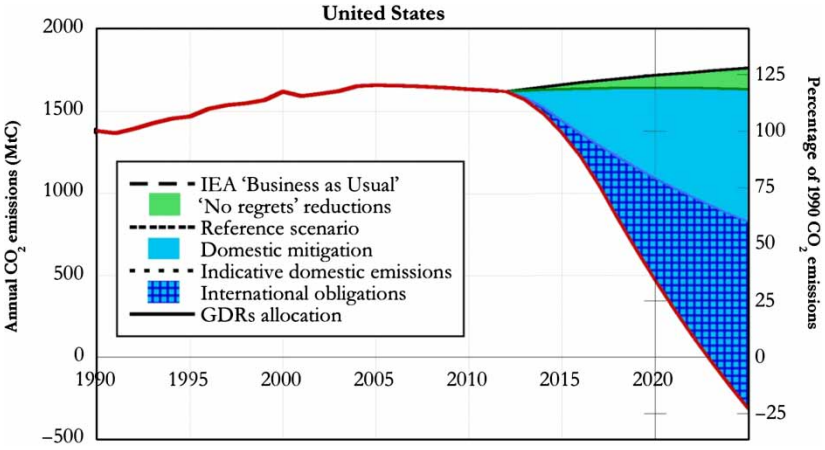


**Figure 4.** Hypothetical distribution of emissions reductions and obligations for the US under the GDRs framework (see main text)

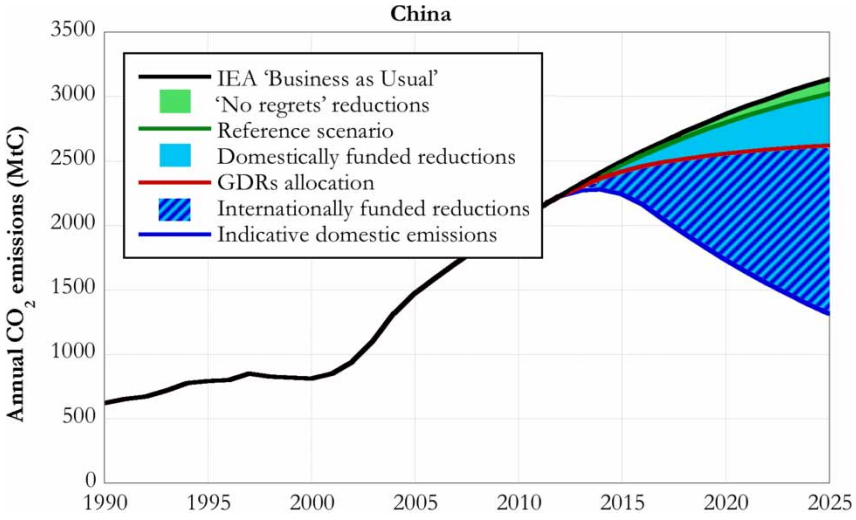


**Figure 5.** Hypothetical distribution of emissions reductions and obligations for China under the GDRs framework (see main text)

allocation, prior to its mitigation obligation, would be less than historical 'BAU' growth due to the availability of 'no regrets' mitigation options.

What we see for the US is a hypothetical 'no regrets' wedge that expands gradually between 2012 and 2025. Beneath that are two additional wedges: a wedge of *domestic mitigation*, calculated in this case to decline at six per cent annually, reaching 90 per cent below 1990 levels in 2050 (consistent with the Annex I target in Figure 1, as well as with the proposal of Al Gore and others for US reduction targets) and a cross-hatched wedge of *international reduction obligations*. Together these two add exactly to the US share of reductions shown in Figure 3, but they are shown against the national baseline rather than the global baseline. What is crucial is that by 2025, US total obligations are substantially larger than very optimistic domestic reductions. The obligations are larger than the US' total current emissions; in effect, a *negative permit allocation*. That is, in order to comply with its obligations, the US must not only purchase permits for its actual emissions, but also enough to cover the 'gap' between its negative allocation and its emissions. Although this may seem counterintuitive, it is not in principle different than being given an allocation that is smaller than a country's actual emissions; it simply means that more permits must be bought to achieve compliance.

The complementary situation for China, whose obligations are substantially *less* than the (assumed) globally cost-effective level of reductions, is shown in Figure 5. We assume here that in a world with an efficient trading regime (remember that this is only a model!), physical reductions in each country would still approximate the necessary global rate. Thus we show overall emissions (the lower line) declining at six per cent annually; the middle wedge represents the emissions reductions that China must pay for (equivalent to China's wedge in Figure 3), and the (substantially larger) striped wedge represents emissions reductions in China paid for by other countries.

Such payment obligations are precisely why one might expect that a framework like GDRs will not easily find favour in the US or other wealthy, high-emitting countries, most of which will also have negative allocations before 2025. However, if one also accepts that it is *necessary* that physical emissions drop as rapidly in China as we show, the fact remains that *someone* will have to pay for them. What we have done is create a method by which all the *people* in the world are effectively allocated obligations proportional to their capacity and responsibility; the international transfers that follow are simply a consequence of the actual distribution of wealth and emissions between and within countries.

We will comment on the political issues raised by the framework in the conclusion of the article. Before that, however, it is worth taking one additional detour to compare the GDRs framework with the most prominent 'equity framework' to date, which is allocation of emissions rights on an equal per capita basis—in particular, the 'Contraction and Convergence' (C and C) framework promoted by the Global Commons Institute in the UK (Meyer 2000). In C and C, emissions allocations 'converge' from allocation in proportion to historical emissions (grandfathering) at the beginning to allocation in proportion to population (equal per capita) at the end of a designated period.

Advocates of C and C argue that the early allocation of 'surplus' permits to low-emitting countries would allow them to fund low-carbon development. However, under global trajectories stringent enough to have a high likelihood of staying below 2°C, like our 'emergency pathway', many developing countries will have to begin reducing emissions immediately or within the next decade, long before they reach the per capita income or emissions levels of the industrialized countries. Furthermore, the system makes no distinction as to capacity between richer and poorer high-emitting countries (for example Belgium and Kazakhstan, both at 3.6tC per capita in 2005) and richer and poorer low-emitting countries (for example Argentina and North Korea, both around 1tC per capita in 2005).[20] In contrast, the GDRs framework moves beyond per capita frameworks to fairly incorporate capacity as well as responsibility into the calculations of obligations, in order to actually protect the 'right to development'.[21]



## Implementation: how GDRs might be used in a post-Kyoto context

By specifying global mitigation obligations in terms of precautionary ecological criteria and offering a formula for quantifying the obligations of states according to their historic responsibility and capacity, the GDRs framework might be used to rectify the shortcomings of the Kyoto Protocol. Whereas the UNFCCC's stated objective is to limit anthropogenic GHG emissions so as to prevent climate destabilization in a manner that takes account of different state capacities, the Protocol's modest reductions and emphasis on flexibility mechanisms, and its failure to offer a principle sufficiently specific to determine obligations, undercut

[20] Emissions data, like most of that used in this analysis, are from the US Energy Information Administration, <http://www.eia.doe.gov/environment.html>.

[21] For a more detailed review of Contraction and Convergence and several other equity-based climate policy frameworks, see Baer and Athanasiou (2007).

its primary purpose. Thus we next consider ways in which GDRs might serve as the basis for a post-Kyoto agreement.[22]

We assume that recent findings of climate scientists, as well as the findings of the 2006 Stern Review (which estimated that the costs of *in*action on climate will dramatically exceed the costs of action) have enhanced the interests of most states in adopting a rigorous post-Kyoto instrument in which all countries, including developing ones, assume more substantive mitigation obligations. Moreover, enhanced perceptions of vulnerability in the global north are also likely, as Biermann (2002) suggests, to increase the power of southern countries in bargaining for equitable treatment in the form of financial assistance, as a condition for their assumption of mitigation obligations. Roberts and Parks argue that dealing southern nations 'a fair and predictable hand' will almost certainly lead to 'an immediate and lasting payoff in terms of international environmental cooperation' (2007, 229–231).



How then could GDRs be brought into the negotiations process to support enhanced cooperation? The key point is that the central quantitative 'result' of the GDRs framework is simply *national shares based on the aggregated capacity and responsibility of individuals*. In this regard it can be used in almost any context within the negotiations in which obligations need to be divided between countries. Mitigation and adaptation are plainly the two 'supercategories', but other types of quantifiable obligations could be divided similarly.

Concerning mitigation, it is useful to consider the two 'ideal type' models we described in the previous section as a starting point for implementation of the GDRs framework. As we suggested, our formula could be used either to define national shares of a global mitigation obligation measured in tons, in which case the key step is to define the allocation of emissions rights in terms of reductions below a particular baseline, or national shares of a global mitigation obligation defined in monetary terms. The former is simple to envision; the system would be essentially the same as the existing Kyoto Protocol's allocation of 'assigned amounts', which fairly closely follow the textbook example of a cap-and-trade system. The difficulties of moving from an industrialized-countries-only system to a global system would be many, and we discuss them in further detail below. But those issues are in general the same as those that will be associated with any extension of Kyoto to most or all of the nations of the world, regardless of the basis of the allocation.

The second case of a central global mitigation fund is also easy to imagine in theory, but harder to imagine soon coming into being. The World Bank has created a 'Prototype Carbon Fund' and a 'Community Development Carbon Fund' which can support various kinds of mitigation activities, but they are voluntarily funded and small relative to the investments implied by a global 'emergency pathway'. Most analysts think that an effective international taxing authority with a mandate of several hundred billion dollars annually is not likely to win the necessary support of sovereign nations.

[22] We use 'post-Kyoto' as shorthand for 'subsequent to the first commitment period of the Kyoto Protocol', which runs from 2008 to 2012. The ongoing negotiations under the so-called 'Bali Action Plan' imply that the Protocol will likely remain in effect, but with new targets established for a second commitment period.

Although the GDRs framework offers the prospect of a global Kyoto-style allocation of tradable permits, and of transcending the artificial Annex I and non-Annex I categories, there are many difficulties along that path. First, the implementation of national mitigation policies capable of supporting the appropriate distribution and trading of a national permit allocation is likely beyond the near-term capacity of many developing countries. Similarly, questions have been raised about the legitimacy of some governments as agents to sell emissions permits on behalf of their citizens (for example Singer 2002). And of course it is problematic to assume that a market for an artificial commodity like emissions permits will smoothly mediate between the demand for and supply of emissions reductions; the volatility of the European Emissions Trading System in its early years should provide ample caution in this regard.

The question remains then what kinds of 'mix and match' institutions might actually meet the mandate implied by the GDRs allocation of obligations. Here it is helpful to consider the current status of the negotiations under the UNFCCC and Kyoto Protocol, as they present some concrete opportunities and constraints with regard to possible institutional requirements and solutions.

Critically, the 'Bali Action Plan' implies a continuation of the broad division between Annex I (industrialized) and non-Annex I (developing) countries. The need for increased mitigation in developing countries was acknowledged in a controversial phrase calling for 'Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner' (UNFCCC 2008b, paragraph 1(b)(ii)). Notably, the phrase 'measurable, reportable and verifiable' ambiguously applies to both sides of the agreement, the 'nationally appropriate actions' in non-Annex I countries, and the 'technology, financing and capacity-building' to be provided by Annex I countries. The GDRs framework offers some insight into both the scale (though not the details) of 'nationally appropriate' mitigation activities in developing countries, and how any funding for substantial monetary or monetarily valued transfers might be fairly allocated.

Beyond that, the questions of governance and procedures for choosing mitigation options are general ones for which the principles of the GDRs framework offer little specific insight. Indeed, one criticism of the GDRs framework is that it does *not* in fact offer solutions to critical institutional problems. It is ultimately premised on the assumption that massive northern capital flows will be necessary to fund mitigation activities in the South, but neither the experience of the Clean Development Mechanism (CDM) to date, nor the broader history of northern development assistance give grounds for optimism about the effectiveness of such flows were they to materialize. As we suggested at the beginning, however, such transfers are apparently a necessary condition of environmental adequacy; what GDRs offers is a possibility to take these transfers out of a simplistic north/south dichotomy by identifying, fairly and quantitatively, the obligations associated with the actual wealth and capacity of the rich and middle classes in poor countries. Beyond that, these problems are our problems but they are everyone's problems as well.

A point worth stressing here is that the GDRs framework, in a sense, is ahead of its time: it is intended as an architecture for a truly 'post-Kyoto' world, in which

the simplistic divisions between Annexes have already been transcended and a global emissions budget adopted. However that time has plainly not yet come. Given the failure of the industrialized countries to meet Kyoto in either letter or spirit, the developing countries are insisting on maintaining the fundamental distinction regarding who gets quantified emissions targets and who does not. Our RCI can be easily used to show how the current Annex I/non-Annex I distinction is inadequate, but its solution of giving *all* countries *some* quantified obligations is not presently on the table. Furthermore, neither the US nor leading developing countries seem interested in proposing or accepting a global mitigation budget consistent with (for example) the 2°C threshold endorsed by the EU and others.

One possible response to this impasse would be the adoption of an abbreviated second commitment period, perhaps from 2013 to 2015. Maintaining the Kyoto distinctions for this short additional period would not greatly increase the burden on the wealthier countries, which are primarily exposed to Kyoto's mitigation costs. It would provide an opportunity for trust-building, since it is enough time to allow Annex I countries to show commitment to both domestic mitigation and international mitigation and adaptation obligations while non-Annex I countries proceed to integrate mitigation and adaptation into their development plans. Meanwhile (concurrently), negotiators could address the larger problems of global targets and comprehensive burden sharing without quite the urgency of the current 2009 deadline.

In the interim phase, GDRs, or something similar, could be used to allocate any obligations or responsibilities that can be quantified and aggregated. For example, the requirement to provide funding for adaptation has yet to be addressed in any principled manner; so far only voluntary commitments and levies on CDM projects in developing countries have been adopted. Other proposals (for example, an aviation levy) seem to rely on the appearance of *not* being tied to acknowledgement of legal liability on any nation's part. In contrast, GDRs offers one way to combine responsibility and capacity that is defensibly related to the obligation to pay for adaptation sufficient to protect likely victims from harm.

Finally, it is worth pointing out that the GDRs framework has implications for the allocation of costs within countries as well as between countries. The allocation of national shares is based on the aggregation of the responsibility and capacity attributed to (modelled) individuals within a country. There is an implicit tax bill (or permit allocation) for every hypothetical individual within a country, with an exemption to all income under the development threshold. If a country were to adopt GDRs as an international position, it would follow that the domestic allocation of costs should be at least equally progressive. This is not to say that the framework as embodied in international law would be able to mandate how nations should raise or distribute funds associated with any domestic policies. However, the privilege of participating in (say) an international trading regime could be conditioned upon some minimal conditions of fairness in the implementation of domestic policies and measures. Conditionalities of various kinds routinely act as 'gateways' for states' participation in international regimes; for example, participation and disclosure requirements must be met if CDM project credits are to be internationally tradable.

## Conclusion

We have some confidence that a proposed international agreement based on the GDRs framework would (eventually) elicit the full participation of developing countries, including those, like India and China, with high aggregate but low per capita emissions, because it specifically protects their right to development. The commitment of these countries to mitigation obligations (with international financial assistance in many cases) is necessary not only for 'climate adequacy', but also to answer the objection of the US, in particular, to the exemption of developing countries from mitigation obligations under the Kyoto Protocol. The GDRs framework accommodates global carbon trading; the resulting global price for carbon would help solve the problem of 'runaway' investment and disadvantages to high-obligation countries in trade, since emission permits at the global price would be required anywhere production is carried out. Carbon trading is favoured by most economists as the most cost-effective way to achieve emissions reductions (see for example Olmstead and Stavins 2006).

However, mitigation commitments on the part of China, India and similar developing countries would be insufficient, we believe, to elicit the near-term support of northern high emitters—especially the US—for a GDRs-based international agreement with a stringent (environmentally adequate) reduction scenario, despite near-universal recognition of the gravity of the climate crisis. This is quite simply because of the financial demands it would place on northern high emitters, whose often stated concern has been that such obligations would diminish economic growth. When the costs of mitigation and adaptation are placed in an appropriate context—such as in comparison to defence expenditures, or to the estimated costs of inaction, as in the Stern Review—they are neither unimaginable nor unmanageable (Stern 2006). But it is not only abstract 'economic growth' that is challenged by what we have proposed. High-emitting developed countries *could* finance mitigation and adaptation by reducing their defence spending proportionately, but at the perceived risk of threatening their positions in the world system—a particular problem for the US. They *could* adopt a suite of policies that provides and encourages the use of public goods and services rather than private consumption, and discourages some forms of private consumption altogether—in other words, a 'strong' version of 'Ecological Modernization'[23]—but this would challenge the freedom of corporations that has been structured into the institutions and rules of so-called 'neoliberal' global capitalism in recent decades.

As a cautionary example, den Elzen et al (2006) approach the question of whether parties *would* undertake the costs of adequate mitigation by constructing what they call '[t]he political willingness scenario for 2020'. The exercise sought to determine implications for long-term stabilization of emissions, given the reductions hypothesized to be politically acceptable between 2012 and 2020.

[23] Eckersley, among others, distinguishes among the substantial range of policy approaches that reside under the umbrella term 'Ecological Modernization'. The weak version 'amounts to little more than a cost minimization strategy for industry'. Alternatively, 'strong' ecological modernization is the product of a discursive, reflexive and critical *process* that translates equitable and precautionary values into deep structural changes in the economy, society and state; it is thus much more than an industrial policy (Eckersley 2004, 70–77).

The authors conclude that even a (long-term) stabilization of 400–450 ppm $CO_2$-e will be beyond reach, given their assessment of political willingness of the developed (Annex I) countries to bear the expense of mitigation up to 2020.[24] A GDRs-style adequate and equitable agreement certainly exceeds these bounds of 'political willingness'.

Nonetheless, we do not present GDRs as a mere thought exercise. We see considerable potential not only in global social justice NGOs, but also in the political movement of citizens nationally and globally, to secure a more just and sustainable future by demanding accountability from states, corporations and undemocratic global institutions. Spokespersons for the global justice movement have specifically called for a regulated and redistributive global capitalism to replace the current 'neoliberal' version that has maximized mobility and minimized the accountability and financial obligations of corporations to society (see George 2004). 'Taming' capitalism in this manner is a prerequisite for the implementation of a rigorous version of Ecological Modernization. Moreover, recent polls conducted by GlobeScan and the Program on International Policy Attitudes at the University of Maryland suggest that publics in both the US and China are receptive to climate adequacy and equity in ways that state managers are not: large majorities of *both* samples (the smallest majority was 59 per cent) agreed that climate change is a serious problem demanding major steps; that behavioural and lifestyle changes are necessary and that fuel prices must go up to encourage such changes; and that 'wealthy countries [should] agree to provide less-wealthy countries with financial assistance and technology' while both wealthy and poor countries agree to limit their emissions (Kull and Miller 2008, 14).

Sustainability and equity may indeed be beyond the capacity of the present neoliberal and Westphalian world order. However, the potential for nonlinear change is characteristic of any complex system, including the global political economy. We conceive GDRs, therefore, as part and parcel of a global social project whose realization is not yet in view but which, at least some evidence suggests, is under construction.



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[24] Den Elzen et al (2006) assume that the US reengages with the UNFCCC/Kyoto process, and reduces its emissions 15 per cent below 1990 levels by 2020.

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