Paper 4

A FAIR SHARING OF EFFORTS IN MEETING THE CLIMATE CHALLENGE

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Executive Summary

The scientific evidence now confronting us demands a break with "politics as usual". An honest assessment of what is needed to keep warming below 2ºC makes it clear that carbon-based growth is no longer an option, neither in the North nor in the South. Our collective response to the climate crisis must recognize this reality and its consequences, and rise to the challenges that they imply. The question before us, is *what kind of a climate regime can bring global emissions rapidly under control, even while the developing world vastly scales up energy services in its ongoing fight against endemic poverty and for human development?*

A global climate regime with any promise of success must acknowledge the right to sustainable human development. The Greenhouse Development Rights framework seeks to not only acknowledge that right but to actually place that right at its structural core. It does this by codifying the right to development in terms of a **development threshold**, an income level below which individuals are not required to help shoulder the burden of solving the climate problem. This development threshold is defined to reflect a level of welfare beyond basic needs, but well short of today's levels of 'affluent' consumption.

We suggest here a development threshold set at an income level of $9,000/year (PPP). We define **capacity** as income, excluding all income below the development threshold. We similarly define **responsibility** as cumulative carbon emissions, excluding all emissions deriving from consumption below the development threshold. It is important to note that capacity and responsibility are defined in individual terms, in a manner that takes explicit account of the distribution of income and emissions – inequality – within countries. This is critical. Relying merely on national per capita averages would fail to capture either the true scale of developmental urgency or the actual extent of the national wealth.

In this paper, we estimate capacity and responsibility for all countries, and combine those estimates to quantify national mitigation and adaptation obligations. The allocation of the burden along these lines would see the United States bearing slightly more than one-third of the global burden, and the EU bearing roughly one quarter, whereas China bears less than three percent, and India roughly one-tenth of one percent.

What becomes plainly clear is that a major commitment to large North-to-South cooperation – including financial and technological transfers – is an inevitable part of climate solution. Domestic reductions by the North, in other words, can fulfill only part of its rightful obligations. For political reasons, however, if not alone for ethical reasons, a commitment from the wealthy of the South is also necessary. Not only is it fair, but it is unlikely that the working consensus to pay a large proportion of the total mitigation

and adaptation costs could ever emerge in the North if the "wealthy" minority in India and China and other developing nations were not also paying their "fair shares." The Greenhouse Development Rights framework is an attempt to define what those "fair shares" are, and to do so in a manner that recognizes and preserves a right to development.

Introduction

The COP-13 negotiation in Bali can be celebrated as a major step and a welcome success. It has delivered us a Roadmap, guidelines for negotiating, a two year deadline for an agreement, and the earnest involvement of all Parties. This is indeed what many observers hoped for as the best possible outcome of the COP.

Yet, at the same time, we have to concede that the Bali consensus was ominously indistinct and rather fragile. It included no explicit guidance on a global emissions objective. It referred to "commitments" for industrialized countries only coupled with the risky phrase "or actions," (although we can assume that most Annex I countries interpret "commitments" in the sense of binding reduction requirements). And, on the critical matter of developing country actions, Bali was an vital step forward, but it moved the negotiations only as far as the edge of a veritable minefield, and it pointed only vaguely in the direction by which it must be crossed.

That minefield is the phrase "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" [1(b)(ii), Decision 1/CP.13]. This dry clause embodies the very nexus of contention of the Bali talks. It is this clause that brought the negotiations to a tense overtime confrontation that ultimately saw the United States negotiators reverse an initial position that would have blocked a unanimous recognition of historical necessity[1]. The reason that "technology, financing and capacity building" are so critical and so contentious is that the control of emissions in the South is an undeniable scientific necessity, yet, at the same time, the South justifiably takes as its utmost priority its ongoing struggle against poverty. The South is thus understandably apprehensive of any climate agreement that would require reductions, without at the same time ensuring that those reductions will not impede its development. This tension – between the demands of our threatened climate and the development of the South – is at the very center of the global climate negotiations predicament. The charged clause 1(b)(ii) of the Bali roadmap, in linking reductions in the South to support from the North, offers the only plausible resolution of this tension.[2]

A thought experiment

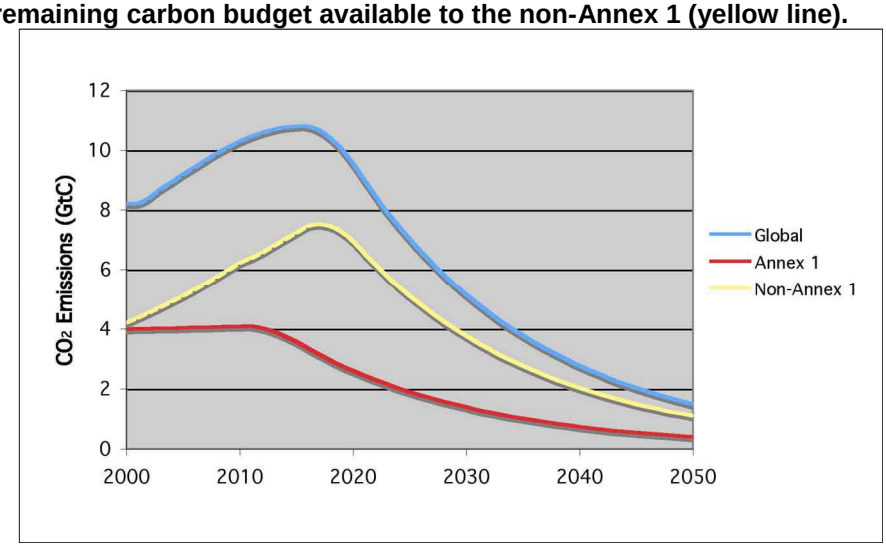
Figure 1 below illustrates the centrality of this tension to the climate problem. The figure conveys a simple "thought experiment" consisting of a bit of science, bit of conjecture, and a bit of arithmetic. The **blue line** ("Global") in Figure 1 is the science; it shows a global emission trajectory that declines rapidly and deeply enough to preserve a reasonable likelihood of keeping global temperature rise within the widely endorsed

[1] That is, a historical necessity that is already clearly embodied in the UNFCCC, most clearly in Art. 4.7.

[2] This clause is further strengthened by clause 1(e)(i), which in the context of both mitigation and adaptation calls for "Improved access to adequate, predictable and sustainable financial resources and financial and technical support, and the provision of new and additional resources, including official and concessional funding for developing country Parties;"

2ºC threshold for maximum tolerable warming (Meinshausen, 2006 [1]; Baer & Mastrandrea, 2006 [2]). Clearly, any such path would entail extremely rigorous mitigation, sufficient to force global emissions to peak by 2015 and to fall by at least 80% below current levels by 2050.[3] Still, even this ambitious trajectory might not be sufficient. It subjects the earth to a 20-35% risk of exceeding the 2ºC threshold[4], and, recent science suggests that stabilizing the climate and avoiding catastrophic climate disruption may require an even more stringent course, one sufficient to return emissions ultimately to zero (Matthews & Caldeira, 2008 [3]) and to stabilize atmospheric CO_2 concentrations no higher than 350 ppm (Hansen et al., 2008 [4]).

Figure 1: A thought experiment, showing the global emissions budget that entails a risk of exceeding 2ºc of 20-35% (blue line), the Annex 1 trajectory assuming an aggressive reduction of 90% below 1990 levels by 2050 (red line), and the remaining carbon budget available to the non-Annex 1 (yellow line).



The **red line** ("Annex 1") in Figure 1 reflects a simple conjecture. It shows the emission trajectory that would result if all Annex 1 countries quickly adopted an ambitious program that forced their emissions to drop to 90% below 1990 levels by 2050, by falling by nearly 6% annually from 2010 onward. It would require intense and concerted effort, and is just barely within the bounds of what can be considered politically plausible today. Indeed, it exceeds the objective of the pending Lieberman-Warner bill in the United States Senate, and the various targets put forward by EU members states. As such, this line does not represent the maximum rate of emissions reductions that may be technically feasible; it is merely a reflection of what level of Annex I reductions is considered politically plausible today, though just barely.

The **yellow line** ("non-Annex 1") in Figure 1 is the arithmetic. It shows, simply by subtraction, what is left of the global budget (blue line) after Annex 1 has consumed its indicated proportion (red line). It is, in other words, the remaining space within which non-Annex I countries would be constrained to develop, and it is quite bracing. It peaks well before 2020, and is soon racing downward at nearly 6% annually. It is this yellow line that captures the truly daunting nature of the climate challenge. It is an ambitious trajectory in any event, but especially so in light of the fact that developing countries

[3] The trajectory shown includes CO_2 only, including approximately 1.5 GtC of emissions from land use in non-Annex 1 countries in 2000. The radiative forcing from non-CO2 gases is assumed to decline by 50% by mid-century.

[4] In the language of the IPCC, it is "likely", but not "very likely" to keep warming below 2ºC. (IPCC 2006; AR4 WGI Chapter 1, Box 1.1, p. 120)

need to continue to expand energy services in order to meet basic development goals (World Bank, 2000 [5]; UNDP, 2002 [6]; UNDP; 2005 [7]). In the less than fifteen years between now and 2020, incomes in developing countries will hopefully grow substantially; but even assuming optimistic growth rates, incomes will still be only one third of *current* developed country levels on average. In other words, the developing world will still be struggling to eradicate endemic poverty, even while its emissions will need to be rapidly declining.[5]

This brings into stark focus the true nature of the climate challenge, and the source of the current climate predicament. *The climate crisis calls for a regime that can rapidly curb emissions globally, without impeding the prospects for developing countries to grow economically, to expand access to energy services, and to earnestly combat poverty.* In other words, what is needed is a climate regime that, by its very design, preserves a *right to development*. Unless a climate regime preserves a right to development, it can not engender the necessary scale of developing country engagement, and is therefore not politically or practically feasible.

One can delineate, in fairly straightforward terms, the threefold objectives that would need to be met for a regime to plausibly preserve a right to development. The first objective is of course mitigation that is sufficiently rapid and global to avoid dangerous climate change, which itself would seriously undermine development. The second objective is adaptation, at a depth and extent that will keep gains in development from being lost in the face of the climatic changes that are now unavoidable. And the third objective – equal in import to the first two – is to achieve the first two objectives in a manner that does not itself undermine the development aspirations of the poor.

In other words, this third objective demands that a climate regime that preserves a right to development must not impose costs on poor communities and nations nor constrain the expansion of energy services in any manner that would impede human development and poverty eradication. It is this sentiment, of course, that is the basis of the hard-won agreement in Bali that developing countries would undertake mitigation actions only “in the context of sustainable development”, and “supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner”.

[5] The flexibility in this trajectory is minimal. The North could perhaps cut emissions by even more than 90% – perhaps 100% – a reduce emissions to zero by 2050, or even earlier, say 2025. But it would not change things very significantly, insofar as it would not open up that much more environmental space for the South. And, relaxing the blue pathway – taking yet greater risks of exceeding 2ºc – only makes a difference if it is relaxed so much as to give up on preserving a reasonable likelihood of keeping warming below 2ºc.

Table 1: Estimates of total costs for mitigation and adaptation span a wide range, but tend to come out in the range of hundreds of billions to perhaps trillions of dollars annually. The following table below cites some such estimates.

Source	Annual Cost (billions)	Notes
Adaptation		
World Bank (2006) [8]	*$10-40*	Costs to mainstream adaptation in development aid
Oxfam International (2007) [9]	*> $50*	Costs in developing countries
UNFCCC Secretariat (2007a [10]; 2007b [11])	*$49-171*	Adaptation costs in 2030 (summarized in Table 65, p. 198)
UNDP (2007) [12]	*$86*	Adaptation costs in 2015
Mitigation		
UNFCCC Secretariat (2007a; 2007b)	*$380*	Costs in 2030 to return emissions to 2007 levels. (summarized in Table 64, p. 196).
IPCC AR4 (2007) [13] (SPM Table 7.)	*<3%*	Costs as percentage of Gross World Product in 2030 for stabilizing in 445 - 535 ppm CO2eq range.
Stern (2007) [14]	*1% (±3%)*	Costs as percentage of Gross World Product through the 2050 for stabilization in the 500-550 ppm CO2eq

Burden sharing: what's on the table?

One can then ask, what do the various climate regime proposals on the table imply with regard to ensuring that national mitigation actions are "supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner" for developing countries from developed countries? To what extent do the various proposals provide frameworks within which resources that are "adequate, predictable and sustainable" could flow?

The first observation to make is that few frameworks explicitly highlight and transparently quantify the issue of support from North to South. It is therefore not really possible to do a framework-by-framework comparison on consistent and comparable grounds, at least not without making numerous additional quantitative assumptions, and some such analyses have been attempted (Höhne, 2006 [15]; Höhne et al., 2007 [16]; den Elzen, 2002 [17]). In this section, we will simply provide a capsule review of several well-known frameworks with regard to the question of international support. In the succeeding section, we elaborate on one of these frameworks – the Greenhouse Development Rights framework – with further quantitative detail.

Emissions rights approaches

There are several approaches that are premised on allocating emission allowances based on the concept of equitable emission rights. Six of these that are broadly representative of the proposals on the table are: Equal Per Capita Emission Rights, Global Climate Certificate System, Contraction and Convergence, One Standard/Two Convergence, Common But Differentiated Convergence, and the Vattenfall proposal.

a) *Equal Per Capita Emission Rights* is a straightforward approach premised on the equal rights to the atmospheric commons. All countries would be awarded emission allowances in proportion to their population, and would be free to trade them. The total number of allowances granted globally would steadily decrease along a path consistent with an agreed climate stabilization goal (Agarwal & Narain, 1991 [18]).

b) *Global Climate Certificate System (GCCS)* is a variant of a per capita approach, in which trades are price controlled, so as to artificially limit the total revenues passing from allowance purchasing countries to allowance selling countries (Wicke, 2005 [19]).

c) *Contraction and Convergence (C&C)* is a hybrid framework combining grandfathered emission rights with per capita emission rights, with a gradual transition from the former to the latter over a specified number of decades. Countries whose emissions start above the global average would receive allowances that gradually trend down to the global average, while countries whose emissions start below the global average would receive allowances that gradually trend up to the global average (GCI, 2008 [20]).

d) *One Standard, Two Convergence* is a proposal by Chen et al. (2005) [21], further elaborated by Gao (2007) [22] which is based on the principle that countries should have access to equal per capita cumulative emissions, in order to allow sufficient space for development. It extends the principle of equal per capita emission rights to historic emissions. The name of the proposal refers to the fact that when the standard of equal per capita cumulative emissions is consistently applied across countries, then developing countries' emissions will rise above the global average (and above the emissions of some developed countries) before converging downward. Chen proposed some further adjustments to account for geographic circumstances, national energy endowment, economic structure, and international trade.

e) *Common But Differentiated Convergence (CDC)* is a variant of Contraction and Convergence, in which nations starting below the global per capita emission level are permitted to exceed the global average for a limited time. Also, the poorest developing countries are exempt from the emission allowances system (and thus have no excess allowances to sell) (Höhne et al., 2006 [23]). This proposal reproduces some features of One Standard, Two Convergence, without explicitly taking equal per capita cumulative emissions as its foundation.

f) *Vattenfall's proposal* is an emission rights proposal premised not on per capita emission equality at all, but on per unit of GDP equality. Based on this foundational principle, three main modifications are then introduced. First, poorer countries below a specified threshold are exempt from the emission allowances system. Second, poor countries above the threshold receive a modest "cross-subsidy" of allowances from wealthier countries to account for the general observation that poorer countries tend to have higher carbon intensity. And third, Annex 1 (but not non-Annex 1) countries have maximum and minimum required rates of emission decline (Vattenfall, 2006 [24]).

In all of these frameworks, the primary means through which the "measurable, reportable and verifiable" and "adequate, predictable and sustainable" support would flow is the mechanism of market-based allowance trading. Countries whose emissions exceeded their allowances would purchase allowances from countries whose allowances exceeded their emissions. One key question, then, is whether this *type* of support is adequate, or if further mechanisms would be needed to ensure that in addition to the availability of finances, there were also technical assistance and capacity building needed to bring about the transition to a low-carbon economy with the necessary adaptation implemented.

The second key question is whether the *scale* of support is adequate, i.e., whether the flow of allowance revenue would provide sufficient support to enable developing countries to undertake the necessary scale of mitigation (and adaptation!) without compromising their development efforts. Roughly speaking, the proposals can be ranked in terms of the scale of the allowance revenue flow (assuming the same global climate objectives): Equal Per Capita Cumulative Emission Rights leads to the greatest flow of allowance revenue, then Equal Per Capita Emission Rights, then CDC, then C&C, and finally Vattenfall's proposal, with the ranking of GCCS among the others depending on details regarding the fixed trading price compares to the actual mitigation costs.

Multi-stage proposals
Multistage proposals categorize countries into different groupings, and assign them qualitatively different sorts of commitments. Generally, the richest and highest emitting countries (i.e., those with the greatest responsibility and capacity) are assigned the most stringent and legally binding commitments (such as emission reduction targets), while the poorest and lowest-emitting countries generally have no binding commitments.

a) *Climate Action Network's "Viable Framework"* is a multistage proposal with three tracks, to which countries are assigned based on responsibility and capacity. The "Kyoto Track" has legally binding reduction commitments, the "Decarbonization Track" have various other forms of less rigorous commitments, and the "Adaptation Track" is for key vulnerable countries (such as LDCs) who would focus on adaptation. Convergence toward equal per capita emission is a stated objective. "Where technical or other assistance is required… this needs to be made available from the industrialized countries." (CAN, 2003 [25]).

b) *South-North Proposal* is a multi-stage proposal with six stages, based roughly on responsibility and capacity, including OECD countries (with stringent binding targets and requirements to provide funding), economies in transition (with binding targets), newly industrialized countries (quantified targets and access to partial funding), rapidly industrializing countries (quantified targets contingent on funding), other developing countries (non-binding targets and partial funding), and LDCs (with nonbinding targets and full funding) (Ott et al., 2004 [26]).

Both of these multistage frameworks explicitly refer to the requirement that technical and financial resources would be made available from wealthier countries to enable developing countries in certain stages to meet their commitments. Whether these resources are sufficient, then, will depend on how the frameworks were actually operationalized, and in particular on the criteria upon which graduation from one stage to the next were based (which determines which countries are eligible to receive support), and the nature and scale of the support.

Greenhouse Development Rights

Here, we examine one specific framework – the Greenhouse Development Rights[6] approach – in detail. It has been elaborated at a sufficient degree of detail (Baer et al., 2007 [27]) that it is able to provide some useful indicative results as to what the Bali

[6] See Baer et al. (2007) for a full explication of the GDR framework. SK is one of its developers, and BK has provided valuable input.

Roadmap might imply with the words “measurable, reportable and verifiable” and “adequate, predictable and sustainable”.

A “development threshold”
The GDR framework, starts from a fundamentally different premise than the emission rights frameworks. It takes as it is central principle the *right to development*, rather than a right to emissions. Emissions are taken as merely instrumental, as having importance only insofar as they contribute to development.[7] The right to development, on the other hand, is fundamental. It is, as Pan (2005) [28] stressed, a right to a certain level of welfare beyond the mere satisfaction of basic needs, but well short of today’s levels of ‘affluent’ consumption.

At this level of welfare, the GDRs framework defines a ‘development threshold’. Individuals below this level are not expected to share the burden of mitigating the climate problem, as they have little responsibility for the climate problem and relatively little capacity to invest in solving it. Indeed, they have development as their proper priority, and should not be saddled with the costs of keeping society as a whole within the starkly limited global carbon budget. Above the development threshold, on the other hand, individuals are expected to help shoulder the burden of solving the climate problem, including both the mitigation and adaptation costs. And, the further above the threshold, the larger their fair share of the burden.

The level at which such a development threshold would best be set is a matter for debate, but the key principle is clear: it should differentiate the global poor, who have pressing and legitimate unmet development needs, from the ‘global consuming class,’ which has reached a level of consumption that yields an appreciable contribution to the climate problem, and has similarly acquired enough capacity to help bear the costs of managing that problem.

Consistent with this principle, the development threshold is set at 150% of a global poverty line. This particular level is, of course, somewhat arbitrary, but its appropriateness is supported by the many other contexts in which 150% of a poverty line is taken to define the upper boundary of ‘exempt’ or ‘lifeline’ income. These include starting points for income tax calculations, eligibility thresholds for social services, and criteria for defining ‘economically vulnerable’ or ‘near-poor’ populations. Thus, while it might be an underestimate, it is a plausible and indicative figure, and as a valid starting point for discussion. As a global poverty line, one can discard the typical figures of $1 per day or $2 per day (World Bank, 1990 [29]), as being too low; many people with incomes much higher than $2 per day still face pervasive exposure to the plagues of poverty: malnutrition, high infant mortality, low educational attainment, high relative food expenditures. A defensible global poverty line above which these plagues of poverty are greatly diminished can be investigated empirically. The evidence suggests that a global poverty line can reasonably be approximated by $16 per day[8], or,

[7] Another approach that takes a development rights perspective is the proposal of Jiahua Pan (2005). Several key features that Pan’s proposal shares with the framework presented in this paper will be highlighted below.

[8] According to Pritchett (2003) the use of this line ‘is justifiable, more consistent with international fairness, and is a better foundation for the World Bank’s organizational mission of poverty reduction.’ See also Pritchett (2006). Note, these figures are on a purchasing power parity (PPP) adjusted basis, and therefore convert to a lower income level in a local developing country currency than if converted at market exchange rates. Different development thresholds are explored via a sensitivity analysis in Baer et al. (2007).

equivalently, $6,000 per year (PPP basis[9]) (Pritchett, 2003 [30]; 2006 [31]). Taking this figure as a global poverty line, we then have (multiplying by 150%) an indicative development threshold of $9,000 per year (PPP).

Burden-sharing

Having defined a development threshold, we can next define a consistent burden-sharing system, and use it to calculate national obligations under a climate regime. This allows one to examine in an explicit and quantitative manner the question of the international support raised by the aforementioned clauses 1(b)ii and 1(e)i in the Bali roadmap.

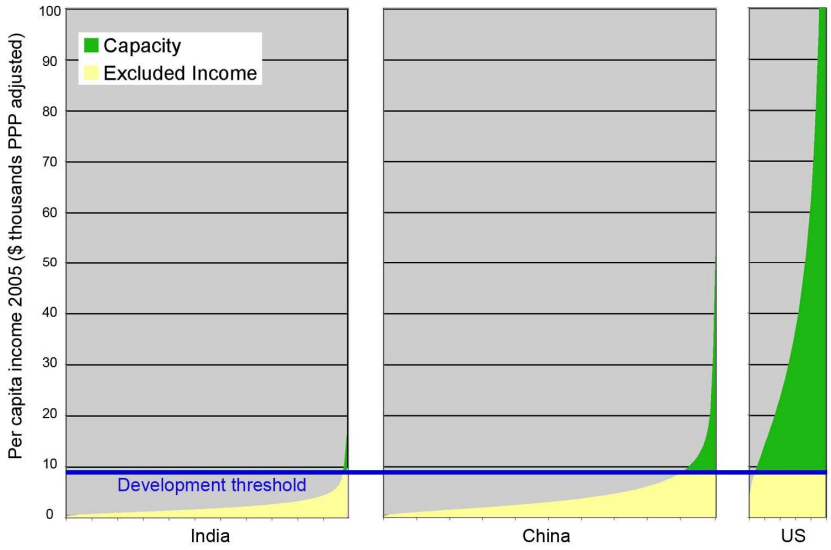
The GDR framework is based on the same two principles that underlie the UNFCCC: capacity and responsibility. The idea that burden sharing should be based on a systematic treatment of responsibility and capacity is reflected in most if not all contemporary burden-sharing proposals.

Capacity in this context means having the financial resources to deal with the climate problem without sacrificing necessities. We calculate it as the aggregate sum of individual income in excess of the development threshold, summed across all the individuals in a country. Figure 2 illustrates this calculation for three countries: India, China, and the United States. It shows the income distribution for each country, estimated on the basis of national per capita income and Gini coefficient (a measure of national income inequality)[10]. This curve shows the income of the corresponding percentile of the population, measured in US dollars per capita (PPP adjusted), rising from the poorest to the wealthiest. The development threshold at $9,000 is shown, cutting through each country's income distribution curve and thus dividing total national income into a fraction (yellow) below the development threshold, and a fraction (green) that the wealthier portion of the population has in excess of the development threshold. The green area thus graphically reflects our estimate of each country's capacity. As it turns out, less than 1% of India's population earns more than $9,000, approximately 10% of China's population, and nearly 95% of the US population.

[9] Note, these figures are on a purchasing power parity (PPP) basis. It thus converts to a lower income level in a local developing country currency than if it were converted at market exchange rates. Different development thresholds are explored via a sensitivity analysis in Baer et al. (2007).

[10] We approximate the national income distributions as lognormal distribution using two country-specific parameters: the mean per capita income and the Gini coefficient. The charts have been scaled so that the length of the x-axis is proportional to population, and thus the areas of the different sections – e.g., the green section representing capacity – can be directly compared in absolute terms. For a full explanation, see the technical appendix in Baer, Kartha, Athanasiou (2007), although note that the calculations here have been updated using World Bank PPP income data released in 2008.

Figure 2: Capacity. The curves are income distributions for India, China, and the United States, with the green area representing income above the $9,000 (PPP) development threshold, or national "capacity".



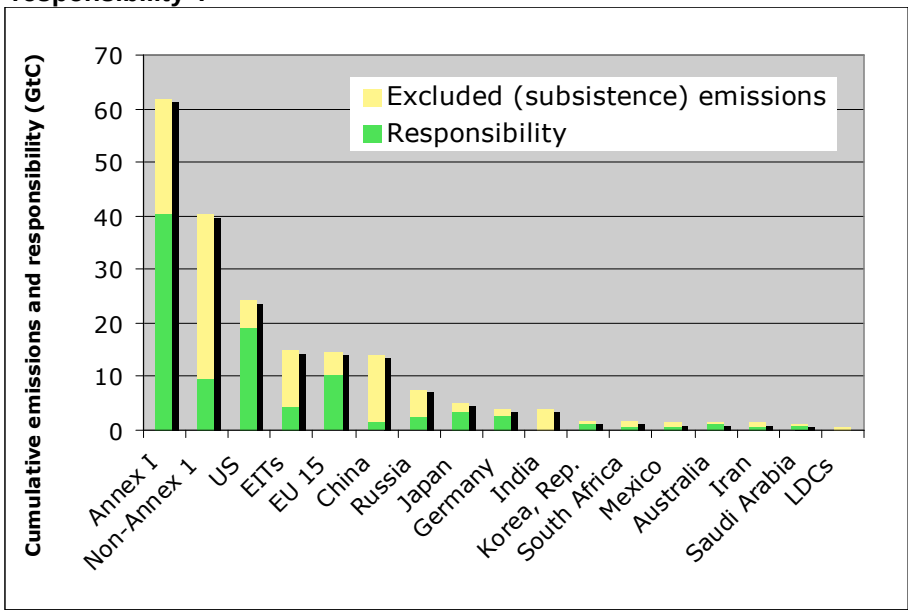
Responsibility, of course, is the central concept behind the 'polluter pays principle', and is interpreted in terms of the greenhouse gases that nations have cumulatively contributed to the atmosphere. We define and calculate responsibility in a manner precisely analogous to capacity, i.e., with respect to the development threshold. Specifically, we calculate a country's responsibility as cumulative emissions *excluding* emissions corresponding to consumption below the development threshold. This definition is a recognition of the distinction between emissions arising from meeting basic needs, and emissions corresponding to discretionary consumption, and reflects the premise that these different types of emissions are of fundamentally different natures: in essence, basic emissions do not imply responsibility, whereas discretionary consumption does. It thus preserves a right to development insofar as it allows people to strive toward the development threshold unencumbered by emissions constraints.

There is little data available that could support a precise country-by-country calculation of emissions by income class, although some national-level studies have been done, including Metcalf (2007) [32] for the US, Brenner (2007) [33] for China, and Ananthapadmanabhan et al. (2007) [34] for India. We make the simplifying assumption that (within any given country) emissions are proportional to consumption, which is in turn proportional to income.[11] One can then straightforwardly generate a national responsibility graph analogous to the Figure 2 graphs of national capacity. To show ore countries, however, we present in Figure 3 a condensed graph that shows several nations and regions, with the total height of each bar reflecting the cumulative emissions since 1990. The yellow portion shows the emissions corresponding to consumption below the development threshold, and the green portion the aggregate responsibility (These are analogous to the yellow and green portions of the graphs in Figure 2, except that they are not presented as a full distribution across the national populations.) Although our indicative calculation of responsibility takes 1990 as the start year, one can certainly argue that an earlier start year would be more appropriate. All else equal, it would increase the relative responsibility of the Annex 1 nations, which began the process of industrialization much earlier, compared to non-Annex 1 nations.

[11] See the technical appendix of Baer, Kartha & Athanasiou (2007) for further discussion.

Capacity and responsibility can now be combined in a straightforward way to yield a combined indicator that can be used as the basis of a burden-sharing allocation. We refer to this as a "Responsibility-Capacity Indicator" or RCI,[12] and amounts to a progressive income/emissions tax. (Pan suggests a structural approach, based on a "basic needs threshold" and a progressive emissions tax above the threshold. Not concidentally, his detailed bottom-up calculation for a basic needs threshold for China comes out very similar to the emissions level implied by our development threshold.)

Figure 3: Responsibility. The total height of each bar gives the cumulative emissions since 1990, the yellow portion is the emissions corresponding to consumption below the development threshold, and the green portion is emissions corresponding to consumption above the development threshold, or national "responsibility".



It is worth stressing here that this burden-sharing framework allocates obligations at the national level, but that it derives these from information at the intra-national level regarding the distribution of wealth and emissions. As emphasized by Pan (2005), this need to look at intra-national disparities is a logical consequence of the premise that a viable climate regime must preserve a right to development, which is itself a right that adheres to individuals, not to countries.

Results

The results are not altogether surprising, as shown in Table 2 for a representative set of countries and regions. The US has somewhat more than one-third of the total global obligation (see rightmost column labeled "Obligation"), the EU-27 has somewhat more than one-quarter, China has less than 3%, and India a rather negligible 0.1%. While we have made various specific assumption in generating this indicative quantification (e.g.,

[12] The RCI is constructed in a simple and generic manner that allows responsibility and capacity to be weighted differently: $RCI = R^{a} \bullet C^{b}$. The exponents *a* and *b* sum to 1, so that, as the paired weights go from *a=1* and *b=0* at one extreme to *a=0* and *b=1* at the other, the *RCI* goes from being exactly equal to responsibility (*R*) to being exactly equal to capacity (*C*). In our reference calculations we set a = 0.4 and b = 0.6, which is to say that we weigh capacity somewhat higher than responsibility. Again, this choice is subject to discussion.

setting the development threshold at $9,000 (PPP), and choosing 1990 as the starting year for calculating responsibility) we argue that any system that quantifies responsibility and capacity in a manner that is premised on the need to preserve a right to development, will not yield dramatically differing results.[13]

Table 2: Global percentage shares of population, income, capacity, cumulative emissions, responsibility, and obligation (RCI) for selected countries and groups of countries.

Capacity, Responsibility, and Obligation						
	Population	Income	Capacity	Cumulative Emissions (1990-2005)	Responsibility	Obligation (RCI)
United States	4.7	22.2	**33.7**	23.7	**38.2**	**36.0**
EU (27)	7.6	23.2	**30.0**	17.8	**23.5**	**27.4**
United Kingdom	0.9	3.4	**4.7**	2.5	**3.6**	**4.3**
Germany	1.3	4.5	**6.1**	3.8	**5.4**	**5.9**
Russia	2.2	3.0	**2.0**	7.4	**5.1**	**2.9**
Brazil	2.9	2.8	**2.2**	1.3	**1.1**	**1.7**
China	20.4	10.0	**2.3**	13.8	**3.4**	**2.7**
India	17.0	4.2	**0.1**	3.8	**0.1**	**0.1**
South Africa	0.7	0.7	**0.6**	1.6	**1.3**	**0.8**
LDCs	11.6	1.5	**0.1**	0.4	**0.0**	**0.0**
All High Income	15.6	59.1	**83.4**	52.7	**79.4**	**82.3**
All Middle Income	47.7	33.5	**16.5**	41.1	**20.5**	**17.6**
All Low Income	36.7	7.4	**0.1**	6.2	**0.1**	**0.1**
World	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

These results help illuminate what might be implied by the phrases "measurable, reportable and verifiable" and "adequate, predictable and sustainable" international support. Each Party's national obligation would amount to its share of the global obligation (rightmost column above) times the global total cost of adaptation and mitigation (see Box 1 for indicative total global costs). These calculations of national obligation explicitly account for the wealth and poverty in each country. They reflect presence in each country (each Annex-I country, China, India, even the LDCs) of a sub-population that is part of the global consuming class and that rightfully has obligations under an international climate regime. They also reflect the presence in each country of individuals (for many developing countries the this is the majority) who have not yet attained a decent standard of living, and who thus contribute nothing to their country's obligations.

We have said nothing about the mechanisms and institutions through which these obligations would be discharged. The only thing that can be said for sure is that the scale and nature of the required financial assistance and technological cooperation is unprecedented; and will call for institutions and mechanisms that have not yet even been envisioned. Some of the adaptation funding could presumably be linked to conventional ODA, though not all of it. And some of the mitigation funding could presumably flow through market-based mechanisms like today's carbon trading systems, though not all of it. Beyond these existing routes, new as yet unnamed channels would need to be conceived and implemented, inevitably posing an impressive set of challenges: how to scale-up? how to build absorptive capacity? how

[13] See Baer, Kartha & Athanasiou (2007) for sensitivity analyses.

to ensure efficiency and avoid waste? how to institute credible governance? These questions and others will be hotly debated, and this GDRs analysis provides no answers. Its aim is simply to draw attention to the enormity of the international cooperation that the climate problem demands, and to the magnitude of the financial assistance and technological cooperation that it implies. By so doing, a discussion about international mechanisms can begin that is in line with the scale of the challenge.

Implications

It is possible to look more closely at the concrete political implication of this burden-sharing framework, by placing it in the familiar language of national emission reduction commitments. We can do this by considering the total volume of mitigation required globally, and allocating it to countries in accordance with their share of the global obligation (as shown in Table 2). The global mitigation requirement is defined as the volume of emission reductions needed to fully shift from a business-as-usual scenario, for which we assume the Reference Scenario of the *World Energy Outlook 2007* (IEA, 2007 [35]), to the 2ºC mitigation path (the blue line) presented in Figure 1. We show this graphically in Figure 4, where the topmost line (the one rising to 14 GtC per year in 2025) is the WEO business-as-usual emission trajectory, while the bottommost line (which bounds the blue area) is the same 2ºC mitigation path presented as the blue line in Figure 1.

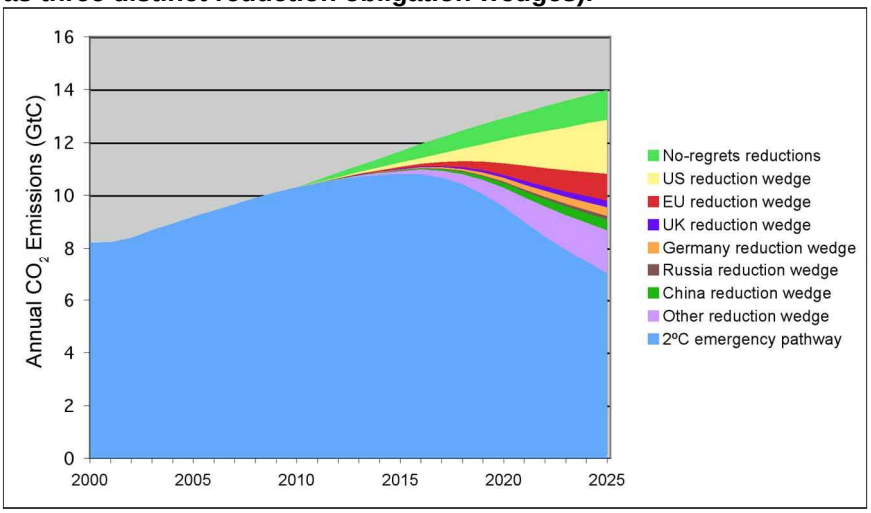
We first note the green wedge, labeled 'No-Regrets', which is an estimate of the negative- and zero-cost emissions reductions available globally.[14] The green wedge, in other words, represents free and profitable reductions – such as cost-effective energy efficiency – which are large, though not by any means large enough to bring emissions all the way down to the 2ºC path. We argue that each nation (wealthy and developing) should be responsible for capturing its own no-regrets reductions, and that only the positive cost reductions should be shared among nations according to the burden-sharing allocation calculated above.

Thus, the global mitigation gap (excluding the No-Regrets wedge) is allocated to nations according to their proportion of global obligation[15] (as shown in Table 2). Accordingly, the US' reduction obligation amounts to 36% of the mitigation gap; the EU, 27%; China 2.7%; and India 0.1% (not shown).

[14] This is estimated from the global abatement cost curves compiled by McKinsey and Company (2007) [36].

[15] It is worth noting that this general approach is not novel. It is a direct descendent of the so-called "Brazilian Proposal," although in that case national percentage shares of a global mitigation objective were to be divided among the Annex I countries alone, in proportion to their contribution to global temperature increase. That proposal would have produced a graph analogous in form to Figure 4.

Figure 4: Global mitigation requirement, divided into 'reduction obligation' wedges that reflect national / regional shares of RCI. (The UK and Germany are of course part of the EU, but are shown separately here; total EU obligation is thus shown as three distinct reduction obligation wedges).

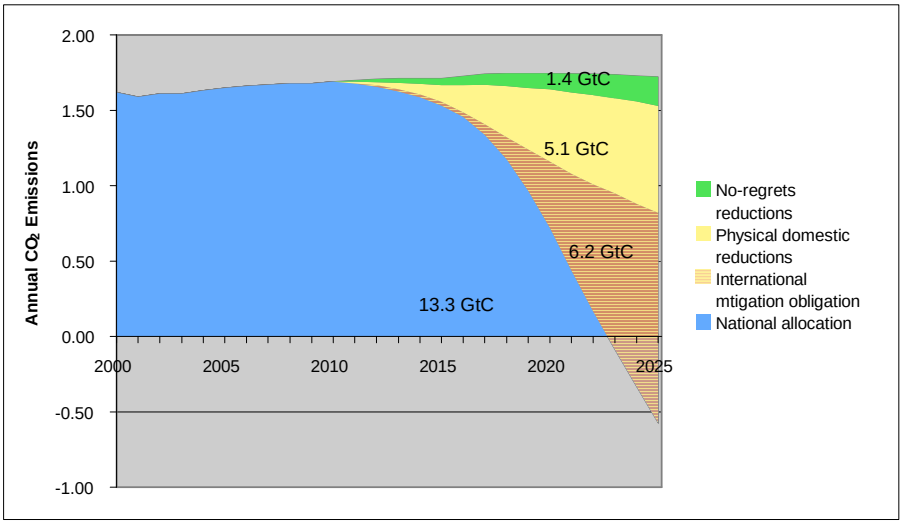


The implications of this burden-sharing allocation are best revealed by "zooming in" on individual countries. Doing this, it becomes evident that, using the quite reasonable assumptions modeled in this study, wealthy and high emitting countries will very quickly come to have emissions reductions obligations that are larger than their projected domestic emissions. We demonstrate this with the case of the US.

Figure 5 shows the US business-as-usual path, along with three wedges of reductions. The first is the green wedge, which corresponds to the no-regrets reduction opportunities available in the US, which like all countries it is required to aggressively exploit. The other two wedges (the yellow and yellow/red striped) together comprise the US' reduction obligation shown in Figure 4 (the yellow wedge equal to 36% of the global mitigation gap). This reduction obligation is divided into two wedges to represent the fact that the US would choose to discharge some of its reduction obligation through reductions *domestically*, and others would be undertaken *internationally*. The GDRs framework makes no intrinsic assumptions about the relative proportion of domestic reductions and international reductions that a country will choose in seeking to fulfill its mitigation obligations. With international purchases managed via a global cap and allocate system, say, a country would, at least in theory, be free to make any portion of its reductions domestically, and the remainder internationally, based on any nationally salient economic or political considerations[16]. What is clear and striking is that even assuming very ambitious domestic reductions (about 6% annually, corresponding to a path heading toward 90% reductions by 2050, as shown by the red line in Figure 1), there is a concurrent need for substantial international emissions reductions.

[16] In practice, it would be important for high RCI countries like the US to make substantial portions of their reductions domestically. This is true for political reasons (a need to build trust, and to not appear to be "buying their way out" of social and technological changes that other countries are expected to make) and also for structural reasons – the need for comprehensive infrastructural change to start early and unfold steadily over an extended period of time, otherwise deep reductions in the long-term become impossible and defaulting on ones reduction commitments becomes a temptation.

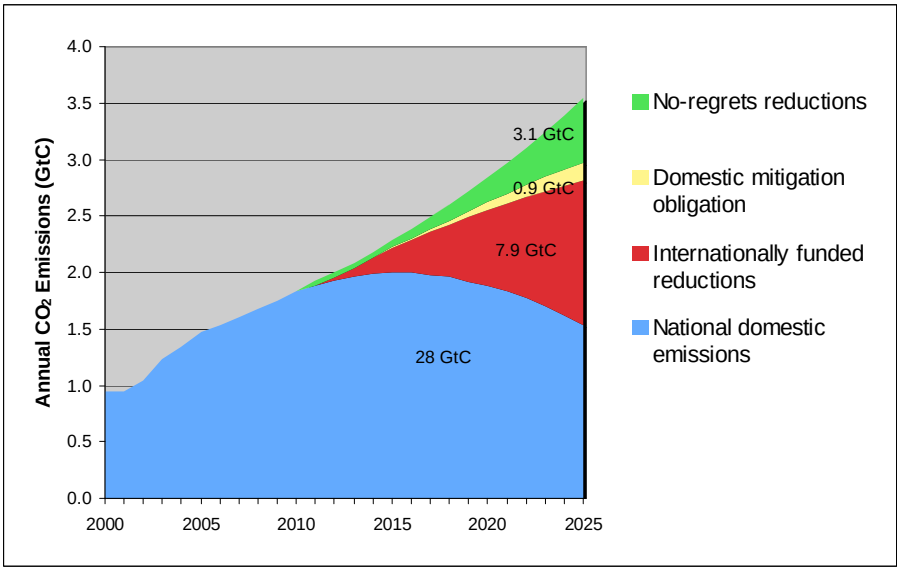
Figure 5: US allocation, showing no-regrets reductions (green), domestically discharge reduction obligation (yellow), and internationally discharged reduction obligation (yellow/red striped).



The developing country complement to the situations illustrated in Figure 5 is well illustrated by the case of China, shown in Figure 6. Again, the top path corresponds to China's business-as-usual path, and the green wedge to its no-regrets opportunities. The yellow wedge corresponds to China's reduction obligation, (2.7% of the global mitigation requirement). The large red wedge shows a large additional set of emissions reductions that are made within China, but are financed by countries (such as the US) working to discharge their own reduction obligations. The red wedge is, in essence, the converse of the yellow/red striped wedge shown in Figure 5. It reflects the mitigation obligation not of China, but of wealthy countries whose obligations extend beyond their borders.

These reductions are a natural and expected outcome of the GDRs framework, and a necessary feature of any climate regime that can possibly solve the climate problem. China's emissions are large, and fully exploiting its mitigation potential is essential if we're to keep within the emergency 2ºC trajectory. Recalling Figure 1, we reiterate that aggressive mitigation in the South is a scientific necessity, but will only occur if it doesn't conflict with the South's urgent development needs.

Figure 6: China allocation, showing reductions (green), reduction obligation (yellow), and further reductions supported and enabled by countries whose reduction obligations exceed their domestic mitigation potential.



Final Comments

The scientific evidence is bracing and demands a break with "politics as usual". The rate at which reductions are needed globally means that carbon-based growth is no longer an option, in either the North or in the South. Our response to the climate crisis must recognize this reality and its consequences, and rise to the challenges that they imply.

A major commitment to large North-to-South assistance – financial and technological – is an inevitable part of that reality, as is clearly captured in para 1(a)ii of Decision 1/CP.13. Domestic reductions by the developed world, in other words, can fulfill only part of its obligation. To be sure, within the industrialized countries, the environmental community – and increasingly other stakeholders such as the private sector, civil society, and forward thinking politicians – have done a spectacular job of putting the need for real *domestic* emission reductions onto the political agenda. But there's been precious little attention given to the underlying structure of the global climate-development problem, and to the consequent *international* responsibility of the wealthy to enable a rapid transition to a low-carbon world.

This will require a fundamental rethinking of many issues, be they political, social, or economic. However, societies both in the North and in the South have grown accustomed to rather rapid and radical structural change in the past, and will certainly be able to do so also in the future. This is all the more important, since national societal enabling conditions are required to formulate negotiation instructions that will lead to robust and implementable international agreements.

For political reasons, if not alone for ethical reasons, a commitment from the wealthy of the South is also necessary. Not only is it fair, but it is unlikely that the working consensus to pay a large proportion of the total mitigation and adaptation costs could ever emerge in the North if the "wealthy" minority in India and China and other developing nations were not also paying their "fair shares."

One might ask, of course, if such a framework, which makes the daunting climate challenge even more overwhelming by conflating it with developmental equity, is at all politically realistic? To this we can only repeat what others have said − that the outer bound of what is politically realistic today is well shy of the inner bound of what is scientifically necessary. Besides, political realism is rather labile, and it is much more likely that political realism will redefine itself (as climate impacts become more acutely felt) than that the physical necessities of climate change will shift. It is now obvious that without an unprecedented level of global cooperation, an emergency program simply can't be implemented. The alternative to a solution along these lines is a weak regime with little chance of preventing catastrophic climate change.

This will require a fundamental rethinking of many issues, be they political, social, or economic. However, as Einstein said, "The significant problems we face cannot be solved at the same level of thinking we were at when we created them." Indeed, societies both in the North and in the South have undergone many times rather rapid and radical changes, and will certainly be able to do so also in the future. Indeed, the negotiators who we are tasking with the design of a viable and effective climate regime can only reasonably be expected to succeed if the necessary societal enabling conditions have been put in place (Kjellén, 2008 [37]).

Since efforts will be demanded by all of us, fairness, equity and justice, real and perceived, are essential prerequisites for success. But the core of the issue is about politics. As nicely as a right to development may accord with an innate sense of justice, this is really a matter of hard-nosed politics. Climate change is a problem − perhaps humankind's first such problem − where poor and wealthy begin to understand that we all share a small planet and that we are all interdependent. It also gives a new dimension to the word solidarity: the survival of the wealthy depends on their solidarity with the poor. And intra-generational equity is a necessity for the inter-generational equity we are striving for. We are all responsible, but the responsibility is indeed differentiated. The climate regime ultimately has to ensure the rights of the billions of people far away from the conference halls: the unseen poor of the planet to-day, and the unborn, future generations. Therefore, in order to ensure our common survival through success in extremely difficult negotiations, the North will have to engage with the South in a way that recognizes and honors legitimate development needs on this shared, finite planet.

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