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Sharing the Emission Budget

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Mitigating climate change: the emission budget approach

The objective of 2 ℃ above the pre-industrial level by 2100 has recently assumed a normative role in understanding what constitutes dangerous climate change; it has also obtained 'significant *international legitimacy*' (Moellendorf, 2009, p. 249, emphasis in the original).

Meinshausen et al., in a study which appeared in *Nature*, focus on cumulative emissions in 2050 to provide a scientific reference framework that defines, over a policy-relevant timeframe, a global emission budget to achieve the 2 ℃ target. Specifically, this study adopts a comprehensive probabilistic approach that takes account of the uncertainties in climate sensitivity and carbon-cycle feedbacks to determine carbon dioxide (CO_2) emission budgets in the period 2000-50 that would limit warming in 2100 to 2 ℃ above the pre-industrial level: '[l]imiting cumulative CO_2 emissions over 2000-2050 to 1,000 Gt [gigatonnes] CO_2 yields a 25% probability of warming exceeding 2 ℃–and a limit of 1,440 Gt CO_2 yields a 50% probability–given a representative estimate of the distribution of climate system properties.' (Meinshausen et al., 2009, p. 1158). The current article uses as a reference the 1,000 Gt with a 25% probability of exceeding the 2 ℃ limit scenario – the illustrative case highlighted by the authors.[1] On the basis of this scenario, and according to their

[1] Meinshausen et al. model for the 1,000 Gt class of scenarios 19 marginal probability density functions (PDFs) of climate sensitivity, whose probability of

estimates and assumptions, the amount of this emission budget from 2010 onwards is 657.1 Gt CO_2 from fossil source and land use change (thus excluding international bunkers such as aviation and shipping). This figure is obtained by subtracting from the reference emission budget (1,000 Gt CO_2) the 2000-06 emissions (234 Gt) and the 2006-2009 ones, calculated assuming Meinshausen et al.'s constant rate of emission of 36.3 Gt CO_2 yr^{-1} (108.9 Gt CO_2).[2]

The purpose of this article is to explore what the application of different ethical perspectives on distribution entails in terms of sharing the 2010-50 emission budget among states, regions and groupings of states. The article first offers some specifications on the

exceeding 2 ℃ ranges from 10 to 42%; the 25% probability is in their study the average result for the class of scenarios considered. Available from: www.primap.org at *THE PRIMAP 2 ℃ Check Tool* [Accessed 24 March 2011].

[2] Some scholars (e.g., Athanasiou et al., 2009; Baer et al., 2009) on the basis of Meinshausen et al.'s (2009) work calculated a slightly different emission budget for 2010-50 (670 Gt CO_2): the divergence is probably due to their inclusion of the dip in emissions in the period 2007-09 caused by the recent economic recession. The WBGU (WBGU, 2009), instead set the 2010-50 CO_2 emission budget at 600 Gt, but this figure excludes emissions from land use change. My figures, here and in the following sections, are only indicative, though in a hopefully rigorous, scientific-based manner, of the scale of the issue at stake. They are by no means intended to confute the hard numbers of climate scientists or to provide new numbers for the policy debate.

distribution of the emission budget.[3] Then it analyses distribution paths, that is, the major families of distribution patterns, principles, and criteria for sharing the emission budget among different states, regions and groupings of states. Distribution patterns are general distributive constructs and include equality, priority, sufficiency (all patterns belonging to the broadly egalitarian conception of distributive justice), and a non-broadly egalitarian pattern. These patterns are translated into burden-sharing schemes by a number of distribution principles. Specifically, in my analysis the egalitarian pattern justifies the Equal per Capita, Equal Burdens and Equal Access principles; the prioritarian pattern substantiates the Historical Responsibility, Ability to Pay and Beneficiary pays principles; while the sufficientarian pattern vindicates the Survival/Luxury emissions principle. To the non-broadly egalitarian distributive pattern is, instead, ascribable the Grandfathering distribution principle. Principles of distribution are eventually operationalized by distribution criteria, which specify what kind of reference bases and data are used and how they are employed to obtain the shares of the emission budget attributed to states, regions and groupings. Subsequently, the article presents and discusses such shares, and it

[3] In the exercise carried out, the available emission budget (657.1 Gt) is distributed in units – emission rights (Er), the elements to be shared, as pointed out below – that entitle the owner to emit over the time period considered (2010-50) an equivalent amount of CO_2, as, for simplicity, it is assumed that 1 Er corresponds to 1 Million tonnes (Mt) CO_2 (0.001 Gt CO_2).

reflects on their implications for the ethics of mitigation. Finally, the article advances some lessons for international climate policy.

Sharing the emission budget: specifications

The distribution of the emission budget should be primarily a matter of distributive justice. It relates to the distribution of benefits and burdens in society and can be articulated into three general questions: 1) who (what) are the subjects of justice, 2) what kinds of benefits and burdens are to be justly shared and 3) what is (are) the pattern(s) and/or principle(s), of distribution?

In this article, the state is assumed to be the subject of justice to which shares of the emission budget pertain: therefore, with regard to point 1, the article acknowledges statist moral agency, as the literature on climate justice more or less implicitly assumes because of the primacy of states in climate negotiations (e.g., Miller, 2008; Neumayer, 2000; Shue, 1993, 1999). Statist moral agency, nonetheless, is still a controversial issue that distresses the majority of ethical theorists, who by and large assume that individual human beings are the ultimate subjects of justice. It therefore needs further explanation and closer contextualization. In this regard, I argue that states, in the ambit of climate change, are conglomerate collectivities (French, 1984) whose in/actions can be considered authentic expressions of their members' identity, public culture and self-determination, even if some members disagree with them. Climate change can thus be produced by state's members in/actions, but, i)

these in/actions largely reflect the public culture and the shared values fostered, or at least not hampered, by governments, and ii) such in/actions are allowed, and/or favoured, by government norms and policies shaped by these culture and values, which are a product of the entire society and as such irreducible to individuals. In light of these arguments, it seems ultimately possible to maintain that, as far as climate change is concerned, states are subjects of justice.[4]

In regard to point 2, the elements to be shared, turned into scarce goods by the emission budget approach, are rights to emit CO_2,[5]

[4] It is of interest that this kind of moral justification for statist moral agency is closely related to a line of thought in public international law that claims that a scheme of liability for climate impacts should target the largest discrete actors, namely states. In fact, if the emissions produced by individuals or corporations within a state over a period of time were sufficiently large to produce, and to have been expected to produce, dangerous climatic impacts, it is likely that the state acted wrongfully in encouraging, or failing to limit, those behaviours (Adler, 2007).

[5] On the contrary, Hayward (2007) claims that Er are not the elements to be shared, basically because such acknowledgment would encourage self-interested claims. He instead points out that such element is the ecological space, a fundamental right deriving from the Earth's natural resources and environmental services: in the context of climate mitigation, it would be the atmosphere's capacity to absorb GHG emissions. Caney (2009) upholds this position, even though he does not focus on Er, but on emissions to which, in his view, no distributive principle applies, because they do not have value in and of themselves but only furnish valuable goods, that is, the services provided by the energy produced from the combustion of fossil fuels. Meyer and Roser (2010) oppose this conclusion and alternatively argue, in line with the assumption of this article, that the elements that

because emissions are the unavoidable by-product of most of the activities that increase the welfare or well-being of people.

According to Gardiner (2010), point 3, with regard to the mitigation of climate change, can be framed as two questions: the first concerns the identification of the appropriate trajectories of emissions reductions, and the second concerns the initial distribution of emission rights (Er) in pursuit of a particular goal: here, the distribution of the 657.1 Gt CO_2 emission budget to achieve the 2 °C target discussed above. This article, as anticipated, deals with this latter point insofar as it aims to quantify the shares of Er that the diverse paths of distribution of the emission budget entail for different states, regions and groupings. The implications in distributive terms of the different trajectories of emission reductions to achieve the 2 °C objective are not dealt with here for two reasons. Firstly not to extend the argument too far, and secondly to respond to Allen et al.'s (2009, p. 1164) evidence about 'insensitivity to the timing of future emissions' for defining the 'Cumulative Warming Commitment

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should be distributed are Er because '...what is limited is not really the *capacity* of the atmosphere to *absorb greenhouse gases* but rather the willingness of humans to put up with the climate quality that ensues from high concentrations of greenhouse gases in the atmosphere' (Meyer and Roser, 2010, Note 10, p. 249 [emphasis in the original]). In the same vein, Shue (1993) and Vanderheiden (2008) maintain that only subsistence (or survival) emissions (see below) – that is, those necessary for pursuing a decent life – constitute an inalienable human right and ultimately the elements to which considerations of justice apply.

(CWC)' – that is, the conclusion that what counts in achieving the 2 ℃ target is more the total amount of CO_2 emissions than their trajectories of abatement.

Imposing an emission budget and sharing it among subjects of justice pertains to what Caney (2010a, p. 204) calls the 'duty of mitigation',[6] that is, the duty to reduce GHG emissions or enhance their sinks. Importantly, scrutiny of the duty of mitigation through the emission budget approach includes intergenerational ethical considerations that demand that the current generation bequeath to future generations their just share of CO_2 emissions. The notion of emission budget has in fact an intrinsic intergenerational span because it is shared among the current and every relevant future generation, without however the possibility of specifically calculating future generations' fair shares, so that the emissions allowed are 'zero-sum across all emitters across foreseeable time' (Shue, 2009, p. 6).

Before the distribution of the emission budget is investigated, three specifications are in order. First, paths for sharing it are articulated into three levels, as anticipated in the introductory section. The first is that of patterns of distribution, which are understood as general

[6] The duty of mitigation specifically concerns net costs that are shouldered for no other reason than combating climate change. It consequently does not refer to costs incurred to reduce energy waste or to increase energy efficiency, because these categories of costs in fact generate savings. Shue (1994, p. 343) calls the former the 'true mitigation budget' and the latter the 'no-regret budget'.

distributive constructs, valid across a wide range of normative issues and grounded in general dimensions of justice that justify the ethical status of subjects of justice without, however, specifying the consequent implications. The main families of distribution patterns, which from a consequentialist perspective underpin, also jointly, comprehensive theories of just distribution that vindicate distributive principles are equality, priority and sufficiency.[7] These patterns are broadly egalitarian. By this is meant that broad egalitarianism is a general distributive profile that has a tendency to equality and aims to improve the lives of the badly off (Arneson, 2008). However, owing to its intuitive appeal and practical success in negotiation processes, I also consider Grandfathering, a distribution principle that can be ascribed to a non-broadly egalitarian distributive pattern.[8]

The second level is that of principles of distribution. These can be generally understood as the translation of patterns of distribution into

[7] Other studies identify different patterns (defined, interestingly, as principles) of distribution, according to a non-consequentialist perspective focused on their intrinsic nature, rather than on the outcomes of distribution patterns (and principles/criteria) as in this article. Ringius et al. (2002), for instance, identify equality, equity and exemption, Torvanger and Ringius (2002) identify responsibility, need and capacity, and Heyward (2007) identifies equality, responsibilities and capacity.

[8] For instance, the Kyoto Protocol adopted it to distribute GHG emissions abatements (in terms of targets against the base year 1990) among Annex I countries to the UNFCCC.

burden-sharing schemes that specify the ethical circumstances of subjects of justice. They are context-dependent moral norms that generate specific distributions in the area investigated, independently of general distributive matters. In this article, principles of distribution morally justify and specify the sharing of the emission budget among states, regions and groupings.

Both these levels of analysis involve important and intertwined ethical questions. However, for reasons of space I will only reference the relevant ethical debate.

The third level, that of distribution criteria, specifies what kind of reference bases (the quantities with no ethical contents on which distribution criteria are calculated) and data are used, and how they are employed to operationalize distribution principles. Although there may be ethical disputes on the operational details of such criteria, they do not involve substantial moral reasoning.

Second, I consider only a non-exhaustive set of elementary principles of distribution. Therefore, I do not take into account complex distributive approaches consisting of several elementary distribution principles (e.g., Caney, 2005, 2009, 2010a; Oxfam, 2007; Baer et al., 2008; Chakravarty et al., 2009) because elementary distributive principles, despite (or because of) their theoretical economy, 'get a sense of the terrain' (Gardiner, 2010, p. 58) and can therefore serve as entry points to composite approaches whose building blocks are, in fact, elementary principles of distribution.

Third, the perspective of justice adopted is problem specific: it does not take account of the (unjust) pre-existing distribution of other goods and deals only with ethical issues arising in relation to the distribution of the emission budget without acknowledgment of the repercussions all-things-considered: that is, other aspects of society (Gosseries, 2007).[9] Therefore, I ultimately espouse Meyer and Roser's (2010, p. 233) argument that, '…whether we like it or not, political reality currently hands us such problems of fair distribution of certain specific goods [i.e., emission rights] in our non-ideal world'.

With these points having been clarified, the following section focuses on the patterns, principles and criteria of distribution summarised in the ensuing Table 1.

Table 1 – Paths for sharing the emission budget

[9] This viewpoint can also be regarded as a local justice approach, where local is not understood in a geographical sense but rather implies that the focus is only on a specific issue or good (here Er) without consideration of the consequences that the application of certain ethical norms to that issue or good has in the rest of society. Caney (2010b, p. 4) argues instead that, for a number of reasons, 'we need to study global climate change ... in conjunction with global economic problems', thus inscribing his argument in an approach of general justice.

Paths for sharing the emission budget

The egalitarian path

Egalitarianism, the first broadly egalitarian distributive pattern considered, demands that justice be concerned with the equality of some currency of justice because being, for no fault of one's own, worse off than others in regard to the equalizandum considered is bad in itself (Temkin, 2003). In regard to the distribution of the emission budget, the currencies of justice employed are *per capita* CO_2 emissions, abatement burdens and energy services.

The most straightforward egalitarian principle of distribution is Equal per Capita, an option that is generally deemed to favour the meaningful participation of all parties, especially of the least developed ones, demanded by the UNFCCC (Posner and Sunstein, 2009).[10] The distributive criterion for operationalizing the Equal per Capita principle adopted in this article envisages amounts of emissions proportional to countries' 2006 population (EPC criterion).[11]

[10] The Equal per Capita principle is advocated by some scholars (e.g., Jamieson, 2005; Singer, 2002). But others (e.g. Caney, 2009; Gardiner, 2010; Miller, 2008; Moellendorf, 2009; Posner and Sunstein, 2009; Shue, 2009;) identify a number of serious problems in its regard.

[11] The states, regions and groupings of states considered in this article and reported in Tables 2 and 3, and all data used to calculate the distribution of the emission budget deriving from the application of distributive criteria are based on the latest (2006) information available, at the time of writing this article, for all 185

According to an alternative egalitarian principle of distribution: '[e]ach state is required to reduce its emissions by a share of the burden of overall emissions reductions that is equal to the burden of every other state' (Moellendorf, 2009, p. 251). This principle is generally known as Equal Burdens (Moellendorf, 2009), and suggests that, because cutting emissions is costly in terms of forgone economic growth and consumption, each state is expected to bear such costs in an equal proportion through the equalisation of the marginal cost (or disutility) of reducing emissions so that the forgone opportunities are equal.[12] The distributive criterion that operationalises the Equal Burdens principle requires understanding of the marginal costs of

countries and for all criteria from the Climate Analysis Indicators Tool (CAIT) database, Version 7.0. (Washington, DC: World Resources Institute, 2010). Available from: http://cait.wri.org [accessed 24 March 2011].

[12] Pros and cons of this principle of distribution have been analysed by Gardiner (2010), Moellendorf (2009) and Traxler (2002). Slightly different interpretations of the equalizandum are offered by Miller's (2008) Equal Sacrifice principle, which aims to equalise states' sacrifices in terms of GDP loss, and by Traxler's (2002) Equal Burdensomeness principle, whose equalizandum is (non-monetary) human well-being. An alternative view holds that the metric for measuring the burden is emissions reduction. It is not taken into account by this article because it neglects the fact that the cost of cutting emissions varies greatly among different socio-economic contexts. Hence equal reductions would imply very different economic and financial burdens with unequal repercussions on well-being and/or welfare that could ultimately induce disingenuous appeals to the Equal Burdens principle in climate negotiations.

CO_2 abatement.[13] On the basis of countries' 2006 GDPs, I calculated a factor that equalises the marginal abatement costs among (groups of) countries, which I then applied to the emission budget to obtain the countries' shares (EB criterion).

The consideration that 'geography matters when it comes to explaining variations in CO_2 emissions' (Neumayer, 2004, p. 39) because different countries may, for instance, have very dissimilar heating and cooling needs, agricultural land and consequent practices and availability of renewables, introduces another egalitarian principle of distribution: that of Equal Access. According to this principle, each subject of justice is entitled to an equitable access to energy services, which are influenced by undeserved inequalities such as different climatic conditions or differences in the use of fertilisers – emitting GHG – required by cultivable lands.[14] At the same time, not all energy services produce emissions: those based on renewables do not, for instance. Therefore, energy services, as understood here, should be considered net of non-emitting ones. The uneven distribution of these characteristics prevents people from attaining genuine equality in accessing energy

[13] I estimated them, for the different world regions, from the figures given by Exhibit A.VI.5 (p. 157) and Exhibit A.VI.8 (p. 159) of the study by McKinsey & Company (2009) on global emission abatement cost curves.

[14] The fair access to energy services is a neglected topic in the literature. For a discussion, see Starkey (2008).

services, and a larger amount of emissions should be allotted to those states that experience the factors that increase needs for energy services to a greater extent. The distributive criterion that operationalizes the Equal Access principle requires that the equal per capita distribution of emissions be corrected by heating and cooling needs (I could not include the other factors influencing needs for energy services owing to problematic data availability and reliability at the global level): a higher sum of heating and cooling needs indicates greater positive correction to the initial egalitarian distribution to maintain the equality of access to energy services, and therefore a proportionally larger share of the emission budget (EA criterion).

The prioritarian path

Parfit (1997), on pointing out the levelling down problem that in his view undermines the moral significance of egalitarianism,[15] advances an alternative broadly egalitarian distributive pattern – prioritarianism – which asserts the importance of assuring specific benefits to the least advantaged subjects. Prioritarianism rejects the idea that inequality is intrinsically bad; rather, it focuses on the absolute situation of the subject of justice: the lower her/his level of the currency of justice, the more s/he should be benefited; that is, given

[15] In brief, this originates from the circumstance that egalitarianism always favours positive distributional outcomes that reduce inequality, even if this is against the interest of the entire society.

some sort of priority in accessing it. Similarly to egalitarianism, the ethical approach of prioritarianism in the context of climate change envisages distributions of the currencies of justice that benefit the worse off, in general the South, in achieving their mitigation objectives. However, as Page (2008) points out, because prioritarianism does not fetishize equality, it is more likely to admit unequal outcomes as long as they make the achievement of other objectives, such as efficiency, possible.

The first prioritarian principle of distribution considered is that of Historical Responsibility, which distributes costs of emission abatement in proportion to past contributions that subjects of justice have made to the overall level of emissions.[16] This is the climate variant of the much-cited Polluter Pays principle. It claims that, in distributing Er, priority should be given to those states which have emitted less CO_2, granting them an amount of emissions inversely proportional to their fault, that is, to their cumulative emissions. Scholars upholding the principle of Historical Responsibility basically claim that ignoring it would be to act in favour of people who lived in the past in heavy-emitter rich countries, and to discriminate against those now living in developing countries (Neumayer, 2000) Those who resist Historical Responsibility usually focus on the nearly insurmountable conceptual and practical difficulties that

[16] Grübler and Fuji (1991) presented instead an egalitarian account of historical responsibility.

responsibility, *per se* 'one of the most slippery and confusing terms in the lexicon of moral and political philosophy' (Miller, 2007, p. 82), entails in the context of climate change.[17]

I envisage the operationalization of the principle of Historical Responsibility in the context of the emission budget through the application of a parameter of responsibility, calculated as the country's share of 1990-2006 cumulative CO_2 emissions in relation to total cumulative CO_2 emissions to distributions based on other distributive principles.[18] More in detail, I argue that the most appropriate criterion is the one that applies the parameter of responsibility to an Equal per Capita distribution of emissions: I call this the Equal per Capita-based Historical Responsibility criterion (HR-EPC criterion). Alternatively, given the practical advantages of Grandfathering (see below), it seems interesting to apply the same parameter of responsibility to a grandfathered distribution: this is the

[17] Caney (2005, 2009), Jamieson (2005), Miller (2008) and Page (2008), although on slightly different grounds, question in fact the significance of the retrospective notion of historical responsibility in regard to climate change. For a very sophisticated treatment of historical responsibility in the context of mitigation, see Meyer and Roser (2010, pp. 233-7).

[18] This indirect operationalization of the principle of Historical Responsibility is due to the unavailability of estimates of 2010-50 BAU emissions for each of the 185 countries considered. In fact, the direct operationalization of this principle would have required the application of the responsibility parameter to the emission budget recalculated based on countries' 2010-50 BAU emissions.

Grandfathering-based Historical Responsibility criterion (HR-GF criterion).

Two other prioritarian distributive principles should be considered: Ability to Pay and Beneficiary Pays. The first is forward looking and demands that the most advantaged states bear the largest quota of mitigation costs due to their greater wealth and capacities. The second, instead, is backward looking and holds that the reason why the most advantaged countries should be the largest contributors to global mitigation efforts is the fact that they have reaped most of the benefits of GHG emitting activities of past generations.[19] The Ability to Pay and Beneficiary Pays principles can be operationalized with a criterion that assigns emission shares by applying to countries' 2006 GDPs (the most common proxy for wealth, that is, both for ability to pay and, indirectly, for the benefits reaped from carbon-based development) a corrective factor based on the share of countries'

[19] Both principles involve some ethical concerns (Caney, 2010a; Page, 2008). The Beneficiary Pays principle, in particular, raises serious issues of intergenerational justice, such as the non-identity problem, which relates to the question authoritatively addressed by Parfit (1984, pp. 351-80) concerning the non-fixed identity of future individuals, (Page, 2008, pp. 562-3; Caney, 2005, p. 757) and the non-reciprocity problem (Page, 2008, p. 563), which entails that intergenerational (climate) justice is not conceivable because there are no direct, mutually advantageous interactions between different generations. It should be borne in mind, however, that the emission budget approach, owing to its intrinsically intergenerational nature (see above), would somehow avoid these problems.

GDPs of the world GDP: a lower value of this ratio indicates a proportionally higher share of the emission budget that is distributed (ATP-BP criterion).

The sufficientarian path

Sufficientarianism, the third broadly egalitarian distributive pattern, holds that every subject must have a sufficient, yet not equal, share of the specific currency of justice: 'what is important from the point of view of morality is not that everyone should have *the same* but that each should have *enough*' (Frankfurt, 1987, p. 21, emphasis in the original). The very point of sufficientarianism is therefore that subjects of justice should have enough to be above a threshold below which it is impossible to have decent life chances. Sufficientarianism, despite its difficulties,[20] has gained a privileged role in the literature on climate (and in general environmental) justice by virtue of its strong acknowledgement of, and accordance with, the requisites of the sustainable development principle (Page, 2006).

The Survival/Luxury emissions principle of distribution arises from the sufficientarian distributive pattern. It identifies, on the one hand, a minimum level of survival emissions – that is, a level of emissions below the moral threshold – between those who have enough and

[20] For their overview in the context of climate change, see Meyer and Roser (2010, p. 236) and Page (2006, pp. 92-5). Gardiner (2010) points out also that it produces distributions that are too similar to those produced by the Equal per Capita principle.

those who have not enough Er to perform, in our still largely fossil fuel-based economies, the basic activities for having a decent life. On the other hand, the principle in question recognises luxury emissions that extend beyond that moral threshold and derive 'from activities usually associated with affluence' (Vanderheiden, 2008, p. 67). The objective of this principle is to allow those (states) below the moral threshold of emissions to freely carry out the CO_2-generating activities necessary for their citizens to pursue a decent life by removing any limits on their emissions.

On practical grounds, the Survival/Luxury emissions principle subtracts from the overall emission budget the future (2010-50 in this case) BAU emissions of countries characterised by survival emissions and distributes the remaining emission budget according to a selected principle of distribution only to states above the moral threshold of emissions. [21]

[21] Despite the statist view adopted, it seems preferable to discriminate on empirical grounds between survival and luxury emissions on a *per capita* basis because of the intrinsically individualistic nature of this distributive principle, whose ultimate goal is to allow individuals to lead decent lives. Once such a distinction has been drawn, it seems possible to assume that states to which the average individual characterised by survival emissions belongs are those that should be brought above the moral threshold of sufficiency through exemption from limits on CO_2 emissions deriving from activities necessary to have a decent standard of living because they are on average, so to speak, characterised by survival emissions.

I argue that the distributive criterion that can adequately serve the Survival/Luxury emissions principle suggests that the lowest x (90) out of the total y (185) countries in terms of per capita cumulative 1990-2006 CO_2 emissions, should be exempted from any emissions limits (S/L criterion). The 90 exempted countries have, in fact, per capita 1990-2006 cumulative emissions below 35 T: this is therefore an apparently sensible (i.e., stringent enough) sufficiency line, as only South America and Sub-Saharan Africa are, on average, below it. After their cumulative BAU emissions over the reference period 2010-50 have been calculated (153.1 Gt), the figure should be subtracted from the total emission budget of 657.1 Gt. The remaining amount of Er (504,000 = 504.0 Gt, in terms of emission budget) should then be shared among the first y – x (95) countries on the basis of an agreed distributive principle. I claim that the most appropriate principle is the Equal per Capita one because, according to the ethical nature of the Survival/Luxury emissions principle, once survival emissions have been excluded, the other subjects of justice should be treated equally.

A non-broadly egalitarian path: Grandfathering

A principle of distribution not ascribable to the broadly egalitarian school of thought is often invoked. Grandfathering, in fact, is 'most often applied in practice' (Caney, 2009, p. 127) and envisages a distribution of the emission budget among states proportional to their respective past shares of emissions at a given date, that is, based on

the *status quo*. Indeed, as Caney (2009, p. 128) states in regard to climate change: '[n]o moral and political philosopher (to my knowledge) defends grandfathering, presumably because it is unjust'. Grandfathering is morally 'implausible' (Jamieson, 2005, p. 230) because it reflects the existing configuration of emissions originating from the chronological priority of the development process, whilst it disregards any considerations on moral entitlements. Therefore, the chronological priority in exploiting a common resource like the atmosphere cannot generate any moral claims to continue such exploitation according to the same, unchangeable, configuration of emissions. However, as has been stated, Grandfathering has had an undeniable popularity ascribable, in Caney's (2009, pp. 128-30) view, to two pragmatic rationales. According to the 'longhaul' argument, it is the necessary first step towards a cap-and-trade system that, once introduced, can be reformed over time in order to achieve more equitable re-distributions of emissions. The 'priority' argument maintains that our most urgent priority is abating emissions, and that for this to succeed all major emitters should be involved. Grandfathering, in this perspective, is the most reliable system with which to engage them and thus protect humankind against climate threats.

The distributive criterion (GF criterion) for operationalizing the Grandfathering principle simply demands that the emission budget be distributed according to the proportion of countries' emissions in a

given year: for the sake of consistency with the other distributive criteria, I selected CO_2 emissions in 2006.

Shares of the emission budget and implications for the ethics of mitigation

The shares of the emission budget, expressed in Er units, attributed by applying the distributive criteria specified in the section above to the top 20 emitting countries and to UNFCCC regions and other groupings of countries are presented, respectively, in Tables 2 and 3.[22]

Shares of the emission budget

It is impossible to find a common denominator for the distributions of Er on the basis of the distributive patterns – egalitarianism, prioritarianism, sufficientarianism, and the non-broadly egalitarian one of Grandfathering – that support distribution principles and criteria. Rather, distributions can be grouped according to the three reference bases of their respective distributive criteria: population (EPC, EA, HR-EPC, S/L criteria), GDP (EB, ATP-BP) and emissions (HR-GF, GF). It should be pointed out that outcomes pertaining to distinct reference-base groups differ considerably. This evidence is the opposite of that found by similar studies (e.g., Ringius et al., 2002; Rose and Zhang, 2004) which show that principles of

[22] As pointed out in the Introduction (Note 3) the emissions budget is shared through distribution of Er.

distribution, despite their theoretical differences, in practice yield very similar outcomes. Moreover, unsurprisingly, it is possible to observe that, in general, population-based distributions tend to be favourable – that is, they tend to attribute larger quotas of Er – to Southern countries, whereas GDP-based ones are more favourable to Northern countries. The two emissions-based distributions considered exhibit an apparently peculiar feature: they disproportionally penalise low-emitting countries, while they are more favourable than GDP-based distributions in regard to non-low-emitting developing countries. All told, the distributions reported always grant the bulk of the emission budget to the top 20 emitters: the least generous are the EPC and HR-EPC with about 60% of Er conferred to them, whereas the EB and GF are the most beneficial, granting them more than 80% of Er.

As far as specific distributions are concerned, the EB one attributes to Northern countries and to their groupings (e.g., Annex I, Annex II, OECD) the largest quota of the emission budget. By contrast, the S/L distribution assigns the largest amount of Er to non-exempted countries of the South (e.g., China (40% of Er), Mexico (3%), Iran (2%), South Africa (1.5%)), although it entails some significant exclusions in the exercise carried out (India and Brazil, two of the largest fast-growing emitters, which are considered actors that are essential for an effective global mitigation regime). The favourability of the population-based S/L distribution for the South is confirmed by

the three other distributions with the same reference basis (EPC, EA, HR-EPC), which in fact allot to non-Annex I countries about 80% of Er, to G77 and China about 75% and to LDCs about 12%, about twice as much as the GDP and emissions-based distributions. However, the S/L distribution is at the same time less stringent to the richer world than the other population-based ones, assigning to Annex I (II) countries 38% (27%) of Er (compared to 20% (14%) of the other population-based distributions).

The population-based EA distribution is extremely similar to the EPC one. It is probable that heating and cooling needs do not constitute a sufficiently robust differentiation factor: their sum is in fact quite similar across all countries. It is very likely that the inclusion in the EA criterion of other differentiation factors whose practical availability for the entire set of countries considered is highly problematic, such as the availability of renewables or the typology of agricultural land and consequent practices, would make this distribution more significant because such factors should be diverse enough to generate dissimilar outcomes.

The responsibility-backed distributions, HR-EPC and HR-GF, are very similar, respectively, to the EPC and GF ones. It seems that on practical grounds, the application of a responsibility parameter, which is apparently significant because it is calculated, as specified above, on the basis of countries' 1990-2006 cumulative CO_2 emissions, to

the EPC and GF distributions does not produce noteworthy outcomes.

The ATP-BP distribution is, in comparison with the other GPD-based one (EB), at the same time fairly beneficial to poorer countries and reasonably penalising to richer ones: it assigns 50% of Er to Annex II countries (58% to OECD) and 41% to non-Annex I countries (34% to G77 and China), compared to the relative favourability of EB to richer countries (54% of Er to Annex II countries, 62% to OECD) and its relative strictness for poorer ones (38% to non-Annex I countries, 32% to G77 and China).

Finally, the *status quo* distribution envisaged by the non-broadly egalitarian GF criterion confirms its injustice towards current low-emitting countries (e.g., 0.6% of Er to LDCs, 0.5% to AOSIS), but, surprisingly, it is not very penalising towards the developing world (49% of Er to non-Annex I countries, 43% to G77 and China), in comparison to GDP-based distributions.

Implications for the ethics of mitigation

The significant differences pointed out in the shares of the emission budget distributed to different countries, regions and groupings of countries according to the alternative principles and criteria of distribution on the one hand make it possible to weigh the relevance of the current ethical debate on the initial distribution of Er; on the other hand, they prompt ethical intuitions that can further inform judgment about patterns and principles of distribution.

The first and most general implication relates to the greater consideration of the sufficientarian pattern of distribution to poorer countries of the South. At the same time, the other broadly egalitarian patterns (egalitarian and prioritarian) do not show the expected favourability to those who are badly off. Therefore, an ethical approach to mitigation attentive to the claims of the South should preferably aim to ensure that every subject receives an amount of Er that enables them to lead decent lives, as demanded by sufficientarianism. Conversely, both an egalitarian approach, such as the one advocated by the Equal Burdens principle, and a prioritarian one, like the one espoused by the Ability to Pay and Beneficiary Pays principles, besides offering a sounder, though still contentious, ethical ground, seem to serve the interest of the industrialised world better than the morally implausible non-broadly egalitarian distribution envisaged by the Grandfathering principle. In sum, the (scant) debate on patterns of distribution of Er *per se* can prove rather academic or even misleading, because the empirical evidence highlights that it is the reference basis of the principle of distribution that largely shapes the outcome.

The favourability of the Equal per Capita principle for the developing world and the potential of bolstering its participation in the climate regime, as well as its ethical justification provided by authoritative scholars (e.g., Jamieson, 2005; Singer, 2002), mean that it is widely advocated for the initial distribution of Er by most Southern policy-

makers and activists. The empirical analysis conducted does not seem to support their preference, as the Survival/Luxury emissions principle attributes larger quotas of the emission budget to the developing countries, and especially to the poorest among them, than does the Equal per Capita principle. The Survival/Luxury emissions principle, however, still raises an awkward theoretical issue, on which more work should be done, and which concerns the identification of what counts as survival emissions, that is, the identification of the sufficiency line. To be noted is also a significant practical drawback to this principle. Exempted states have, in fact, no obligations to cut emissions. Consequently, they have also no incentives to exploit low-carbon technologies and therefore risk being irremediably left behind in future non-fossil development. To obviate this danger, it would be necessary to compel, as the Greenhouse Development Rights Framework (Baer et al., 2008) suggests, exempted states to pursue no-regret mitigation policies, such as those highlighted in Note 6. According to Baer et al.'s construct such states, always to this end, should also be provided with financial support.

By contrast, the Equal Burdens principle, despite its egalitarian background, implies wide disparities in terms of Er that disproportionally penalise the developing countries. It also contradicts the ethical cornerstone of the Convention, namely the principle of common but differentiated responsibilities (see below). It

thus seems to be a controversial principle, also because the equalisation of the marginal cost of emissions' reduction proves to be a theoretically questionable reference, given that its utility metric disregards many other potential equalizanda of justice, such as well-being or capabilities, which are very important for the developing world.

The Equal Access principle is, in my view, theoretically promising in regard to the initial distribution of Er. Unfortunately, the current lack of the necessary data – whose collection should indeed be promoted – precludes any further reflections on its largely underexplored theoretical facets.

As far as the responsibility-backed distributions are concerned (HR-EPC, HR-GF), my opinion is that, both because of the deep theoretical perplexities that the principle of Historical Responsibility raises, because of its difficult operationalization for the reasons pointed out in Note 18, and also because of its scant political feasibility, such principle should be employed with particular caution in the mitigation context of distributive justice envisaged by the emission budget approach.

Both the Ability to Pay and Beneficiary Pays principles of distribution generate outcomes that can be considered to be attentive to diverse circumstances, captured by GDP, that characterise countries. This encouraging empirical evidence suggests that attention should concentrate on its theoretical pitfalls, which, as pointed out, remain

substantial. Some of the most alarming ones should be addressed, and deeper understanding should be gained of the appropriateness of its utility metric in this context.

Finally, the Grandfathering principle, which is theoretically impossible to defend, also seems empirically fragile, owing to the somewhat ambiguous outcomes produced and to its manifest injustice towards low-emitters. This is an inadequacy that should override the pragmatic rationales usually invoked for its adoption.

The ethical intuitions triggered by the empirical analysis can be better justified by taking account of the degree of consistency of the distributions of the emission budget examined with the relevant ethical provisions of the UNFCCC. The Convention, in fact, still plays a central role in the international politics and policy of climate change, and it can provide a solid reference for the development of agreed principles on distribution of the mitigation duty. Article 3.1 states that parties 'should protect the climate system for the benefit of present and future generations of humankind', thus acknowledging the intergenerational dimension of justice, and they must act 'on the basis of equity'. Moreover, the same article affirms that states must operate 'in accordance with their common but differentiated responsibilities and respective capabilities' and that, '[a]ccordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof'. From a broader perspective, elements of justice are also apparent in article 3.2,

which provides that 'the specific needs and special circumstances of developing country Parties ... should be given full consideration'; in article 3.4, which demands that parties have a right to develop in a sustainable manner; in article 4, which divides obligations between those pertaining to the developed countries and those imposed on all Parties.

In light of the analysis conducted and of this overview of the ethical substance of the Convention, the Survival/Luxury emissions principle seems to represent the most promising option for distributing the emission budget. In addition to its theoretical robustness and empirical sense of balance, it is also consistent with the ethical provisions of the Convention because it is coherent with the right to development, with the division of obligations between richer and poorer countries, and with the acknowledgment of the specific needs and special circumstances of poorer countries. Finally, indirectly and avoiding any reference to the notion of historical responsibility (Shue, 2009) – which is still a political non-starter for richer and powerful countries, despite the support of most of the developing world – it is also compatible with the principle of common but differentiated responsibilities and respective capabilities.[23]

[23] As regards the intergenerational notion of justice, it should be again borne in mind, as already made clear at the outset of the second section, that the emission budget approach is in itself eminently intergenerational. Therefore, when the Survival/Luxury emissions principle, like the other distributive principles, is applied to such a construct, it necessarily resolves the dilemmas related to the

Conclusions: lessons for international climate policy

What general lessons might be drawn from the foregoing analysis and from the critical considerations that have been raised? How might these lessons be applied to international climate policy?

As anticipated, it seems that the distribution of the emission budget envisaged by the Survival/Luxury emissions principle ensures that poorer countries, and especially the underdeveloped ones, can pursue their right to development in a global socio-economic system still largely locked in carbon-intensive mechanisms and practices. However, as a matter of fact, in the negotiating context, its favourability towards poorer countries could undermine its political acceptability. The S/L distribution would in fact give a large share of the emission budget to poorer countries (especially the largest among them, such as China, Iran, Mexico and South Africa), and it would therefore be adamantly opposed by the rich and influential countries. However, it should be underlined that the Survival/Luxury emissions principle, at the same time, does not disproportionally penalise the richer world, though it is sufficiently demanding in terms of emission reduction for industrialised countries.

On this basis, I argue that the Survival/Luxury emissions principle might represent a good compromise with which to achieve a distribution of the emission budget that is acceptable to both the

considerations of future generations because it acquires an implicit intergenerational span.

South and the North; a distribution far more satisfactory than that envisaged by the Equal per Capita principle, which is generally considered best suited to achieving the meaningful participation of all countries demanded by the UNFCCC, and vocally supported by the Group of 77 and China.

Furthermore, by accepting subsequent market redistributions of Er through emission trading, the Survival/Luxury emissions principle also furnishes a more efficient and flexible approach to limiting emissions within a given budget that would ultimately benefit also the North.[24] This is because the marginal cost of emissions abatement differs greatly among countries (typically, it is much higher in Northern countries), with the consequence that the search for

[24] Emission trading is a much debated question. Muller (1999) identifies the ethical argument underpinning emission trading as the entitlement theory of justice: from a libertarian perspective, the transfer of justly acquired emission rights is morally legitimate and intrinsically just. However, emission trading raises some serious ethical issues (Caney, 2010b; Page, 2009). The most debated and feared ethical concern relates to the commodification (i.e., the attribution of an economic value to something that traditionally would not be considered in economic terms) of the atmosphere brought by a surrender to neoliberal ideology (Athanasiou and Baer, 2002). This would allow developed countries to 'buy their way out of their commitments' (Ott and Sachs, 2000, p. 17) without substantially reducing their emissions, an outcome which Page (2009) defines as the erosion of environmental morale. Caney (2010b) has recently argued that emission trading is ethically defendable only if it fulfils conditions related to the cutting of emissions and to the distribution of the burden that its application generates.

efficiency requires a redistribution of Er that equalises the different marginal costs. Practically giving a greater share of Er to the South, as conceived by the Survival/Luxury emissions principle, is therefore efficient. It is so because, according to the exercise carried out, this share seems to be greater than that necessary – it is twice as much as the EPC distribution, for instance – for the South to pursue its right to development and to sell the Er in excess to the North.[25] The South may thus obtain money transfers that could be used not only for direct climate-related actions but also to support pro-development initiatives that can ultimately contribute to undermining the risk, emphasised above, of being left behind by the (hopefully) upcoming green tech revolution. At the same time, the North's purchase of Er would give industrialised countries much greater flexibility in their emission abatement strategies, because the additional buy option can prove less costly than the make option of cutting emissions.

In a general sense, therefore, the Survival/Luxury emissions principle, complemented by emission trading, seems justified by the internal principle of justice of mutual advantages, which states that actions should have positive net benefits for all (Gauthier, 1986). It is in fact favourable for the South in terms of larger emission shares that can be both used and sold, to the North for the greater flexibility

[25] It would be very likely necessary to set some quantitative limits on Er selling in order to avoid the risks highlighted in Note 24.

in abatement strategies, and to all parties involved for its higher efficiency and lower total cost.

A second lesson is that when the emission budget approach is applied, emission trading is necessary to increase the efficiency, and thus the acceptability, of the distributions generated. In terms of international climate policy, this requires introducing a cap-and-trade system that allows a very substantial trade in Er from developing countries with efficiently low marginal abatement costs to industrialised countries with inefficiently high marginal abatement costs. In fact, this system, besides being efficient, also produces a reverse flow of financial resources, which, as has been noted, may ultimately prove useful for the general development of the South.

A third lesson for international climate policy is that the explosive concept of historical responsibility should be avoided in the negotiating context. The current climate change regime, in fact, does indeed embrace a notion of distributive justice based on responsibility (see *supra*); but it does not offer any effective indications as to how this ethical category should be operationalized, apart from the rather generalist provisions concerning the principle of common but differentiated responsibilities. In this regard, the Survival/Luxury emissions principle obtains the same result as claimed by the standard responsibility argument – that is, those who have no limits for emissions are the same as those who have not benefitted from past emissions – without advancing the risky

consideration of the historical dimensions of responsibility, as Shue (2009) points out.

A concluding remark, possibly a general lesson, is in order. The emission budget approach requires specific emission limits that should be achieved within a cooperative regime, and only commitments – requirements that a state voluntarily assumes – can hold such a regime together: before undertaking costly actions, in fact, countries require the assurance that other signatories will also do their part as a form of guarantee of mutual actions (Bodansky, 2003). The likelihood of an agreement among parties involved depends essentially on the non-controversiality of its provisions, and on the rigidity (and consequent cost) of commitments. A lower degree of controversiality and rigidity leads to greater acceptability and ultimately political feasibility, because there is no legally binding mechanism with which uninterested sovereign states can be forced to enter into an international agreement. With regard to the controversiality of provisions, I maintain, as anticipated, that looking at the past is a major stumbling block. In fact, it means entering into inextricable arguments about contributions to the problem and its anthropogenic origin, awareness about the dangerousness of emissions, culpability of past generations and so on. Forgetting the past and concentrating on the present and the future, as the Survival/Luxury emissions (and also the Equal Access) principle requires, would therefore greatly facilitate any climate agreement on

distributing the emission budget. Furthermore, as far as the rigidity of commitments is concerned, in a negotiating context that allows emission trading, principles of distribution that assign proportionally larger quotas of Er to the South would make such commitments more flexible, less costly and ultimately more acceptable for countries – like Northern ones, through Er purchases from the South – that should bear the largest part of the mitigation burden. Again, the Survival/Luxury emissions principle offers this advantage.

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Table 1 – Paths for sharing the emission budget

Pattern	Principle	Criterion
Broadly Egalitarian I (Egalitarian)	Equal per Capita	EPC: proportionality to countries' 2006 population
	Equal Burdens	EB: proportionality to countries' 2006 GDP corrected by a factor equalising marginal abatements costs
	Equal Access	EA: proportionality to countries' 2006 population corrected by an energy services factor (heating/cooling needs)
Broadly Egalitarian II (Prioritarian)	Historical Responsibility	HR-EPC: proportionality to countries' 2006 population corrected by the historical responsibility factor (CO_2 1990-06 cumulative emissions)
		HR-GF: proportionality to countries' 2006 emissions corrected by the historical responsibility factor (CO_2 1990-06 cumulative emissions)
	Ability to Pay	ATP-BP: proportionality to countries' 2006 GDP corrected by the wealth factor (aggregate country's GDP)
	Beneficiary Pays	
Broadly Egalitarian III (Sufficientarian)	Survival/Luxury emissions	S/L: proportionality to countries' 2006 population only for countries above the threshold of subsistence
Non Broadly-Egalitarian	Grandfathering	GF: proportionality to countries' 2006 emissions

Table 2 – Top 20 emitters: % and number of Emission rights (Er) (1 Er = 1 Mt = 0.001Gt)

	EPC		EB		EA		HR-EPC		HR-GF		ATP-BP		S/L		GF	
	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er
China	0.203	133,078.1	0.107	70,206.6	0.205	134,726.9	0.181	119,191.8	0.143	94,033.5	0.097	63,891.7	0.397	200,055.1	0.218	143,455.1
USA	0.046	30,248.1	0.229	150,711.7	0.046	30,553.2	0.037	24,588.5	0.196	128,853.3	0.182	119,648.4	0.090	45,471.6	0.203	133,382.3
Russia	0.022	14,603.4	0.033	21,587.0	0.023	15,243.5	0.022	14,352.1	0.073	47,796.5	0.032	21,159.8	0.044	21,953.1	0.057	37,314.1
India	0.170	111,663.5	0.048	31,743.9	0.165	108,615.8	0.173	113,419.0	0.042	27,766.8	0.047	30,650.4	exempt	exempt	0.047	30,766.1
Japan	0.020	13,034.7	0.071	46,944.1	0.020	13,121.3	0.020	13,085.6	0.053	35,118.5	0.067	44,297.3	0.039	19,595.0	0.044	28,836.2
Germany	0.013	8,413.0	0.048	31,529.8	0.013	8,537.5	0.013	8,567.6	0.040	26,095.2	0.046	30,453.4	0.025	12,647.3	0.030	19,468.3
Canada	0.005	3,296.3	0.021	13,782.2	0.005	3,405.1	0.005	3,412.4	0.023	15,245.3	0.021	13,664.6	0.010	4,955.3	0.019	12,705.4
UK	0.009	6,143.9	0.036	23,632.3	0.009	5,972.3	0.010	6,350.2	0.025	16,326.9	0.035	23,094.8	0.018	9,236.1	0.019	12,606.0
Korea (South)	0.007	4,926.7	0.021	13,655.1	0.007	4,833.9	0.008	5,121.5	0.019	12,410.6	0.021	1,3541.1	0.015	7,406.3	0.018	11,637.6
Iran	0.011	7,047.9	0.012	8,066.5	0.011	7,100.0	0.011	7,355.8	0.015	9,655.0	0.012	8,064.2	0.021	10,595.0	0.017	10,914.1
Italy	0.009	5,978.8	0.030	19,869.4	0.009	5,988.2	0.009	6,207.6	0.020	13,242.4	0.030	19,525.4	0.018	8,987.8	0.017	10,907.2
Mexico	0.016	10,516.6	0.024	16,069.7	0.016	10,248.6	0.017	10,954.7	0.017	11,001.1	0.024	15,879.5	0.031	15,809.5	0.016	10,197.6
Australia	0.003	2,081.1	0.012	7,883.2	0.003	2,061.7	0.003	2,171.5	0.015	9,816.5	0.012	7,883.0	0.006	3,128.5	0.014	9,229.1
France	0.009	6,209.9	0.034	22,609.4	0.010	6,244.4	0.010	6,463.5	0.018	11,546.1	0.034	22,128.5	0.019	9,335.3	0.014	8,981.8
Indonesia	0.034	22,500.1	0.013	8,806.5	0.035	22,887.2	0.036	2,3541.8	0.012	7,914.6	0.013	8,794.6	exempt	exempt	0.013	8,330.0
Brazil	0.029	19,059.5	0.030	19,478.2	0.029	19,007.6	0.030	1,9916.4	0.013	8,805.7	0.029	19,152.0	exempt	exempt	0.013	8,216.8
Spain	0.007	4,427.2	0.022	14,601.6	0.007	4,415.2	0.007	4,628.2	0.013	8,517.2	0.022	14,459.8	0.013	6,655.4	0.012	8,196.0
Saudi Arabia	0.004	2,358.5	0.001	599.1	0.004	2,395.8	0.004	2,468.0	0.012	7,821.7	0.009	6,006.9	0.007	3,545.5	0.012	8,172.9
South Africa	0.007	4,783.7	0.008	4,971.5	0.007	4,724.8	0.008	4,997.6	0.014	8,966.5	0.008	4,992.3	0.014	7,191.2	0.012	8,052.7
Ukraine	0.007	4,805.4	0.005	3,340.6	0.007	4,917.3	0.008	4,999.0	0.018	11,916.0	0.005	3,362.5	0.014	7,223.9	0.011	7,329.2
Total	*0.632*	*415,176.5*	*0.807*	*530,088.4*	*0.632*	*415,000.2*	*0.611*	*401,792.7*	*0.780*	*512,849.6*	*0.747*	*490,650.2*	*0.781*	*393,791.9*	*0.805*	*528,698.6*

Table 3 – UNFCCC regions and other groupings of countries*: % and number of Emission rights (Er) (1 Er = 1 Mt = 0.001Gt)

	EPC		EB		EA		HR-EPC		HR-GF		ATP-BP		S/L		GF	
	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er	%	Er
Annex I	0.195	128,425.3	0.621	408,261.2	0.198	130,021.8	0.191	125,517.6	0.582	382,634.8	0.590	387,580.1	0.383	193,060.7	0.509	334,770.9
Non-Annex I	0.805	528,674.7	0.379	248,838.8	0.802	527,078.2	0.809	531,582.4	0.418	274,465.2	0.410	269,519.9	0.616	310,539.5	0.491	322,329.1
Annex II	0.137	89,777.3	0.542	356,396.7	0.138	90,367.7	0.131	85,958.2	0.442	290,668.8	0.507	333,291.5	0.268	134,961.3	0.403	265,021.9
EITs	0.063	41,232.5	0.071	46,753.2	0.064	42,371.1	0.064	42,325.3	0.153	100,768.3	0.076	49,697.3	0.117	59,021.5	0.114	74,963.4
EU 27	0.076	49,990.3	0.221	145,270.7	0.076	50,257.7	0.079	52,011.1	0.186	122,142.6	0.242	158,781.2	0.150	75,150.2	0.145	95,208.4
G77 China	0.767	503,669.3	0.324	213,180.0	0.764	502,319.0	0.769	505,429.1	0.355	233,474.1	0.343	225,678.9	0.546	275,930.8	0.434	285,063.5
G8	0.134	87,928.2	0.503	330,665.9	0.136	89,065.5	0.126	83,027.4	0.448	294,224.3	0.447	293,972.3	0.263	132,181.5	0.402	264,201.4
G20	0.624	410,200.4	0.790	519,345.6	0.624	409,888.7	0.604	396,683.7	0.750	492,531.0	0.731	480,020.3	0.767	386,311.4	0.779	511,916.0
G2 (China/US)	0.249	163,326.2	0.336	220,918.2	0.252	165,280.1	0.219	143,780.3	0.339	222,886.7	0.279	183,540.1	0.487	245,526.7	0.421	276,837.4
LDCs	0.118	77,367.9	0.012	7,876.9	0.117	76,749.0	0.125	81,827.7	0.005	3,327.0	0.016	10,641.6	0.000	74.2	0.006	3,858.8
OECD	0.181	119,088.2	0.618	406,108.7	0.182	119,482.1	0.177	116,576.7	0.512	336,763.2	0.586	385,102.2	0.356	179,024.2	0.465	305,285.3
OPEC	0.056	36,886.1	0.035	22,775.8	0.056	37,114.2	0.059	38,800.9	0.055	36,138.0	0.049	32,121.6	0.058	29,301.4	0.057	37,224.0
AOSIS	0.007	4,606.6	0.006	3,630.9	0.007	4,607.0	0.007	4,871.2	0.006	3,697.2	0.007	4,729.0	0.006	3,370.9	0.005	3,411.5

Source, World Resources Institute-Climate Analysis Indicators Tool (CAIT) database. Available from:

http://cait.wri.org/cait.php?page=notes&chapt=4 [accessed 24 March 2011]

* For the definition of UNFCCC regions and groupings of countries, see the World Resources Institute-Climate Analysis Indicators Tool (CAIT) database.