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THE EQUITABLE SHARING OF ATMOSPHERIC AND DEVELOPMENT SPACE: SOME CRITICAL ASPECTS

Martin Khor

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Martin Khor[*]

SOUTH CENTRE

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ACRONYMS

AAUs	Assigned Amount Units
AI	Annex I countries
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action
CDM	Clean Development Mechanism
COP	Conference of the Parties
CSE	Centre for Science and Environment
EGTT	Expert Group on Technology Transfer
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GNP	Gross National Product
IPCC	Intergovernmental Panel on Climate Change
IPCC A1FI SRES	Fossil Fuel Energy Intensive, Special Report on Emissions Scenarios
IPRs	Intellectual Property Rights
KP	Kyoto Protocol
LDCs	Least Developed Countries
LULUCF	Land use, land-use change and forestry
MAC	Marginal Abatement Cost
MRV	Measurement, Reporting and Verification
NAI	Non Annex I countries
R and D	Research and Development
UNFCCC	United Nations Framework Convention for Climate Change
WBGU	German Advisory Council on Global Change

THE EQUITABLE SHARING OF ATMOSPHERIC AND DEVELOPMENT SPACE: SOME CRITICAL ASPECTS

1. INTRODUCTION

In the quest for an international agreement on actions to address the climate change crisis, three aspects have to be the basis simultaneously:

- The environmental imperative, to prevent the climate from changing to the extent that would have disastrous consequences.
- The developmental imperative, in that developing countries have the needs and goals of eradicating poverty and providing jobs, fulfilling basic and human needs of the population, and
- The equity imperative, as a global agreement that works has to be based on an equitable sharing of responsibilities and rights towards meeting the environmental imperative, and be based on the understanding of the developing countries' development needs.

This EDE formula requires that the different pieces of the climate negotiations be seen and addressed as a whole, in a holistic way.

Thus, it is important to fix environmental goals, relating to limiting global warming to a certain temperature rise threshold, and to a corresponding target for global emissions reduction. However this has to be done simultaneously with an understanding on how this is to be done, particularly on the distribution of the tasks as between developed and developing countries. This will require an agreement on what is a fair division of the responsibilities between these countries in terms of emissions reductions.

This raises the question of the historical responsibilities and the different capacities of the countries. In the United Nations Framework Convention for Climate Change (UNFCCC), the developed countries have accepted that due to their being the main cause of much of the greenhouse gases in the atmosphere, that they have to take the lead in mitigation, while also assisting developing countries through finance and technology transfers to take their climate actions.

In the UNFCCC talks, the main issues are mitigation, adaptation, finance, technology and “shared vision”, including a long-term global goal for emission reduction. These issues are inter-connected. It is important to see their inter-connections and to take this into account in the negotiations, as pieces of a jigsaw puzzle that have to be pieced together.

In particular, setting the global goal for emission reduction has to take account of the environmental imperative, and also deal with the emission reduction of Annex I and Non-Annex I Parties. A global carbon budget of how much more emissions should be allowed between now and 2050 should be fixed, and also how that budget should be allocated especially between developed and developing countries. Should a global goal and an Annex I countries’ goal only be fixed, a goal for developing countries is also being fixed, although implicitly and perhaps not known to many. The issues must be clear and transparent and the parts of the equation should be known and discussed in the thorough manner they deserve.

Developing countries have also agreed to take mitigation actions, and these are indeed important as a

needed contribution to the global effort. However, the efforts of developing countries to avoid emissions during their development process are tied to the availability and level of international financing and technology transfer, since these countries want to maintain their economic goals.

Thus a fixing of a temperature target and of a global emissions reduction goal must be accompanied or preceded by a paradigm or framework for the equitable sharing of the atmospheric space and the development space. The sharing of the mitigation efforts, and the support that must accompany this sharing, is a most critical piece of the jigsaw puzzle.

This paper aims to contribute to the discussion on the issues of environment, development and equity that are at the centre of the climate, development and equity nexus.

The paper begins with some equity considerations in the UNFCCC, then summarises the climate challenge with estimates of the carbon budget (what has been emitted in the past and what space is left to absorb further emissions). It examines the historical emissions and compares these with the "fair share" as represented by population ratios. The paper then discusses the concept and estimation of carbon debt, the sharing of the remaining carbon space and implications of these for the question of emissions reduction goals and the sharing of responsibilities for these.

The paper briefly discusses the issue whether "equal per capita emissions" is an adequate principle that meets equity and development criteria. The multiple tasks of developing countries in achieving both development and environment goals are briefly touched on. The paper then discusses at some length the issue of finance needed by developing countries both as a means to discharge the carbon debt as well as to support and enable developing countries' climate actions. Estimates of the scale of financing required are given. Finally the paper discusses some implications of these issues for the UNFCCC negotiations.

2. SOME EQUITY CONSIDERATIONS IN THE UNFCCC

The UNFCCC recognises the equity principle specifically and also in the shaping of the provisions and the content of many of them.

The Convention recognises that the developed countries are mainly responsible for the climate problem in that most of the addition to the stock of carbon and other greenhouse gases in the atmosphere were from these countries. The Convention then accepts that these countries take the leadership both in their own mitigation actions and in assisting developing countries to take their climate actions, through the provision of finance and technology.

The Convention also recognises that developing countries have development imperatives, which they must pursue as a priority. Their ability to undertake climate actions depend on the extent of support they receive from the developed countries.

In view of this, the Convention distinguishes between the mitigation "commitments" of developed countries and the mitigation "actions" by developing countries, in the understanding that the extent of developing countries' actions depends on the extent of the developed countries meeting their finance and technology commitments.

Binding commitments to reduce emissions are undertaken under the Convention and the Kyoto Protocol by the developed countries. Developing countries do not have to take binding commitments on emissions reduction, although they also agree to take mitigation actions.

Some of the important provisions relating to the above points are as follows:[1]

> Preamble: Noting that the largest share of historical and current global emissions of greenhouse gases (GHGs) has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs.
>
> Article 3.1. The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of **equity and in accordance with their common but differentiated responsibilities** and respective capabilities. Accordingly, the developed country Parties **should take the lead in combating climate change** and the adverse effects thereof.
>
> Article 4.3. The developed country Parties and other developed Parties included in Annex II **shall provide new and additional financial resources to meet the agreed full costs** incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1.They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the **agreed full incremental costs of implementing measures** that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.
>
> Article 4.5. The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, **the transfer of, or access to, environmentally sound technologies** and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.
>
> Article 4.7. The **extent to which developing country Parties** will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that **economic and social development and poverty eradication are the first and overriding priorities** of the developing

[1] See Annex 3 for more relevant provisions of the Convention that relate to equity considerations.

country Parties.

3. THE CLIMATE CHALLENGE AND CARBON BUDGET ESTIMATES

Before the industrial revolution, there were already carbon dioxide and other greenhouse gases in the atmosphere. The CO_2 concentration in the atmosphere was 280 ppm. Since the industrial revolution, emissions caused mainly by human activity have increased the concentration to 384 ppm in 2009 (CDIAC, 2009).

Between 1850 and 2009, about 1,280 gigatonne of C02 were emitted, thus adding to the stock of CO_2 in the atmosphere. Of this, 650 Gt was emitted in 1850 to 1990 while the remaining 630 Gt was emitted in just 20 years from 1990 to 2010 (Sivan Kartha,).

Since 1800, there has been global warming by 0.8 degrees Celsius. The Intergovernmental Panel on Climate Change (IPCC) warns that a high-emission path will lead to warming by 2100 of 3-7 ºC from the pre-industrial level, while a low-emission path will lead to 2-3 ºC warming.

To achieve a 67 per cent probability of limiting the temperature rise to within 2 ºC, CO_2 emissions in 2010-2050 must be kept to around 750 Gt, with only a small amount being emitted post 2050. To achieve a 75 per cent probability, the carbon budget for this period would be 600 Gt. (WBGU, 2009, pp. 15, 25). This is seen to correspond to around 450 ppm concentration. At current emission rates this CO_2 budget will be exhausted in 25 years, and sooner if emissions continue to rise.

To reverse this trend, global emissions if they peak by 2010 would have to go down by 50-85 per cent by 2050 vis-a-vis 1990. If the peaking year is later, the global reduction would have to be steeper, by 5 per cent a year (relative to 2008) if peaking is at 2015 and 9 per cent a year if peaking is at 2020. (WBGU, 2009).

Recently some prominent scientists including J. Hansen have warned that global warming should be limited to below 1.5 ºC and concentrations below 350 ppm. To attain this safer limit, the carbon budget allowed for 2010 to 2050 would have to be significantly below the already stringent budgets of 750 Gt that was estimated to give a 67 per cent probability or the 600 Gt budget with a 75 per cent probability for a 2 degree limit. One estimate is that the 350 ppm carbon budget would be around 400-450 Gt for this period.

The above figures are extremely sobering and demonstrates the great challenge for humanity to take effective action to prevent climate disaster or catastrophe.

In order to share the responsibilities of action equitably, the historical record of the sources of emissions is important.

4. HISTORICAL AND CUMULATIVE EMISSIONS AND CARBON DEBT AND CREDIT

This section deals with the historical situation. It looks at the total global emissions of CO_2 from 1850-2008. It estimates the fair share of this total for Annex I and Non-Annex I countries, based on the proportion of each to their average share of world population in this period. It estimates the actual emissions during this period of each group of countries. The difference between the fair share of emissions and the actual emissions provides the estimate of carbon debt or carbon surplus. The situation is shown in table 1.

Table 1
Fair carbon shares and actual emissions of CO_2, 1850-2008
(gigatonnes of CO_2)

Group	Actual cumulative emissions CO_2 1850-2008	Actual share in total cumulative emissions CO_2 1850-2008 (%)	Fair share for cumulative emissions based on population share	Over-Use/Under-use of Share in Total Cumulative Emissions (1850-2008 emissions and 2008 population share)	% Over-use/Under-use cumulative emissions over proportional share 1850-2008
Annex I	878	72	310	568	183
Non-Annex I	336	28	904	-568	-63
World	1 214	100	1 214		

Cumulative global emissions have totaled about 1214 Gt in 1850-2008. Of this total:

- Annex I countries accounted for 878 Gt or 72 per cent of the total. Since their share of world population was about 25 per cent in this period, their fair share of emissions was 310 Gt. Therefore their overuse of their fair share was 568 Gt. This overuse was 183 per cent above the fair proportional share.

- Non-Annex I countries accounted for 336 Gt or 28 per cent of the total. Their fair share of emissions was 904 Gt (given their share of total population of 75 per cent). Therefore the under-use was 568 Gt or 63 per cent below their fair share.

The carbon debt of Annex I countries was thus 568 Gt for the period 1850-2008. At present these countries are still accumulating debt because their actual emissions as a group in 2009 still exceeds their fair share. It is important to conceptualise how this debt is to be discharged, preferably before or by 2050, because after that year there would be little or no "carbon space" left to allow further

emissions in the world.

Table 2
Cumulative emissions. Fair shares and carbon creditors and debts: Selected Countries, 1850-2008
(in billion tonnes or gigatonnes)

Country	Cumulative CO_2 Emissions 1850-2008	Cumulative Fair Share CO_2 Emissions 1850-2008	CO_2 Debt or Credit As of 2008	
Australia	13.7	3.8	9.9	Debtor
Bolivia	**0.3**	**1.5**	**-1.2**	**Creditor**
Brazil	**9.9**	**30.5**	**-20.6**	**Creditor**
Canada	25.5	6.4	19.1	Debtor
China	**113.8**	**265.5**	**-151.7**	**Creditor**
France	32.9	16.5	16.4	Debtor
Germany	81.1	23.7	57.4	Debtor
India	**33.2**	**193.1**	**-159.9**	**Creditor**
Japan	45.9	30.1	15.8	Debtor
Tanzania	**0.1**	**4.7**	**-4.6**	**Creditor**
United Kingdom	69.8	17.2	52.6	Debtor
United States	343.1	61.8	281.3	Debtor
Annex I	878	310	568	Debtor
Non-Annex I	**336**	**904**	**-568**	**Creditor**
World	**1 214**	**1 214**		

* Countries in **bold** are developing countries.
** **Carbon debt** refers to the amount by which the country's cumulative emissions exceeded what its cumulative fair share of emissions (based on its population) should have been for the same period 1850-2008. **Carbon credit** refers to the amount by which cumulative emissions are less than the cumulative fair share for the same period.

The analysis of carbon debt or credit can be done for individual countries. Table 2 shows the position of a few countries regarding their cumulative emissions (1850-2008), their fair share of emissions and their debit or credit position. Some illustrative cases:

- The United States is the largest over-user of carbon space, having emitted 343 Gt in 1850-2008 compared to its fair share of 62 Gt, causing a debt of 281 Gt by 2008. Other developed countries also have large debts: Germany 57 Gt, United Kingdom 53 Gt, Canada 19 Gt, France 16 Gt, Japan 16 Gt, Australia 10 Gt.

- On the other hand, developing countries have used less than their fair share and are climate creditors. China has a cumulative fair share of 266 Gt in 1850-2008 but used 114 Gt, and has a 152 Gt credit as at 2008. India has a fair share of 193 Gt and only used 33 Gt, so it has a 160 Gt credit. Brazil has a credit of 21 Gt. Tanzania, an LDC, has a fair share of 4.7 Gt but its cumulative emission is 0.1 Gt and thus has a credit of 4.6 Gt. Bolivia has a credit of 1.2 Gt.

These estimates of national positions are useful in illuminating the contribution of individual countries to the stock of CO_2 in the atmosphere and in the possible allocation of rights and responsibilities for future emission scenarios and plans.

5. SHARING THE REMAINING CARBON SPACE

There is very limited stock of "carbon space" left in terms of emissions that should be allowed from 2010-2050 if the global mean temperature rise is to be under 2 ºC and especially under 1.5 ºC.

The carbon debt/surplus situation as at 2008 should be an important parameter when determining the allocation or distribution of emissions and the quantum and rates of emission reductions, particularly as between Annex I and Non-Annex I countries.

It is important to recognise two important distinct though related concepts:

- The allocation of carbon space as according to rights and responsibilities, that is linked to the equity principle and fair shares in the carbon budget, and the implications of this for the obligations in terms of the sharing of emissions reductions (for example by 2050).

- The actual carbon budget (and related physical emissions reduction schedule) that countries eventually put forward as what they can physically undertake.

This distinction and the calculations should be made especially for Annex I and Non-Annex I countries as a whole.

There could be a difference between the allocation of responsibilities and rights, and the actual emissions reduction or related budgets. Therefore:

- Countries that are allocated a responsibility to limit their future emissions within a certain budget or limit but are unable to physically undertake the task fully can compensate for this unmet part of their obligation.

- Countries that are allocated rights to their share of the global carbon budget, and do not make full use of these rights, can benefit by obtaining the adequate means (from UNFCCC funds) to improve their economic performance while developing a low-emissions pathway.

In any calculation of the sharing of remaining carbon space, the carbon debt owed by Annex I countries at the end of 2008 i.e. 568 Gt of CO_2, should be taken into account. Similarly the credit that developing countries have (the same amount of 568 Gt) should be factored into the calculations.

Table 3.1
Allocation for 2010-2050*
(in Gt CO_2)

Group	1850-2008			2010-2050*	1850-2050	2010-2050*
	Fair share emission budget	Actual emissions	Cumulative emission debt	Fair share emission budget	Fair share emission budget	Allocated budget**
Annex I	310	878	568	120	430	-448
Non-Annex I	904	336	- 568	630	1 534	1 198
Total	1 214	1 214		750	1 964	750

* Assuming a global budget of 750 Gt CO_2 (corresponding to a 67% chance of not exceeding 2 ºC by 2050) and a 16% average share for Annex I countries of the global population from 2010-2050
** Taking into account cumulative emission debt from 1850-2008

Table 3.2
Allocation for 2010-2050*
(in Gt CO_2)

Group	1850-2008			2010-2050*	1850-2050	2010-2050*
	Fair share emission budget	Actual emissions	Cumulative emission debt	Fair share emission budget	Fair share emission budget	Allocated budget**
Annex I	310	878	568	96	406	-472
Non-Annex I	904	336	- 568	504	1 408	1 072
Total	1 214	1 214		600	1 814	600

* Assuming a global budget of 600 Gt CO_2 (corresponding to a 75% chance of not exceeding 2 ºC by 2050) and a 16% average share for Annex I countries of the global population from 2010-2050
** Taking into account cumulative emission debt from 1850-2008

Thus in the 2010-2050 carbon budget:

- If a total budget of 750 Gt is taken, and Annex I countries' population ratio to world population is 16 per cent, then the Annex I countries' fair share is 120 Gt. However to fully discharge its carbon debt (568 Gt) as at 2008, its allocation for 2010-2050 is a negative budget of 448 Gt.

- Developing countries with an average population ratio of 84 per cent would have a fair share of 630 Gt of the total 750 Gt budget. However since it has a credit of 568 Gt in 2008, its allocation for 2010-2050 would be 1198 Gt.

Using the same methodology, a similar calculation can be done for any other total carbon budget decided on. For example, for a 600 Gt global budget, and with the same population ratios:

- Annex I countries' fair share would be 96 Gt and the allocation after taking into account 568 Gt debt would be – 472 Gt.
- Non-Annex I countries' fair share would be 504 Gt and its allocation would be 1072 Gt.
- Both Annex I and Non-Annex I countries have a smaller budget because of the more stringent total budget of 600 Gt but the reduction is equitably shared using this method.

One method of discharging the debt or part of it is to work out and agree to a methodology of payment or compensation into a Fund, which can be used for developing countries for mitigation actions. For example, the debt of 568 Gt of CO_2 as at 2008 could be given a value (for example $40 a tonne) and the total amount could be contributed in installments of a number of years into the Fund. This is further discussed in a later Section of this paper.

6. IMPLICATIONS FOR EMISSIONS REDUCTION AND ALLOCATION OF RESPONSIBILITIES

The allocation of responsibilities and rights in the global carbon budget has implications for the distribution of global emissions reduction as between Annex I and Non-Annex I countries.

Depending on the choice of the global emissions cut by a certain year (e.g. 2050) and certain assumptions (about the peaking year, etc.), a global carbon budget for a period (e.g. 2010-2050) can be worked out.

Using the equity principle (fair shares according to population ratio) the emissions cuts for Annex I and Non-Annex I countries for that period can be worked out, taking into account also the cumulative emissions and debt/credit.

The methodology would be as follows:

1. Take a goal for limiting temperature rise, e.g. 1.5 or 2 ºC.
2. Take a corresponding carbon budget for the period 2010-2050, e.g. 500 or 600 or 750 Gt (depending on the range of probability to be agreed on to achieve the chosen temperature goal).
3. Choose a global peaking year (e.g. 2015, 2020).
4. Work out the global emissions pathway for 2010 to 2050, giving the percentage reduction of

global emissions by 2050.

5. Taking into account the carbon debt (of Annex I countries) and the carbon surplus (of Non-Annex I countries) as of 2008, and their fair shares of the chosen global carbon budget for 2010-2050, work out the allocation of emissions for Annex I countries and Non-Annex I countries and their corresponding emissions pathways, with their end-points in 2050.

It should be noted that the allocated pathways for emissions reduction for Annex I countries need not and probably would not be the actual pathways implemented, due to the very high environmental ambition required to fulfill the allocated pathway.

The difference between the pathway allocated and the actual pathway taken would be the subject of compensatory mechanism.

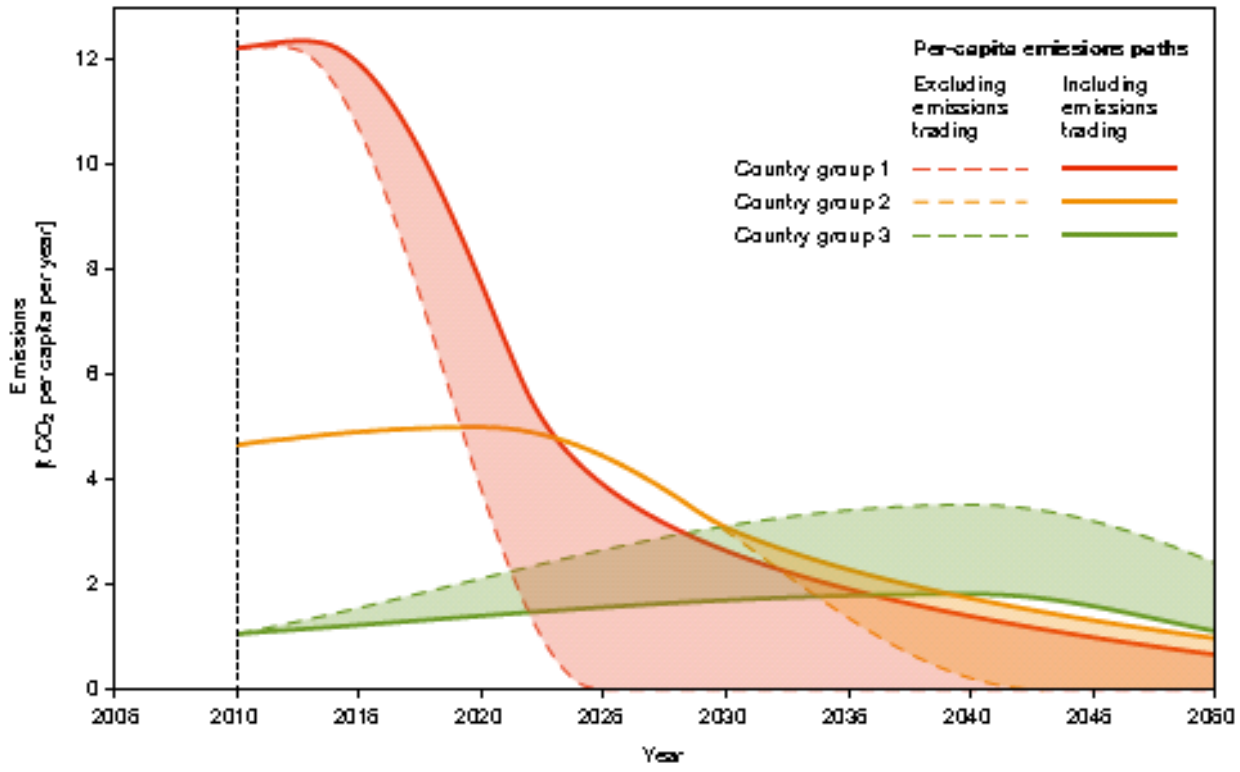
An illustration of this point can be seen in the study by WBGU (German Advisory Council on Global Change) on the budget approach. The study takes into account historical responsibility (with a starting year of 1990), and works out a budget for selected countries for 1990-2050. One of the two models in the study chooses a 75 per cent probability of remaining within 2 ºC warming, and with thus a corresponding carbon budget of emissions allowed of 1100 Gt in 1990-2050 (600 Gt for 2010-50 because of 500 Gt actual emissions in 1990-2010). It finds that three countries (USA, Germany, Russia) have already emitted in 1990-2009 their entire allocated budget for 1990-2050 and therefore begins with negative emission allocations for the 2010-50 period. The United States has an emission allocation of minus 56 Gt of CO_2 in its 2010-50 budget.

The study shows a graph with two pathways for three groups of countries. The first two groups, with high and medium emissions, buy emission rights from the third group. Thus they are able to have higher actual budgets than their allocated budgets, and can stretch out their emissions for many more years. The third group emits much less than their rights, and receives funds from emissions trading instead. This is reproduced as Chart I.

The graph is reproduced for illustrative purposes as to an example of the methodology of assigning allocated budgets to groups of countries, and allowing for countries to under-fulfill their obligations while the study assumes that the difference between allocated emissions and actual emissions is paid for through the carbon trade mechanism. There could of course be different methods of assessing the value of the difference and compensating or paying for these. Instead of using carbon trading, the country could be responsible for mobilising the funds (through environmental taxes, innovative sources, etc.) and for arranging for the payment into a Fund or Funds.

The WBGU study also recognises historical responsibility but does its calculation based on a base year of 1990. This does not do justice to the full emissions discharged since the industrial revolution. Thus there will be different results as to the carbon budgets, when other base years such as 1850 are used. However, the study is a very useful example of making use of the methodology of carbon budgeting.

Chart I



NOTES:

1. This graph is from the German Advisory Council on Global Change (WBGU) (2009, p. 39), "Solving the climate dilemma: the budget approach". It is reproduced here for illustrative purpose, to show an example of the use of the concepts of allocated emission budget to groups of countries, and the actual emissions of these countries, and the compensatory mechanism (in this case carbon trading) used to transfer financing from one group of countries to another group of countries.

2. The note accompanying the graph in the WBGU report explains: "Examples of per-capita CO_2 emissions trajectories from fossil sources for three country groups under the WBGU budget approach. The broken curves show theoretical per-capita CO_2 emissions trajectories without emissions trading. These would allow compliance with the national budgets, but would be partly unrealistic in practice. The unbroken curves show emissions trajectories that could result from emissions trading. It is assumed that Group 1 countries increase their budget by 75 % by purchasing emission allowances for 122 Gt CO_2. Group 2 countries purchase emission allowances totaling 41 Gt CO_2. The suppliers of the sum total, i.e. 163 Gt CO_2, are the Group 3 countries, resulting in a decrease of around 43 % in their own emissions budget. Towards the end of the budget period, convergence of real CO_2 emissions occurs at around 1 tonne per capita per year (based on the population in 2010). The areas between the curves represent the traded quantities of emission allowances..."

Critique of existing proposals on global emissions reduction

Given the above analysis and methodology, it is possible to assess the implied carbon budgeting involved in proposals that have been put forward by Annex I Parties during the UNFCCC negotiations and also that are contained in various versions of the draft texts of the Chair of the AWG-LCA (Ad Hoc Working Group on Long-term Cooperative Action).

The main proposal (from some Annex I Parties) is for a 50 per cent global emissions cut by 2050 (compared to 1990) and an 80 per cent cut for Annex I Parties. This was for example proposed during the small meeting of political leaders in Copenhagen by Chancellor Merkel of Germany.

This proposal has several problems.

Firstly, the 50 per cent global cut is environmentally not ambitious enough It would correspond to a carbon budget far above the minimum 600 Gt or 750 Gt in 2010-2050 required to keep temperatures within 2 ºC, let alone 1.5 ºC. According to South Centre estimates, the global budget would be 1,200 to 1,500 Gt, depending on various assumptions.

Secondly, the implied distribution of the carbon budget as between Annex I and Non-Annex I countries is unfair. According to South Centre estimates, the 50 per cent global cut and 80 per cent Annex I countries' cut would give Annex I countries a budget share of 30-35 per cent, compared to their projected share of world population of 16 per cent during this period. Thus they could get double the share of the budget than their share of population, thus worsening their cumulative carbon debt of 1850 to 2008.

Thirdly, if this proposal is accepted, then the UNFCCC including the developing country members would have explicitly accepted not only the unfair distribution of the 2010-50 carbon budget, but also implicitly the writing off of the 1850-2008 cumulative debt of the developed countries.

Fourthly, the implication of accepting a 50 per cent global cut and an Annex I countries' cut of 80 per cent would be to also accept a specific emissions cut target for developing countries, as well as the locking in of this whole distribution of carbon budget and set of emissions cuts.

The global emissions cut is made up of Annex I countries'(AI) cuts and Non-Annex I countries'(NAI) cuts. Once the global cut is fixed, then the lower is the AI cut, the higher is the NAI cut. Once the AI cut is also fixed, the residual cut has to be made by NAI.

The implications for developing countries of some proposed scenarios of a global cut and an Annex I countries' cut by 2050 are shown in table 4.

In 1990 the global emissions of all greenhouse gases (without Land use, land-use change and forestry - LULUCF) was 30 Gt (per capita emissions of 5.6 tonnes). Annex I countries' emissions were 18 Gt (15.4 tonnes per capita) or 60 per cent of the total. Non-Annex I countries' emissions were 12 Gt (2.9 tonnes per capita).

(By 2005, Annex I countries' emissions were 17.8 Gt and had per capita emissions of 14.1 tonnes. Non-Annex I countries' emissions were 19.5 Gt with per capita emissions of 3.7 tonnes).

By 2050, a global cut of 50 per cent from 1990 would bring emissions down to 15 Gt (1.6 tonnes per capita). An 80 per cent cut by Annex I countries would then result in the following in 2050:

- Annex I countries' emissions would go down by 80 per cent to 3.6 Gt. Their per capita emissions would be 2.7 tonnes or 83 per cent below the 1990 level.
- Non-Annex I countries' emissions would go down by 5 per cent to 11.4 Gt. Their per capita emissions would be 1.5 tonnes or 50 per cent below 1990 levels. This level would also be about half the level of Annex I countries' per capita emissions in 2050. This implies that Non-Annex I countries would have a drastic cut by 50 per cent or half in per capita emission levels.
- The Non-Annex I countries' cut is even higher if a base year nearer the present is taken, instead of 1990. This is of course very relevant to policy makers, who have to make mitigation plans based on the present levels. Compared to its 2005 level, the Non-Annex I countries' total emission in 2050 would be 42 per cent below and its per capita emission would be 61 per cent below, which are very steep cuts indeed.

Table 4
Implications of Proposed 2050 Global and Annex I Countries' Emission Targets for Developing Countries

Global 2050 Emissions Budget (Gt)		Less Annex I 2050 Emissions Budget (A1e)			Equals Non-Annex I 2050 Emissions Budget (NA1e)		
50% below 1990	**14.986 $GtCO_2eq$**	**3.60 $GtCO_2eq$**	(80% below 1990)	***(2.68 ton/cap; 82.61 % below 1990 per cap)***	**11.385 $GtCO_2eq$**	(4.87% below 1990)	***(1.46 ton/cap; 49.77% below 1990 per cap)***
		0.90 $GtCO_2eq$	(95% below 1990)	***(0.67 ton/cap; 95.65% below 1990 per cap)***	**14.085 $GtCO_2eq$**	(17.69% above 1990 – 27.62% below 2005)	***(1.80 ton/cap; 37.86% below 1990 per cap)***
85% below 1990	**4.496 $GtCO_2eq$**	**3.60 $GtCO_2eq$**	(80% below 1990)	***(2.68 ton/cap; 82.61% below 1990 per cap)***	**0.895 $GtCO_2eq$**	(92.52% below 1990)	***(0.11 ton/cap; 96.05% below 1990 per cap)***
		0.90 $GtCO_2eq$	(95% below 1990)	***(0.67 ton/cap; 95.65% below 1990 per cap)***	**3.596 $GtCO_2eq$**	(69.95% below 1990)	***(0.46 ton/cap; 84.14% below 1990 per cap)***

NOTES:
1. Base Year Data
1990 global emissions – 29.971 $GtCO_2eq$
1990 Annex I countries' emissions – 18.003 $GtCO_2eq$; 15.39 tonnes/cap
1990 Non-Annex I countries' emissions – 11.968 $GtCO_2eq$; 2.90 tonnes/cap

2. The top part of the table depicts the implications of the dominant proposal of some Annex I countries that there should be a global emissions cut of 50% by 2050 (compared to 1990) and an 80% emissions cut by Annex I countries. Another scenario of a 95% cut by Annex I countries is also depicted. If these are undertaken, then developing countries would implicitly be asked to do the residual reductions (last two columns).

3. The bottom part of the table depicts a situation where there is a global cut of 85% and cuts by Annex I countries of 80% or 95%. The residual cuts to be undertaken by developing countries are depicted in the last two columns.

If a global cut of 50 per cent by 2050 is retained and the target for Annex I countries increases to 95 per cent below the 1990 level, the developing countries would still have to cut their emissions to 1.8 tonnes per capita which is below their 1990 per capita level. Their absolute emissions would go to 14 Gt, which is 18 per cent above their 1990 level but 28 per cent below their 2005 level.

If a goal is set for a global cut of 85 per cent by 2050, in order to more satisfyingly fulfill environmental ambitions, the predicament for developing countries is even more acute, because the carbon space is so limited. In this scenario, if developed countries were to cut their emissions by 95 per cent from 1990 levels, the developing countries would have to cut their emissions from 12 Gt in 1990 to 3.6 Gt in 2050. This is 70 per cent below their 1990 level and 82 per cent below their 2005 level in absolute terms. The per capita emission would have to be cut to 0.46 tonne, which is 84 per cent below the 1990 level and 88 per cent below the 2005 level.

Link between CO_2 per capita levels and Emissions Reduction for Developed and Developing Countries

In order to fulfill the environmental goal of a global cut of 50 per cent to 85 per cent (and the upper end is more appropriate to approach the required global carbon budget), it is clear that developed countries will have to go into the territory of "negative emissions", in order that the developing countries can have a decent level of "development space" through being allocated allowed emissions sufficient to cushion their path to low-emissions growth.

Table 5.1 and Annex 1 show different scenarios for a global cut of 50 per cent below 1990 levels. The following are some conclusions to be drawn from this table:

- If the Annex I countries cut emissions by 80 per cent, then developing countries would have to cut their per capita emissions by 50 per cent, to 1.5 tonnes.
- To avoid a per capita emission cut by 2050, developing countries would retain a level of 3 tonnes per capita, resulting in a 3 per cent increase in per capita for them, as shown in 4th line from the top. In this same line, Annex I countries would have to cut their total emissions by 147 per cent i.e. cut by 100 per cent to zero and then cut by another 47 per cent to reach negative emission level of 8.4 tonnes.
- If a goal is set for developing countries (NAI) to double their per capita emissions from 1990 to 2050, then the scenario in the 1st line applies. Non-Annex I countries increase their per capita emission by 107 per cent to 6 tonnes per capita, and Annex I countries have to cut its aggregate emissions by 277 per cent (go down from 18 Gt in 1990 to zero and then cut by another 31.8 Gt by 2050). This frees the space to enable developing countries to have 47 Gt of emissions. The addition of the two (- 31.8 plus 46.8) results in the new 2050 global emission of 15 Gt.
- In this Line 1 scenario, the global goal is set at 50 per cent emission cut, with a 277 per cent cut by Annex I countries and a 291 per cent increase by Non-Annex I countries.
- This metrology can be used to add on other scenarios.
- If Annex I countries cannot realistically meet the targets set especially at levels higher than 100 per cent, then the mechanism of compensatory payment to developing countries to assist in fulfilling the allocated targets can be used, as discussed earlier.

Table 5.1
Global emissions reduction goal of 50% below 1990 levels (14.986 $GtCO_2eq$ global)*

NAI CO_2eq Ton/Capita 2050	NAI aggregate % relative to 1990	AI aggregate % relative to 1990	2050 AI per Capita % relative to 1990	2050 NAI per Capita % relative to 1990
6	291%	(277%)	(254%)	107%
5	226%	(234%)	(216%)	72%
4	161%	(190%)	(178%)	38%
3	96%	(147%)	(141%)	3%
2	30%	(103%)	(103%)	(31%)
1.80	17.69%	**(95%)**	**(95.65%)**	**(38%)**
1.46	(4.87%)	**(80%)**	**(82.61%)**	**(50%)**
1	(35%)	(60%)	(65%)	(66%)

* AI $GtCO_2eq$ emission reductions from 1990 levels needed taking into account NAI emissions per capita growth for development

Table 5.2
Global emissions reduction goal of 85% below 1990 levels (4.496 $GtCO_2eq$ global)*

NAI CO_2eq Ton/Capita 2050	NAI aggregate % relative to 1990	AI aggregate % relative to 1990	2050 AI per Capita % relative to 1990	2050 NAI per Capita % relative to 1990
6	291%	(335%)	(304%)	107%
5	226%	(292%)	(267%)	72%
4	161%	(248%)	(229%)	38%
3	96%	(205%)	(191%)	3%
2	30%	(162%)	(154%)	(31%)
1	(35%)	(118%)	(116%)	(66%)
0.46	(69.95%)	**(95%)**	**(95.65%)**	**(84%)**
0.11	(92.52%)	**(80%)**	**(82.61%)**	**(96%)**

* AI $GtCO_2eq$ emission reductions from 1990 levels needed taking into account NAI emissions per capita growth for development

Table 5.2 has the same format as Table 5.1 in showing various scenarios, but with the more ambitious goal of a global cut of 85 per cent by 2050 below 1990 levels. A few significant points:

- With this more stringent global goal, the developing counties would have to undertake very drastic emissions cuts if developed countries remain in "positive" rather than "negative emissions" territory. For example, even a 95 per cent cut by Annex I countries would imply that Non-Annex I countries have to cut by 84 per cent per capita compared to 1990.
- With the same goals of maintaining or increasing per capita emission levels of developing countries, the developed countries have to have higher targets. For example, a 3 per cent increase in Non-Annex I countries'per capita emission implies a 205 per cent aggregate Annex I countries cut; and a 107 per cent increase in Non-Annex I countries' per capita emissions means a 335 per cent cut by Annex I countries.
- Again, under an agreed compensatory system, Annex I countries can choose to transfer some of their obligations to developing countries.

7. PER CAPITA EMISSIONS, EQUITY AND DEVELOPMENT CONCERNS

Until recently, there was a widely held belief that complete equity would be achieved when each person or country would emit (or have emission rights of) the same per capita emission.

This would result in equal emissions per person. However it would not result in an equitable outcome, from a developmental perspective.

This is because countries and persons have different capacities as a starting point. The application of equal treatment or equal "emission rights" to countries and persons that are unequal in capacity would result in an unequal outcome in terms of income or living standards or capacity for development.

Presently, developed countries enjoy at least four advantages over developing countries:

- They have far better developed infrastructure such as roads, buildings, factories, power plants, etc., much of which were built cheaply but also were emission-intensive to build because of the use of fossil fuels. This infrastructure reflects high levels of embedded carbon and the carbon debt built up since the industrial revolution.
- The far superior levels of technology in terms of machinery, knowledge and innovation capability.
- The greater human and organizational capacity, including to turn around the economy towards low-emissions pathways.
- They have far higher levels of income that also enable them to pay for and be better at the three above factors.

These factors mean that developed countries have greater capacities to progress towards a low-carbon economy and society, while retaining or expanding their level of development and living standards.

Thus, if a level of 1 tonne per capita is chosen as a "sustainable level" to avoid climate damage, it is conceivable that developed countries can reach that low-carbon per capita level, with technological and other changes, and retain their present level of living, such as $30,000 per capita income or more.

On the other hand, a country that now has a per capita emission of 1 tonne of emissions or below may retain that level and not be able to climb up the income scale, so that its economic level remains at, for example, $1,000 or less. Also, developing countries that are currently at moderate emission levels of 3 to 8 tonnes per capita would find it difficult to reduce their emission levels while maintaining or expanding their economies through a low-emissions path, as they are lacking in the three factors.

Of course, with massive transfers of finance and technology, such a country could improve its economic condition. However it is unlikely that a developing country will be able to match the developed countries in the above factors.

Thus, to oblige the different countries to have the same per capita emission level would be to "lock in" the economic disparities among them. This should be avoided.

On the other hand, the concept of per capita emissions equity is a useful one, if all countries are at the same or similar levels of development.

One possible approach is to retain the aim of having an equal per capita emission as a starting point, but to provide countries with coefficients. Thus a country that is much poorer and lacks in infrastructure and technology could have a "multiplier" of 5 or 10 to apply to its coefficient of 1. Another country that in contrast is very advanced in technology and income could have a coefficient below 1, and may even have a negative coefficient so that it has a target of a negative emission. The coefficient would be a measure of the relative capacities of the countries, in terms of incomes, infrastructure, technology and human capacity.

8. DIFFICULT MULTIPLE TASKS FACING DEVELOPING COUNTRIES

The developing countries are facing very serious and difficult challenges.

- They face a development challenge as in most countries there is still substantial poverty, unemployment and social problems, which require economic growth to resolve.
- They are still in the initial phases of industrial development and require increasing amounts of energy (both for industry and household use), while fossil fuels are becoming more expensive and renewable energy is still expensive.
- There is very little carbon space left, and to avoid disastrous climate change, the developing countries also have to contribute in curbing emissions (initially through slowing down their growth) in physical terms.
- Maintaining the ambition of high economic growth while increasingly economising on carbon emissions so as to eventually achieve emissions reduction, or to avoid a carbon growth path altogether (especially for low income countries) is an extremely complex and difficult task, which the developed countries have not had to go through.

An important and perhaps in future the most important task is to define and aim for efficiency in terms of obtaining the maximum amount of economic output (GNP) for each unit of carbon (e.g. from fossil fuels) which in turn is getting more scarce.

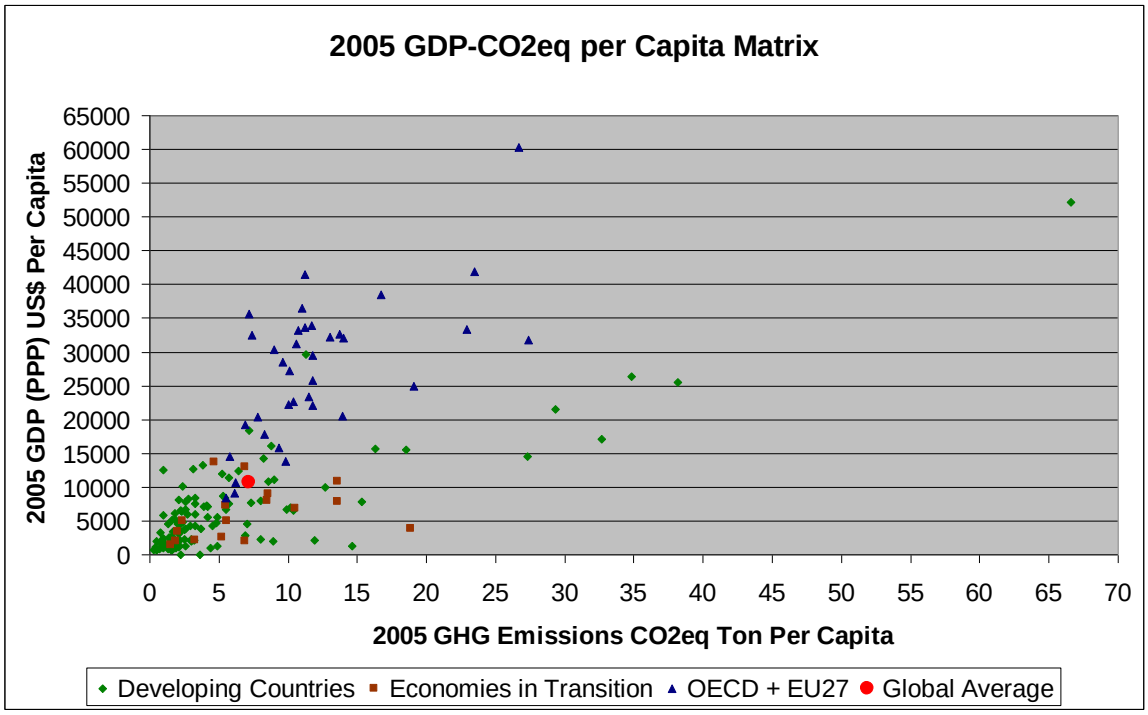
If the climate-development dilemmas and trade offs between climate mitigation actions and

development-poverty-employment imperatives are not resolved, it will be difficult for developing countries to undertake technological leap-frogging and the shift to a low-emissions path to economic growth.

The objective should be to retain the objective of moving towards higher development levels while also simultaneously moving towards greater efficiency in carbon and emissions avoidance.

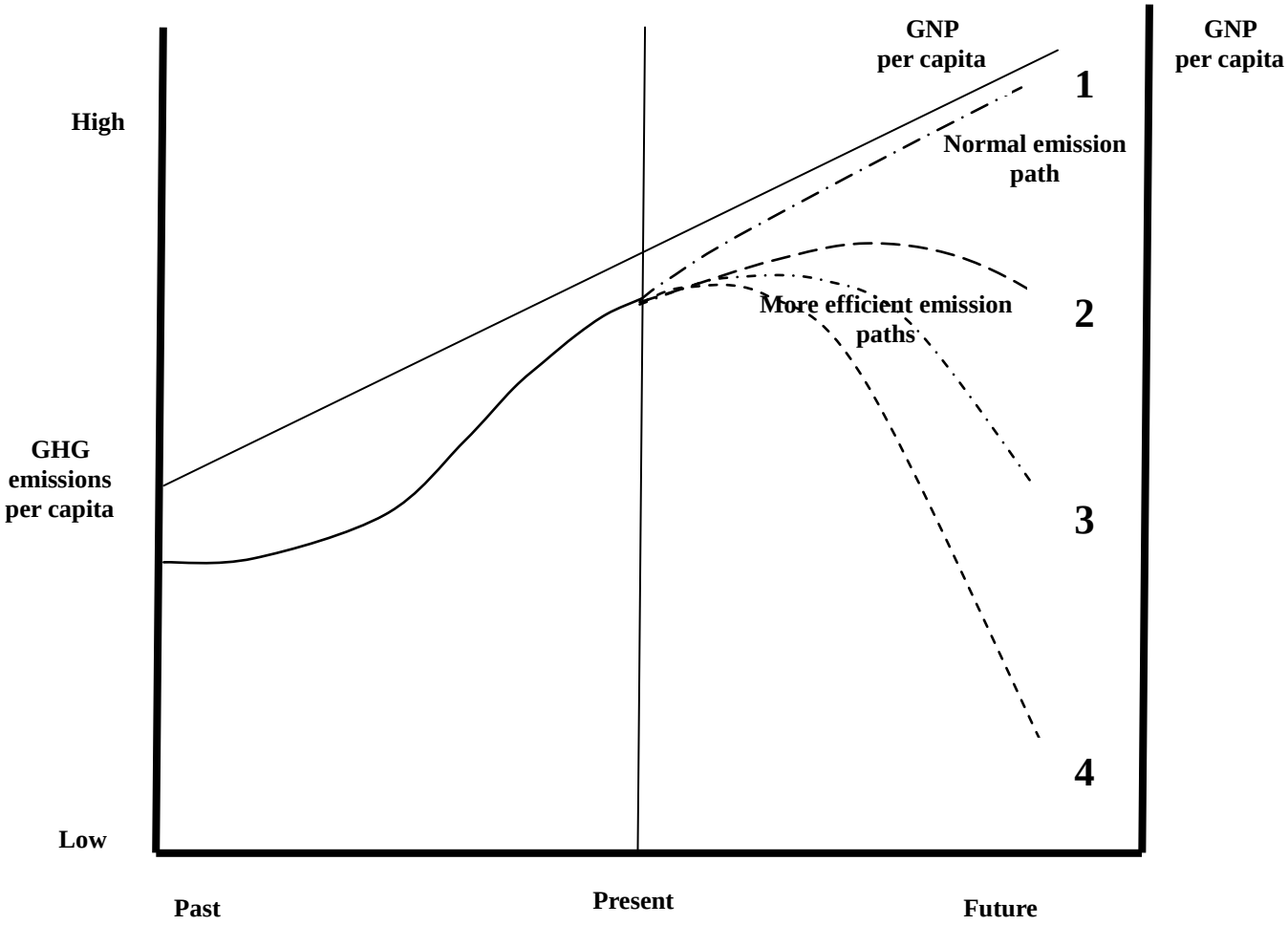
In the conventional growth path, economic growth and emissions growth are closely related and tied together. Chart II shows the close relation between per capita income and per capita emissions. Countries with higher per capita income generally have higher per capita emissions.

Chart II



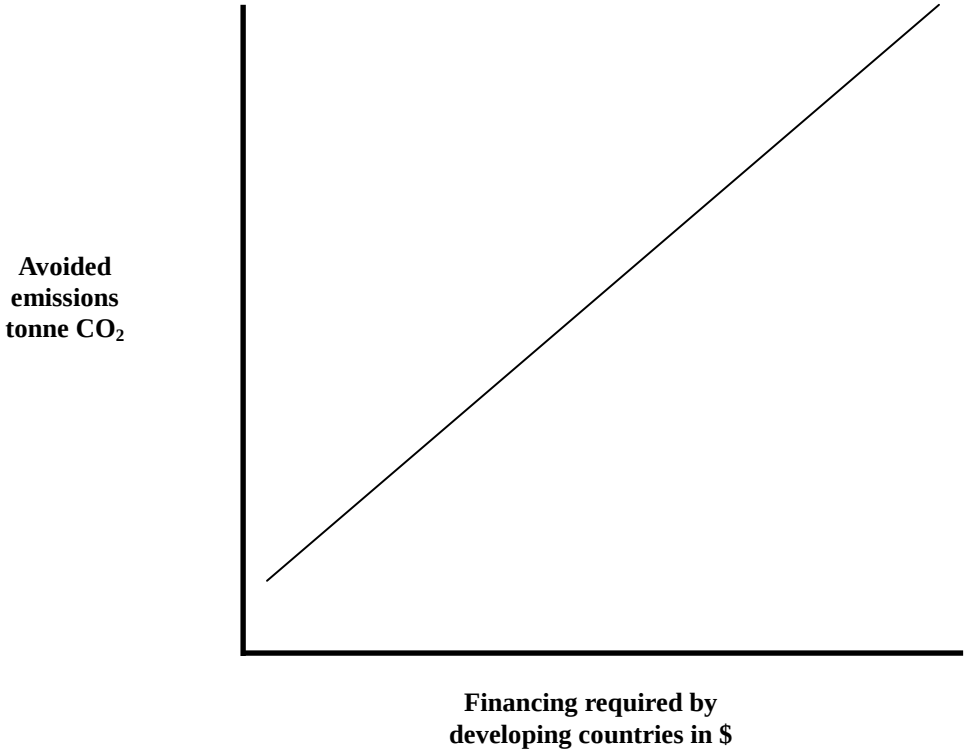
The de-coupling of conventional economic growth from emissions growth potentially benefits both the country and the world through increasing units of avoided emissions. There are theoretically possible increasing gaps between the growth of GNP (and the business-as-usual accompanying high growth of emissions) on one hand, with more efficient emissions paths, as shown in Chart III. However the efficient emissions pathways can be achieved only with international cooperation in transfers of finance and environmentally-sound technology. As illustrated in the Chart III, higher levels of finance and technology transfers would lead to a greater efficiency in terms of lower emissions per capita while GNP per capita also continues to grow, and enable mitigation actions of developing countries. The relation between available financial resources and avoided emissions is shown in Chart IV.

Chart III: Some Pathways for Avoiding Emissions in Developing Countries



NOTE: The Chart illustrates that the developing countries have an economic growth path which they need to maintain for purposes of social and economic development. In a business as usual scenario, the growth of emissions would be in line with economic growth, in Path 1, the "normal emission path." Paths 2, 3 and 4 indicate more efficient emission pathways, with emissions reduced while normal economic growth is maintained. Path 4 involves greater avoided emissions than the other paths. The more the efficiency in avoided emissions, the greater is the gap between the efficient emissions path and the normal emissions path as well as the gap with the GNP line. The gaps have to be supported and enabled by finance and technology. Thus the more efficient is the emissions path, and the greater is the gap, the more are the finance and technology required.

Chart IV: Relationship between Mitigation Effort of Developing Countries and Financing to Them



9. FINANCE ISSUES IN THE EQUATION

General

The equity principles of common but differentiated responsibilities, historical responsibility, commitments of Annex I Parties to take the lead in mitigation, and in provision of finance and technology to developing countries, and the principle that the extent of actions of developing countries depend on the extent of Annex I countries implementing their finance and technology commitments, as well as the objectives of the Convention pointing to high ambitions for the environment and economic development, lead to the following conclusions:

- Due to human activity having exhausted the atmospheric space in a short period, there is very little atmospheric space left to absorb more greenhouse gas emissions. The developed countries have occupied most of the existing atmospheric space through their cumulative emissions, so to keep global warming within a level that avoids disastrous effects, the world as a whole has to cut its rate of emissions very rapidly and bring emissions to zero or closer to zero as soon as possible.

- This poses a major dilemma for developing countries, which have not been responsible for much of the problem, but which still need enormous amounts of carbon space should the conventional way of growth continue. To break the link between emissions growth and GNP growth, massive transfers of finance and technology are required by the developing countries.

- The principles and analysis of historical responsibility should lead to positive action that can contribute to the resolution of the climate crisis. The climate debt of developed countries can be discharged through financing and technology transfers to developing countries to enable them in the decoupling and in the shift to low-emissions growth. It is desirable that there be a large extent of financial and technology transfers so as to enable the large extent needed for climate actions in developing countries.

- Methods should be developed to assess the existing climate debt and to transform this into financing for developing countries. Further, future debts (in terms of over-use of emissions in relation to population ratio) can also be compensated through mechanisms to enable developing countries to take mitigation actions.

- It is important to assess the mitigation and adaptation costs that developing countries will have to incur if they are to undertake adequate mitigation and adaptation measures. The greater the mitigation actions (or emission curbing that is required for developing countries to take), the greater the amounts of financing and technology are required. The greater the shortfall in terms of global mitigation actions, the greater the amounts of financing required for adaptation actions by developing countries.

Legal Obligations of Developed Countries: Why Climate Finance is Different from Aid

Climate financing is often treated like development aid. But unlike aid, which is voluntary and based on humanitarian concerns, the provision of financial resources to developing countries is a legal obligation of developed countries, which made commitments under the UNFCCC.

The developed countries (listed in Annex II of the UNFCCC), as part of their treaty obligations, are committed to provide financial resources to developing countries, in at least three ways:

- Under Article 4.3 of the Convention, developed countries are obliged to provide new and additional resources to developing countries that would meet the agreed full incremental costs (including for technology transfer) of developing countries to implement their obligations under Article 4.1.
- They are also obliged to meet the full agreed costs for preparing and submitting developing countries' national communications, under Article 4.3.
- Under Article 4.4, developed countries are also obliged to assist developing countries to meet the costs of adaptation.

In addition, developed countries have obligations on technology transfer under Article 4.7 of the Convention.

The developing countries therefore have rightly considered climate financing as fundamentally

different from development aid. Aid has been to a significant extent an act provided under a framework of charity or humanitarian concern. Climate financing is a treaty obligation established to address a global crisis, in a framework and Convention which recognises that developed countries are responsible for causing most of the problem and have a legal duty to take the lead in emission reduction themselves and to support and enable developing countries to take their own mitigation and adaptation actions.

Elements of Climate Financing for Developing Countries

The provision of climate financing is not the only key element in globally addressing the climate crisis. For example, there is a great need for developed countries to reduce their emissions as quickly and steeply as possible. However, climate financing is crucial in supporting and enabling developing countries to take their own climate actions and thus to contribute to the global solutions.

The following are some elements of climate financing:

(1) Resolution of the climate debt

In Sections 3 and 4, the carbon debt and estimates of it were discussed. The carbon debt accumulated from 1850 to 2008 by Annex I countries is estimated at 568 Gt of CO_2 at the end of 2008. The credit that developing countries have is the same amount.

One method of discharging the debt obligation is to assess its value and plan its repayment.

Concepts and estimates regarding allocation of emissions rights were given by the economist Nicholas Stern in his book The Global Deal: "If the allocations of rights to emit in any given year took greater account both of history and of equity in stocks rather than flows, then rich countries would have rights to emit which were lower than 2 tonnes per capita (possibly even negative). The negotiations of such right involve substantial financial allocations: at $40 per tonne CO_2eq a total world allocation of rights of, say, 30Gt (roughly the required flows in 2030) would be worth $1.2 trillion per annum".

Stern recognises the concepts of equity, historical emissions and the fact that if these are applied to rights to emit, developed countries' rights could even be negative. This concept of allocation of negative emissions has been used in earlier parts of this paper. The use of the level of $40 per tonne of CO_2 equivalent is also a significant example. It is also important that Stern recognises that the value of the emission rights may be worth more than US$1 trillion a year.

A carbon debt of 568 billion tonnes, valued at $40 a tonne, would be worth $23,000 billion. An amount like this, contributed to a Fund to be accessed by developing countries, would go a significant way to support and enable their climate actions. If this amount is divided into 40 installments (corresponding to the period 2010-2050), then a sum of about $600 billion a year (not counting interest on the capital amount or the effects of inflation on future value of the amounts) could be paid into the Fund. This is about 1.5 per cent of the current GNP of developed countries.

(2) Financing for mitigation

Developing countries require financing for mitigation activities, which is required to contribute to the world keeping to the carbon budget for 2010-2050. According to the Convention's Article 4.7, the extent to which developing countries take climate actions depends on the extent to which developed countries meet their commitments on providing finance and technology transfer. The commitment is to meet the full incremental costs of mitigation in developing countries.

The costs can be very significant, and thus the amounts required should match this. Middle income developing countries that have moderate per capita emissions require substantial finance to mitigate and to avoid future emissions. This is to avoid taking either the inefficient growth path. However low-income countries also require substantial financing, perhaps even more, because their growth path may be even more difficult, as they could attempt to avoid "moving up the per capita emissions pathway" before climbing downwards, as they develop, build economic and social infrastructure and industrialise. The avoided emissions required may be even higher for low-income countries throughout their movement towards higher development levels.

The World Bank in its World Development Report 2010 has estimated that: "In developing countries mitigation could cost $140 to $175 billion a year over the next 20 years (with associated financing needs of $265 to $565 billion)." This is associated with stabilising greenhouse gas concentration at 450 ppm. The Bank's conclusion is made after a survey of various existing studies. The Bank distinguishes between mitigation cost (which it defines as the incremental costs of a low-carbon project over its lifetime) and incremental investment needs (the additional financing requirement created as a result of the project). According to the report, because many clean investments have high up-front capital costs, followed later by savings in operating costs, the incremental financing requirements tend to be higher than the lifetime costs reported in mitigation models, and the difference could be as much as a factor of three.

It should also be noted that if the stabilisation target is more ambitious than the 450 ppm chosen, the mitigation costs to developing countries would go up correspondingly.

The widely used method of conceptualising mitigation costs is to estimate the cost of avoiding emissions. It has been argued that this "abatement cost" is cheaper in developing countries than in developed countries. The UNFCCC's investment and financial flows report concluded that $200-211 billion is needed globally in one year (2030) in order to reduce emissions worldwide by 31.7 Gt CO_2eq. Of this, an annual flow to developing countries of $65 billion is needed which would reduce emissions by 21.7 Gt (or 68 per cent share of global emissions). However an update of the UNFCCC report (2009, p. 56) recognises its under-estimation of mitigation costs, as the $200-210 billion covers only the initial capital cost of new physical assets and covers only the use of known technologies; it does not include the costs of capacity building, creation of enabling environment, or the development and use of new technologies. Moreover, it admits that the estimates for the cost of additional investment needed in 2030 have gone up since its original report (for example the cost of reducing energy-related CO_2 emissions is 170 per cent higher in a 2008 report than in the 2007 report it had based its estimates on). However it does not update its own overall cost estimate.

Much more work needs to be done on estimating costs in developing countries through a "bottom-up approach". The UNFCCC financial flows report, using marginal abatement cost (MAC) curves, shows that in general it is much cheaper at first to reduce emissions in developing countries, but that the costs go up significantly after the initial and easier measures have already been taken. "Available information shows that significant mitigation potential exists until 2020 with known technologies.

However to achieve the necessary reductions in 2030, mitigation actions have to be scaled up considerably and new mitigation opportunities need to be identified and developed" (UNFCCC, 2009, p. 56).

This point, of an easy start but of increasingly difficult follow-up phases, is made in a study in India of the six most emissions intensive sectors to determine India's low carbon growth options. The study by the Centre for Science and Environment (CSE, 2010) concludes: "The fact is that till 2020 India's current commitment (20-25 per cent reduction in emissions intensity of Gross Domestic Product - GDP) is easy to meet…It is about picking off low-hanging options, which will cost but not enough to be undoable. This is the easy part. The tough part is what begins now for the future. The fact is that in all high-polluting sectors, the technology options for emissions reduction stagnate after 2020. There is no real way we can reduce emissions without impacting growth as we know it, once we cross the current emissions-efficiency technology threshold....It is for this reason that India (and all other late entrants to the development game) must not give up on their demand for an equitous global agreement."

The CSE study estimates that for the most important sector, power generation, a low-carbon strategy could reduce emissions in India cumulatively by 3.4 Gt by 2030-31. The additional cost of generating power from renewable technologies in the low-carbon strategy over business-as-usual until 2030-31 is estimated at 8470 billion rupees (US$203 billion) at 2010 constant prices, or about $10 billion a year. This also means an average cost of 2,500 rupees, or $60 per tonne of CO_2 emissions avoided. The study notes that this is three times the price of carbon credits traded on the European Climate Exchange either under the Clean Development Mechanism (CDM) or the European Union Emissions Trading Scheme. "This means that the CDM cannot pay for the transition to low carbon in the power sector in India, and a new international mechanism will be required to fund the transition" (CSE, 2010, pp. 36-37).

It should also be noted that the UNFCCC report had concluded that a large majority of the emission reduction potential in developing countries can be realised at a cost of below $25 per tonne of carbon. However the CSE study estimates a cost of $60 per tonne for the Indian power sector, and that a payment below that through a carbon trading regime would not be able to finance the transformation needed.

(3) Financing for Adaptation

There are various estimates of adaptation financing needs of developing countries. Most of the studies done are limited in scope (because they leave out several sectors and activities) and thus in their cost estimates. The World Bank's recent report on "The costs to developing countries of adapting to climate change" estimates that "the cost between 2010 and 2050 of adapting to an approximately 2 degree ºC warmer world by 2050 is in the range of $75 billion to $100 billion a year." In its wetter scenario with a total $102 billion adaptation cost, the study concludes that the costs are $29 billion for East Asia/Pacific, $23 billion for Latin America and Caribbean, $19 billion for Sub-Sahara Africa, $17 billion for South Asia, $11 billion for Europe and Central Asia and $4 billion for Middle East and North Africa.

The Bank's estimate is higher than the UNFCCC's financial flows report, which estimated the cost of

adaptation for developing countries at $27 to $66 billion a year (with the global cost being $49-171 billion a year).

The most comprehensive estimate is by a team of scientists led by Martin Parry, former Co-Chair of the IPCC working group on impacts, vulnerabilities and adaptation. The study found that the UNFCCC report had significantly underestimated adaptation costs because it left out several sectors (mining, manufacturing, energy, retail, finance, tourism) and under-stated the costs in the sectors it covered by 2 to 3 times.

In the sectors covered by the UNFCCC report (water, health, infrastructure, coastal zones), the real costs are 2 to 3 times greater than estimated by that report. For example, in infrastructure, the UNFCCC estimate of $8-130 billion assumed that low levels of infrastructure investment will continue to characterise development in Africa and other poor parts of the world. But the Parry report takes the view that such investment must increase to reduce poverty and avoid high vulnerability to climate change. The costs of upgrading the housing and infrastructure in developing countries would be $315 billion a year over 20 years and adapting to climate change for the upgraded infrastructure will cost an additional $16-63 billion a year.

If the Parry report estimate is that the UNFCCC estimate is 2 to 3 times too low for the sectors it covered, then the real cost would be $68 to $165 billion a year for developing countries (using a multiplier of 2.5). If we also add the adaptation costs to ecosystems that UNFCCC did not cover, the additional cost is $65-300 billion. Moreover the costs of "residual damage" (the damage caused from situations where adaptation is not economical or technically feasible) not covered, are very substantial. A background paper for UNFCCC by Dlugolecki (2007) estimated the costs of damage from present extreme weather at $200 billion a year, and pointed out that this reflects the current scale of inadequate adaptation.

A rough estimate of the cost of adaptation needs, based on the above, is that developing countries require $68 to 165 billion plus a fraction of the global $65 to 300 billion for ecosystem protection and of the $200 billion if costs of damage from weather events are to be included. Taking the upper end of the first item, half of the second item and the two-thirds of the third item, the cost comes to about $450 billion annually. This figure does not include the costs of several sectors that are not included.

(4) Financing for technology cooperation and transfer

The UNFCCC's expert group on technology transfer (EGTT) provides estimates of additional financing needed to achieve projected implementation of specified mitigation technologies. The total finance needs are $300-1,000 billion a year on average from now to 2030 (UNFCCC, 2009, pp. 58-59). Of this total, developing countries are estimated to have additional funding needs of $182 – 505 billion a year, for deployment and diffusion of technology. This does not include research and development or demonstration, which are assumed to be additional financing in developed countries.

More research needs to be done on the cost of technology transfer to developing countries and on research and innovation in developing countries themselves. It should however be noted that there are separate costs involved for technology development and transfer, although there may be an overlap of some costs with mitigation or adaptation.

Conclusion on Finance

An equitable framework for sharing the atmospheric space requires the discharging of the historical responsibility of developed countries through enabling developing countries to take climate actions in mitigation, adaptation, capacity building and technology.

A major method of realising this is through the provision of finance and technology, massive amounts of which are required. The discussion above indicates some measure of the amounts of financing required:

- **Resolution of the climate debt, at a possible estimate of $600 billion a year over 40 years.**
- **Financing for mitigation, which the World Bank estimates will cost up to $565 billion a year.**
- **Financing for Adaptation, which can be estimated at $450 billion a year.**
- **Technology financing needs, estimated at up to $505 billion a year.**

These are rough estimates and more work is required on the carbon debt as well as additional costs for which developing countries need financing. The above suggests that about $2,000 billion or equivalent of 6 per cent of the current GNP of developed countries is required.

10. IMPLICATIONS FOR NEGOTIATIONS

The analysis in this paper has implications for various aspects of the UNFCCC negotiations. Below is a brief summary of these:

(a) Shared Vision

In the negotiations on shared vision, developing countries have argued that a decision on a global goal (whether a temperature limit or a global emissions reduction) should be in the context of equity and even to be preceded by a paradigm for the equitable sharing of the atmospheric space or resource. This should also be the case for the wording on a global peaking year.

This is a correct position because the global goals for temperature and emissions reduction have implications (explicit or implicit) for the responsibilities of developing countries or for their options in their emissions and thus their economic pathways. This principle of equity in sharing of atmospheric space has to be operational, with the use of the concepts and data on cumulative emissions, carbon debt and credit, and how to discharge the debt, etc. The data on fair shares and actual emissions and thus on debt/surplus also have major implications for the sharing of the carbon space in the 2010-2050 period, and thus of the allocation of emission obligations and rights as would be expressed in the shared vision's important element of “global goal for emissions reduction.”

It is suggested that special sessions of the AWG-LCA be held to deal with the issues of “the equitable

sharing of the atmospheric space", which will discuss the inter-related issues of historical emissions, the remaining carbon space up to 2050, the emissions reduction required, and how this burden of reductions should be shared, based on the equity principles of the UNFCCC.

(b) Mitigation

The concepts and figures on cumulative emissions and carbon debt/surplus make it clear that Annex I Parties must continue to "take the lead" in emissions reduction. Thus in the current negotiations for the mid-term up to 2020, and even in the discussion on 2050 targets, there should not be an "escape" from this leadership responsibility by arguing that certain developing countries have to join in the effort if there is to be a binding obligation on Annex I Parties or that they would not want to have a binding commitment on emissions reduction because developing countries are not prepared to join in. The reiteration of historical emissions and historical responsibility and carbon debt are relevant in an argument in favour of binding targets for developed countries, for the continuation of the Kyoto Protocol (KP) and for comparable effort for those Annex I Parties that are not in the KP.

It must be recognised that if developed countries undertake only weak targets for the next commitment period (2013-2017 or 2013-2020), and their emissions are only reduced a little (or even increases), then there is even less carbon space left for developing countries. The present pledges made either in the Copenhagen Accord or previously in the Kyoto Protocol working group are simply inadequate. Various analyses (most notably one in Nature journal) show that the Annex I countries' (including the US') pledges add up collectively to only a 16 per cent reduction at best (by 2020 compared to 1990) and if loopholes (through LULUCF and Assigned Amount Units - AAUs) are taken into account there can even be a 6.5 per cent increase in Annex I countries' emissions. If the carbon debt approach is taken (where poor performance is not simply ignored but is made accountable through the increase in carbon debt, with implications for compensation), then there is a greater incentive or imperative for Annex I countries to play their leadership role.

The analysis should also be useful in supporting the argument that developing countries' mitigation actions have to be supported and enabled by finance and technology, as is stated in the Bali Action Plan and the Convention's articles.

(c) Finance

The historical carbon debt that developed countries hold should be discharged through compensation into a UNFCCC Fund. This could be a lump-sum payment or payments over the 40 years 2010-2050 in yearly installments. The funds will enable developing countries to undertake climate and development actions.

Besides this, the developed countries have obligations under the UNFCCC to meet the additional or incremental costs of developing countries in mitigation and in preparing their national communications, as well as to meet additional costs for adaptation and technology.

The paper indicates that the quantum of funds for discharging the carbon debt and for meeting the additional costs are large, but this is to be expected since the financial requirements of adaptation, mitigation, capacity building and technology are massive. This is so under a framework of limiting

temperature rise to 2 ºC. It is even much larger should a limit of 1.5 ºC be agreed upon.

It is also important to ensure that the funds are additional, predictable and stable and are not mostly loan-based as this would only add on to the financial debt burden of developing countries.

The amounts so far announced ($10 billion a year from 2010, and $100 billion by 2020 made up of private and public funds, etc.) are grossly inadequate given the enormity of the tasks facing developing countries and the estimates of the needs.

The Group of 77 and China have estimated a value of at least 1.5 per cent of the GNP of developed countries as the basis of the finance needed by developing countries. In the light of the analysis of this paper, this figure is inadequate, and may have to be reconsidered. The paper indicates that the financing aspect should be 6 per cent of GNP. More research can be undertaken on this issue.

(d) Technology

It is clear that if the world is to achieve a temperature limit that gives a reasonable chance of survival, developing countries will have to play their role in avoidance of emissions, while at the same time not sacrificing their development goals.

This requires a tremendous technological leap or leap-frogging that involves access to climate-related technology at the most affordable rates. The avoidance of disastrous climate change is definitely a global public good, which must have higher priority than commercial interests. Thus the developing countries are correct to take the position that

(1) They must have the maximum access at least cost to the best technologies;

(2) Barriers to technology transfer must be addressed, including the issue of intellectual property rights (IPRs);

(3) Developing countries must be assisted in the development of endogenous technology and to undertake their own R and D and develop innovation, with international support;

(4) R and D activities should be financed by UNFCCC funds, and the products from these should be in the public domain;

(5) Sufficient funds be provided for technology development and transfer to developing countries;

(6) A Technology Policy Board or Council be set up under the Conference of the Parties (COP) to address all the technology issues.

(e) Measurement, Reporting and Verification (MRV)

Developed countries have been pressing to create new MRV obligations on developing countries. These pressures are unfair when the developed countries themselves are preparing the ground for abandoning the Kyoto Protocol or any form of binding commitment on developed countries on an aggregate reduction target that is adequate in line with the science. In other words they are preparing to

abdicate their leadership role in emissions reduction, while shifting the burden onto developing countries. The MRV requirements that they seek to impose would impose more conditions on developing countries without any corresponding increase in the obligations of developed countries.

It is thus important to establish a binding, adequate and useful MRV system on the implementation of the commitments of developed countries to provide finance and technology to developing countries. This should be placed in the draft texts of UNFCCC and a negotiating group on this issue should be established.

Annex 1:

Global emissions reduction goal of 50% below 1990 levels (14.986 $GtCO_2eq$ global)

AI $GtCO_2eq$ emission reductions from 1990 levels needed taking into account NAI emissions per capita growth for development

NAI CO_2eq Ton/Capita 2050	NAI $GtCO_2eq$ Aggregate 2050	NAI aggregate % relative to 1990	AI $GtCO_2eq$ Aggregate 2050	AI aggregate % relative to 1990	AI CO_2eq Ton/Capita 2050	2050 AI per Capita % relative to 1990	2050 NAI per Capita % relative to 1990	2050 AI per Capita % relative to 2005	2050 NAI per Capita % relative to 2005
6	46.83	291%	(31.84)	(277%)	(23.66)	(254%)	107%	(267%)	62%
5	39.02	226%	(24.04)	(234%)	(17.86)	(216%)	72%	(226%)	35%
4	31.22	161%	(16.23)	(190%)	(12.06)	(178%)	38%	(185%)	8%
3	23.41	96%	(8.43)	(147%)	(6.26)	(141%)	3%	(144%)	(19%)
2	15.61	30%	(0.62)	(103%)	(0.46)	(103%)	(31%)	(103%)	(46%)
1.80	14.085	17.69%	0.900	**(95%)**	0.67	**(95.65%)**	**(38%)**	**(95.27%)**	(51.25%)
1.46	11.385	(4.87%)	3.601	**(80%)**	2.68	**(82.61%)**	**(50%)**	**(81.07%)**	(60.59%)
1	7.80	(35%)	7.18	(60%)	5.34	(65%)	(66%)	(62%)	(73%)

Global emissions reduction goal of 85% below 1990 levels (4.496 $GtCO_2eq$ global)

AI $GtCO_2eq$ emission reductions from 1990 levels needed taking into account NAI emissions per capita growth for development

NAI CO_2eq Ton/Capita 2050	NAI $GtCO_2eq$ Aggregate 2050	NAI aggregate % relative to 1990	AI $GtCO_2eq$ Aggregate 2050	AI aggregate % relative to 1990	AI CO_2eq Ton/Capita 2050	2050 AI per Capita % relative 1990	2050 NAI per Capita % relative to 1990	2050 AI per Capita % relative to 2005	2050 NAI per Capita % relative to 2005
6	46.83	291%	(42.33)	(335%)	(31.46)	(304%)	107%	(323%)	62%
5	39.02	226%	(34.53)	(292%)	(25.66)	(267%)	72%	(281%)	35%
4	31.22	161%	(26.72)	(248%)	(19.86)	(229%)	38%	(240%)	8%
3	23.41	96%	(18.92)	(205%)	(14.06)	(191%)	3%	(199%)	(19%)
2	15.61	30%	(11.11)	(162%)	(8.26)	(154%)	(31%)	(158%)	(46%)
1	7.80	(35%)	(3.31)	(118%)	(2.46)	(116%)	(66%)	(117%)	(73%)
0.46	3.596	(69.95%)	0.900	**(95%)**	0.67	**(95.65%)**	**(84%)**	**(95.27%)**	(87.56%)
0.11	0.895	(92.52%)	3.601	**(80%)**	2.68	**(82.61%)**	**(96%)**	**(81.07%)**	(96.90%)

Annex 2

Some useful data relevant to the Carbon Budget analysis

Data Item	Value
AI 1990 aggregate emissions CO_2eq	18.003 billion tonnes (Gt)
NAI 1990 aggregate emissions CO_2eq	11.968 Gt
Global 1990 aggregate emissions CO_2eq	29.971 Gt
AI 1990 per capita emissions CO_2eq	15.39 tonnes
NAI 1990 per capita emissions CO_2eq	2.90 tonnes
AI 1990 population	1.169739 Billion
NAI 1990 population	4.120713 Billion
AI 2005 aggregate emissions CO_2eq	17.757 Gt
NAI 2005 aggregate emissions CO_2eq	19.459 Gt
Global 2005 aggregate emissions CO_2eq	37.216 Gt
AI 2005 per capita emissions CO_2eq	14.14 tonnes
NAI 2005 per capita emissions CO_2eq	3.70 tonnes
AI 2005 population	1.256 Billion
NAI 2005 population	5.256 Billion
NAI 2020 aggregate emissions CO_2eq projected under IPCC A1FI SRES (Fossil Fuel Energy Intensive, Special Report on Emissions Scenarios) baseline scenario	35.126 Gt
NAI 2020 population (projected UN)	6.353 Billion
AI 2020 population (projected UN)	1.321 Billion
AI 2050 population (projected UN)	1.346 Billion
NAI 2050 population (projected UN)	7.804 Billion

Notes on data sources:

1. World Resources Institute, Climate Analysis Indicators Tool (CAIT) ver 7.0, Emissions data for 1990-2005. Available from http://cait.wri.org.

2. Michel den Elzen and Niklas Höhne, *Emissions projections for 2020: Table 4, Reductions of greenhouse gas emissions in Annex I and Non-Annex I countries for meeting concentration stabilisation targets*, Climate Change (2008), 91:249-274, p. 261. Available from http://www.springerlink.com/content/r272jg6071257627/fulltext.pdf. (This is the study referred to by the EU in its Dec 2008 communication on the Copenhagen agreement to support its 15-30% below baseline proposal.)

3. Populations data from UNDESA Population Division, The World Population Prospects: 2008 Revision Population Database. Available from http://esa.un.org/unpp/.

Annex 3.

SOME RELEVANT PROVISIONS OF THE UN CLIMATE CONVENTION THAT RELATE TO EQUITY

Some of the important provisions in the UN Framework Convention on Climate Change relating to equity and development concerns are as follows:

Preamble: Noting that the largest share of historical and current global emissions of greenhouse gases (GHGs) has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs,

Preamble: Affirming that responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty,

Preamble: Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development and that, in order for developing countries to progress towards that goal, their energy consumption will need to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general, including through the application of new technologies on terms which make such an application economically and socially beneficial,

Article 2. The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Article 3.1. The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of **equity and in accordance with their common but differentiated responsibilities** and respective capabilities. Accordingly, the developed country Parties **should take the lead in combating climate change** and the adverse effects thereof.

Article 3.2. The specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.

Article 4.2. The developed country Parties and other Parties included in Annex I commit themselves

specifically as provided for in the following:

(a) Each of these Parties shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention...

Article 4.3. The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.

Article 4.4. The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

Article 4.5. The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

Article 4.7. The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.

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Chemin du Champ d'Anier 17
PO Box 228, 1211 Geneva 19
Switzerland

Telephone : (41 22) 791 8050
Fax : (41 22) 798 8531
Email : south@southcentre.org

Website :
http://www.southcentre.org

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