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## Sustainable development: how to allocate CO2 emission reductions?

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# **Sustainable Development: How to Allocate CO<sub>2</sub> Emission Reductions?**

*Udo E. Simonis*

Among all of today's global environmental problems, climate change is the most urgent and the most threatening one. Climate change must be addressed because it will exacerbate all other problems such as deforestation, species extinction, loss of topsoil, etc. One could, however, easily argue that all other major environmental problems of today must be addressed primordially because they all end up having effects on climate.

*Eco-Currents, January 1992*

## **Introduction**

Sustainable development implies that in the future, economists and development planners, diplomats and politicians will not only have to deal with growth and development processes, but will have to pay increasingly more attention to reduction and redistribution processes. This is particularly true with regard to the most important global environmental problem so far, climate change. Up to the present, this problem has been mainly caused by the industrial countries, and the debate is about how much the North should give up in climate relevant emissions. The developing countries might, however, follow suit if they keep to the "standard development path." Ecologically, it will be the developing countries which will suffer most from the effects of climate change. Economically, cost incidence will depend on the kind of preventive or adaptive measures taken, on institutional arrangements made, and on the wisdom of global environmental diplomacy. Some of these measures, arrangements and diplomacies will be dealt with in this chapter.

## Greenhouse gas emissions

In analyzing global climate change and in formulating a corresponding policy (*global climate policy*), three categories of emissions are important: absolute emissions, per capita emissions, and emissions per unit of gross domestic product (GDP) or gross national product (GNP).

*Table 1* shows the net national emissions of carbon dioxide, methane and chlorofluorocarbons (*absolute emissions*) for 30 countries and entails a "greenhouse index" in form of an unweighted component index.

*Table 2* shows the corresponding net emissions per capita (*per capita emissions*).

*Figure 1* shows the greenhouse gas emissions per unit of gross national product for three groups of countries (*emissions per unit of GNP*).

From these few (but still weak) basic statistical data it already becomes clear what a formidable task the reduction of, or adaptation to, climate change will present to the world in general, and to industrial and developing countries, respectively. Negotiations on this task are presently under way, concrete results, however, are still lacking. These negotiations center around a new distribution problem, the solution of which is extremely difficult. Some points of orientation have emerged, but a final solution is not yet in sight.

Ideally, all greenhouse gases should be comprised by an international agreement on their reduction (*climate convention* and *respective protocols*). This, however, would be a quite unrealistic proposition. Technical, economic, social and political aspects of emission reductions for individual gases differ quite remarkably from country to country. While the industrial countries are responsible for approximately 80 percent of the global CO<sub>2</sub> emissions (among them the USA, with its rather inefficient energy and transport structures), the developing countries are mainly responsible for methane emissions (from paddies and cattle ranching). While for some of the greenhouse gases it is easily possible to control (capture) emissions, for others this can only be achieved through adjustments of the product mix and of production technology. While for some gases a quick and complete phasing out (e.g., CFCs) seems necessary and possible, for others (e.g., methane, nitrogen oxide) a reduction is conceivable only as a slow step-by-step process.

**Table 1: Greenhouse Index: The 30 countries with the highest greenhouse gas net emissions, 1987**

(Carbon dioxide heating equivalents, 000 metric tons of carbon; unweighted index)

Country	Greenhouse Index rank	Carbon dioxide	Greenhouse gases		Total	% of total
			Methane	CFCs		
United States	1	540,000	130,000	350,000	1,000,000	17.6
U.S.S.R.	2	450,000	60,000	180,000	690,000	12.0
Brazil	3	560,000	28,000	16,000	610,000	10.5
China	4	260,000	90,000	32,000	380,000	6.6
India	5	130,000	98,000	700	230,000	3.9
Japan	6	110,000	12,000	100,000	220,000	3.9
Germany, Fed. Rep.	7	79,000	8,000	75,000	160,000	2.8
United Kingdom	8	69,000	14,000	71,000	150,000	2.7
Indonesia	9	110,000	19,000	9,500	140,000	2.4
France	10	41,000	13,000	69,000	120,000	2.1
Italy	11	45,000	5,800	71,000	120,000	2.1
Canada	12	48,000	33,000	36,000	120,000	2.0
Mexico	13	49,000	20,000	9,100	78,000	1.4
Myanmar	14	68,000	9,000	0	77,000	1.3
Poland	15	56,000	7,400	13,000	76,000	1.3
Spain	16	21,000	4,200	48,000	73,000	1.3
Colombia	17	60,000	4,100	5,200	69,000	1.2
Thailand	18	48,000	16,000	3,500	67,000	1.2
Australia	19	28,000	14,000	21,000	63,000	1.1
German Dem. Rep.	20	39,000	2,100	20,000	62,000	1.1
Nigeria	21	32,000	3,100	18,000	53,000	0.9
South Africa	22	34,000	7,800	5,800	47,000	0.8
Ivory Coast	23	44,000	550	2,000	47,000	0.8
Netherlands	24	16,000	8,800	18,000	43,000	0.7
Saudi Arabia	25	20,000	15,000	6,600	42,000	0.7
Philippines	26	34,000	6,700	0	40,000	0.7
Laos	27	37,000	1,000	0	38,000	0.7
Vietnam	28	28,000	10,000	0	38,000	0.7
Czechoslovakia	29	29,000	2,200	2,700	33,000	0.6
Iran	30	17,000	6,400	9,000	33,000	0.6

Source: World Resources, 1990-91, p. 15. On the methodology used, see p. 18

*Table 2: Per capita Greenhouse Index: The 30 countries with the highest per capita greenhouse gas net emissions, 1987*

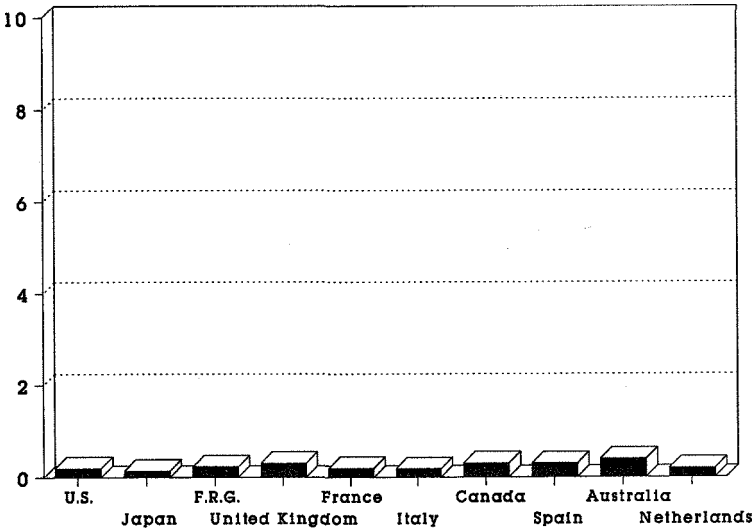
Country	Rank	Tons per capita
Laos	1	10.0
Qatar	2	8.8
United Arab Emirates	3	5.8
Bahrain	4	4.9
Canada	5	4.5
Brazil	6	4.3
Luxembourg	7	4.3
United States	8	4.2
Ivory Coast	9	4.2
Kuwait	10	4.1
Australia	11	3.9
German Dem. Rep.	12	3.7
Oman	13	3.5
Saudi Arabia	14	3.3
New Zealand	15	3.2
Netherlands	16	2.9
Denmark	17	2.8
Costa Rica	18	2.8
Germany, Fed. Rep.	19	2.7
United Kingdom	20	2.7
Singapore	21	2.7
Finland	22	2.6
U.S.S.R.	23	2.5
Ireland	24	2.5
Belgium	25	2.5
Switzerland	26	2.4
Nicaragua	27	2.4
Colombia	28	2.3
Trinidad and Tobago	29	2.3
France	30	2.2

Source: World Resources 1990-91, p. 17

Figure 1: Net greenhouse gas emissions per U. S. Dollar of Gross National Product, 1987

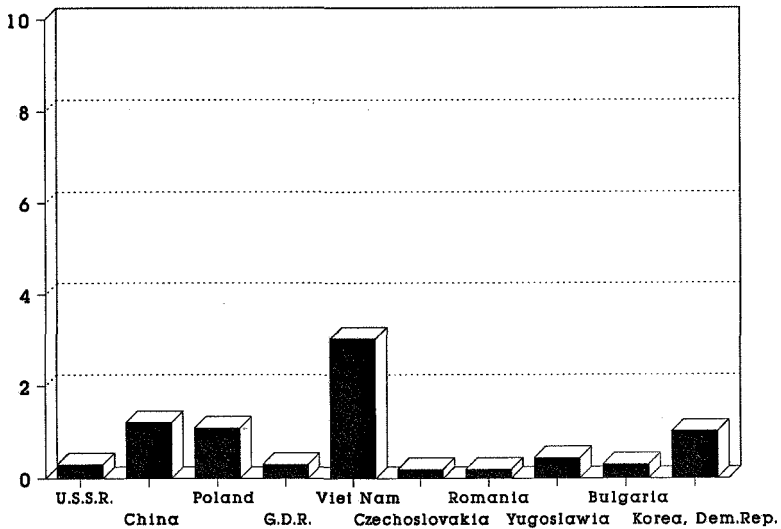
A. OECD countries

Carbon dioxide heating equivalents (kilograms of carbon per \$US of GNP)



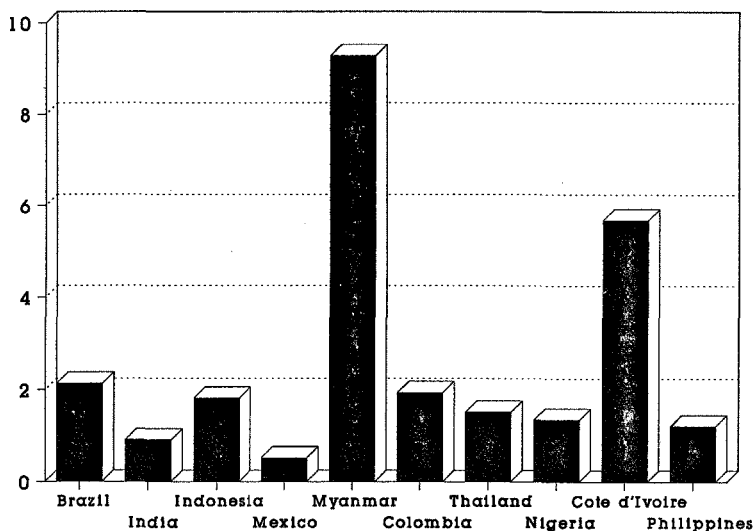
B. Planned economies

Carbon dioxide heating equivalents (kilograms of carbon per \$US of GNP)



### C. Developing countries

Carbon dioxide heating equivalents (kilograms of carbon per \$US of GNP)



Source: World Resources 1990-91, p. 19.

Accordingly, in drafts for a framework convention on global warming (*climate convention*) the problems involved have been described, the necessary actions were acknowledged, and further research and monitoring programs were initiated. Such a convention will have to be implemented by one or several *protocols*, specifying targets and measures for the reduction of the respective greenhouse gas emissions ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ). It is here that the real work on details begins, including the struggle for the distribution of costs and benefits, on finance and technology transfer, and on the employment of suitable economic and regulatory instruments, like charges and taxes, on the one hand, and norms and standards, on the other hand.

What can the discussion on the implementation of a global climate convention, and the corresponding protocols, build on? What experiences have been made with regard to agreements on environmental protection involving both industrial and developing countries?



## Global environmental policy: experiences so far

The number of effective international agreements on environmental protection comprising more than a single region (like, for example, river basins) and more than individual projects (like debt-for-nature swaps or the tropical forest action plan), and having been signed both by industrial and developing countries, i.e., agreements whose structure is relevant with regard to the climate convention, is rather limited. Volkmar Hartje who investigated this question, names only four of them (Hartje, 1989): the London Dumping Convention (1972), the Convention for the Prevention of Sea Pollution by Ships (1973 and 1978), the UN Conference on the Law of the Sea (1973-1982), and the Vienna Convention (1985) together with the Montreal Protocol on the Protection of the Ozone Layer (1987).

These agreements contain innovative regulations and instruments, including not only technical provisions, but also fiscal incentives and quota systems. The Montreal Protocol (with the succeeding revisions) is even considered a model blueprint as regards international environmental regimes (Gehring, 1990), an example of intelligent "ozone diplomacy" (Benedick, 1991).

Up to the present, however, these agreements were only of minor significance for the developing countries, in that they hardly had to fulfill any obligations for the reduction of harmful emissions. In this respect, too, the Montreal Protocol is a new beginning—modified, though, by a ten-year grace period for and by provision of information and technology transfer to the developing countries. A functioning global climate convention, by contrast, will imply significant economic adjustments not only for the industrial countries but also for the developing countries, with regard to production as well as technology.

Theoretically speaking, a relative and/or an absolute reduction of all the relevant greenhouse gases is to be aimed at. In doing so, basically all conceivable mechanisms and instruments could be used: *negative lists* (London Dumping Convention), *technical provisions* (Marpol Agreement), *property rights* (the Law of the Sea Conference), *rates of reductions or cancellation of production* (Vienna Convention, Montreal Protocol), etc. In view of a continuing high population growth in the developing countries, on the one hand, and urgent economic needs (i.e., necessary increases of income), on the other hand, *relative* limitations (with regards to population or gross domestic product) or *absolute* limitations of greenhouse gases would generate quite different consequences. These consequences, of

course, will influence the readiness of countries to cooperate or to oppose in the process of negotiating the climate convention and the respective protocols.

Regarding only the major greenhouse gases, these are probably the most important measures to be considered:

- relative *or* absolute limitation of carbon dioxide emissions ( $\text{CO}_2$ ) resulting from the combustion of fossil fuels;
- cancellation *or* conversion of the trends of  $\text{CO}_2$  emissions from biotic sources (i.e., reduced deforestation and increased reforestation, respectively);
- phasing out consumption *and/or* not taking up production of chlorofluorocarbons (CFCs);
- relative *or* absolute limitation of methane emissions ( $\text{CH}_4$ );
- relative *or* absolute limitation of the use of nitrogen fertilizers ( $\text{N}_2\text{O}$ ).

Taking the formulation of the CFC reduction plan (not its implementation) as basically solved, the further negotiations on the global climate convention will focus on a  $\text{CO}_2$ -, a  $\text{CH}_4$ - and a  $\text{N}_2\text{O}$ -Protocol, or a combination of them, and a supplementation by other protocols (on reforestation and desertification). At this point in time, there is only one greenhouse gas (apart from CFCs) which has been discussed seriously on the international level (leaving aside some detailed individual suggestions regarding other factors) and whose regulation can possibly be achieved in the current decade. That is carbon dioxide ( $\text{CO}_2$ ). In the following, I shall, therefore, concentrate on this gas.

### **Reduction and redistribution processes: theoretical considerations**

In the process of the Montreal Protocol three steps, or targets, emerged: *freeze*, *reduction*, and *phasing out*. The negotiations centered on rules to reach a quantitative reduction, while a solution via fiscal disincentives ("CFC tax") was not pursued. The volume of funds made available ("CFC Reduction Fund") is rather modest and sufficient at best to cover the costs of information transfer. With regard to the other greenhouse gases, especially  $\text{CO}_2$ , however, a further *growth* of emissions must be expected; freezing or reduction seem technically feasible, phasing out is impossible.

With regard to global environment policy, solutions via price and quantitative regulations are basically "ideal," as far as mechanisms of stim-

ulation and/or sanctioning are concerned (Bonus, 1991). At the very beginning of all environment policy, the market mechanism is being changed. There are two approaches: One is to fix prices for environmental services, while it is left to the market mechanism to decide what emission level is economical (*price solution*); or a quota is fixed for the quantity of emissions allowed, while the prices for using the environment are left to develop in the market (*quantity solution*). These two basic approaches are symmetrical to one another, but they are not equivalent. One parameter, price or quantity, is fixed while the other is left to the market mechanism. The real question is which of these parameters should be fixed with regard to which environmental problem!

The crucial problem with price solutions (*taxes, charges*) is to determine the correct level of the price to be fixed (*shadow price*). The crucial problem with quantity solutions is to determine the appropriate quantitative ceiling (*quota*) of emissions to be permitted. In either case, if the determination is wrong, permitted emissions may exceed the absorption capacity of the ecological system (in our case, the climate system). Price as well as quantity solutions may, therefore, miss the actual target, i.e., conservation, stabilization or restoration of the ecological system. With regard to a CO<sub>2</sub> protocol it is to be expected that in the course of the negotiations, both types of solutions will be introduced. Up to date, quantity solutions are in the forefront, while the discussion on price solutions (*global resource tax, national CO<sub>2</sub>-charge, "climate tax"*) has only just begun.

Moreover, with regard to quantity solutions legal rules (*reduction duties*) do prevail. However, the use of market-based instruments (*certificates or tradeable permits*) seems to be gaining ground. This suggests the implementation of certain framework parameters (for example: a certain rise in temperature) by emission quotas (see Tietenberg, 1985). These systems would have to be transformed into specific certificates which entitle the holder (country, group of countries) to an (annual) emission of a certain amount of a specified pollutant (in this case: CO<sub>2</sub>). These certificates (or tradeable permits) could be regionally or globally transferable (*exchange*). They would be exchanged in the market at prices corresponding to their scarcity, and the ensuing income might then be used for substituting high emission products and technologies by low emission products and technologies. The certificates would add up to the set framework parameters (*global emission limit*). The certificates traded could thus be interpreted as a compensation for partial renunciation of production or use, respectively.

A special problem in regard to the implementation of a CO<sub>2</sub> protocol is the uncertainty as far as cause-effect-relations between emissions and impacts on climate (rise in temperature) are concerned. This problem could, however, be forestalled by corresponding (yearly) devaluations of the certificates. This would lead to either reduced emissions or to the need to purchase additional certificates.

It appears that CO<sub>2</sub> emissions qualify for a quantity solution, in the form of certificates to be traded at the firm, the national, the regional and even the international level. Specific conditions, however, would have to be met to implement this theoretical option smoothly in actual practice. There are also alternative instruments of global climate policy, like a tax on fossil fuels or a CO<sub>2</sub>-charge. The related questions of these solutions, however, cannot be addressed in this chapter.

### Global CO<sub>2</sub>-emission reductions: three scenarios

In the following, three global emission reduction-scenarios are briefly compared. They include all important greenhouse gases. For reasons of clarity, however, only the CO<sub>2</sub> data are considered in detail.

Bach derives drastic reduction duties from the (catastrophic) projections of climate models, whereas Mintzer and EPA define the emission reductions from possible or probable changes of relevant parameters (especially energy intensity, mileage efficiency, energy tax). Accordingly, the three scenarios differ quite a bit (see *Table 3*).

- *Scenario A* can be called a strict "preventive strategy," i.e., a drastic reduction of CO<sub>2</sub> emissions from the burning of fossil fuels and also from biotic sources (clearing of forests, burnings, losses of vegetation);
- *Scenario B* occupies a "middle position." A reduction of CO<sub>2</sub> emissions from fossil fuels of less than 40 percent is expected, and an active reforestation policy is envisaged, leading to negative net emissions (via an enlargement of CO<sub>2</sub> sinks);
- *Scenario C* may be regarded as "modest policy." Prevention fails, emissions from the burning of fossil fuels double, changes in land use have only minor relieving effects; the resulting increase of average temperature (2075/1860: = 2.3 up to 7° Celsius) makes far-reaching adaptive measures necessary.

Table 3: Scenarios of CO<sub>2</sub> reduction (1975-2100)

Scenario A: "Preventive Strategy"; Bach, 1988

	Real emissions 1980	Estimated emissions 2100
CO <sub>2</sub> (million tons)		
- Fossil fuels	18,000	6 - 9
- Change of land use	4,000	0 - 4
<b>Total</b>	<b>22,000</b>	<b>6 - 13</b>

Δ T 2100/1860 = 1.5 to 4.5 degrees Celsius

Scenario B: "Intermediate Position"; EPA, 1989

	Real emissions 1985	2025	Estimated emissions		
			2050	2075	2100
CO <sub>2</sub> (billion tons)					
- Fossil fuels	19.4	20.5	n.a.	n.a.	12.2
- Change of land use	3.0	-1.1	n.a.	n.a.	-0.4
<b>Total</b>	<b>22.4</b>	<b>19.4</b>	<b>16.0</b>	<b>14.1</b>	<b>11.8</b>

Δ T 2100/1860 = 1.4 to 2.8 degrees Celsius

Scenario C: "Modest Policy"; Mintzer, 1987

	Real emissions 1975	2025	Estimated emissions		
			2050	2075	--
CO <sub>2</sub> (billion tons)					
- Fossil fuels	17.1	21.3	28.3	34.6	--
- Change of land use	3.8	3.0	2.7	2.5	--
<b>Total</b>	<b>20.9</b>	<b>24.3</b>	<b>31.0</b>	<b>37.1</b>	<b>--</b>

Δ T 2075/1860 = 2.3 to 7 degrees Celsius

Source: Compiled from Hartje, 1989

Of course, it is difficult to predict which of these scenarios will be taken as reference for the global climate convention, and the respective protocols. According to recent climate conferences of scientists and politicians, a limitation of average global warming to below two degrees Celsius might develop as a reference point. The implied "mixed strategy" of precaution (*prevention*) and adaptation (*cure*) actually will be determined by three major factors: (1) the real or supposed costs and benefits of the corresponding measures, (2) the perception of the irreversibilities caused by climate change, and (3) the institutional and instrumental measures which can be agreed on in the North-South-context.

The current discourse over the reduction of CO<sub>2</sub> emissions is an indicator of an already existing *common interest* in sustainable development of both North and South. In fact, there are interesting and surprisingly coincident plans, summarized in the following section.

### CO<sub>2</sub>-emission reduction plans: three examples

At the Second World Climate Conference in Geneva 1990, two plans on CO<sub>2</sub>-emission reduction for the time until 2050 were presented: the IPCC proposal and the Ministers' proposal. The "International Panel on Climate Change" (IPCC) called for drastic and rapid reductions of CO<sub>2</sub> emissions in the OECD member countries, whereas overall global emissions will decrease only after the year 2005, and shall then fall by 46 percent until 2050, below the level of 1987 (see Table 4).

Table 4: CO<sub>2</sub>-emissions plan - Second World Climate Conference  
- The IPCC proposal (base year 1987, in percent)

Year	Industrial countries			Developing countries	World total
	OECD	others	total		
1990	+5	+5	+5	+11	+6
1995	+7	+8	+7	+24	+11
2000	-4	+5	-1	+37	+7
2005	-20	-10	-16	+50	-3
2020	-50	-30	-43	+60	-21
2050	-80	-70	-76	+70	-46

Source: WMO/UNEP, 1990

The Ministers' proposal was less drastic and with some temporary delay (see Table 5). The ministers, however, followed the scientists' notion, whereupon a further increase of CO<sub>2</sub> emissions should be accorded to the developing countries because of their need for further economic growth.

Table 5: CO<sub>2</sub>-emissions plan - Second World Climate Conference  
- The Ministers' proposal (base year 1987, in percent)

Year	Industrial countries	Developing countries	World total
1990	+5	+11	+6
1995	+8	+24	+11
2000	+5	+37	+12
2005	0	+50	+10
2020	-20	+60	-4
2050	-60	+70	-33

Source: WMO/UNEP, 1990

The plan of the "Enquête-Kommission" of the German Parliament might be taken as a third reference case (see Table 6).

Table 6: CO<sub>2</sub>-emissions plan  
- The German Enquête-Kommission (base year 1987, in percent)

Year	Industrial countries			Developing countries	World total
	economically strong	economically less strong	economically weak		
1990	+5	+5	+5	+11	+6
1995	+5	+7	+8	+24	+10
2000	-10	-4	+5	+37	+4
2005	-30	-15	-5	+50	-5
2020	-50	-35	-25	+60	-20
2050	-80	-80	-80	+70	-50

Source: Enquête-Kommission, 1990

This proposal differentiates the industrial countries according to their gross domestic product and suggests CO<sub>2</sub>-emission reductions to be

accorded to the developing countries. Thus, implicit criteria for the allocation of reduction duties, and the related redistribution goals, between industrial and developing countries, North and South, can be inferred from the three plans. In the following, special features of these sensitive issues for a global CO<sub>2</sub> protocol are addressed more explicitly.

### **Possible criteria for the distribution of CO<sub>2</sub>-emission reductions between North and South**

The allocation of the duties of the climate convention, and the accompanying protocols, between industrial and developing countries depends on various factors. Especially, to what degree should a certain greenhouse gas be reduced in relation to other gases, and what criteria should be applied for the reduction? A comprehensive strategy for reducing *all* greenhouse gases would probably focus on their relative importance for climate change, respectively on the global benefits of a climate stabilization. A partial strategy for one *single* greenhouse gas will probably focus less on possible benefits but on the technical options, the costs of emissions reduction, or on the substitution of the reduction duties vis a vis other gases.

For example, a total phasing out of CFC production in the industrial countries theoretically would allow for a less strict reduction of CH<sub>4</sub> or N<sub>2</sub>O, which is technically difficult to achieve in the developing countries. At this stage, however, there is no need to go deeper into such "substitution dispute." Instead, I shall focus on CO<sub>2</sub> only - which, as noted earlier, causes more than 50 percent of the greenhouse effect. The remainder of the chapter attempts to illustrate the range of possible and realistic criteria for CO<sub>2</sub> reduction policies.

Two successful international environmental agreements may be the points of departure for the decision on such criteria: The ECE Convention on Long-Range Transboundary Air Pollution (1979), and the Montreal Protocol (1987). With the signing of the ECE convention a small number of ECE countries joined a "30-percent Club" as regards the reduction of sulfur dioxide (SO<sub>2</sub>). Other ECE countries joined the "club" subsequently. Decisive for this success in beginning to control acid rain was not only the pressure ensuing from the observed damage to the forest ecosystems ("Waldsterben"), the formation of the electorate, the generation of techni-



cal and financial solutions, but also the consensus achieved by the "club" over a simple distribution criterion: "Every country shall reduce its SO<sub>2</sub> emissions by the *same* rate of 30 percent!" (This consensus had been reached after an intense discussion of the questions, whether the current or the accumulated emissions, the size of the country, its emission export/import situation, etc. should be taken into account or not). In this way, the given departure point was "legitimized," prior accomplishments or geographic and other peculiarities were not considered. Thus, this case exemplifies

*Allocation criterion I:*

*A proportionally equal reduction rate for all countries  
referring to the starting point (and a base year)*

The Montreal Protocol also requires a proportionally equal reduction rate (50 percent at first, 100 percent later on), but permits a temporary exemption from this rule for the developing countries. The developing countries were relieved from the reduction duty, because it was judged as being unfair: The industrial countries had caused the damage to the ozone layer with their accumulated CFC emissions, thus developing countries could not be expected to assume a proportional part of the duties. They might even have a right to emit in the future. On this line of argument is founded the

*Allocation criterion II:*

*A proportionally equal reduction rate for one group of countries  
(industrial countries), and fixation of a limited permissible increase  
of emissions for the other group (developing countries)*

The Montreal Protocol concedes the developing countries a CFC production of up to 0.3 kilogram per capita for ten years, and then requires a reduction to 50 percent. In comparison with CO<sub>2</sub> emissions, the reduction of CFC emissions needs but slight adjustment measures, because of quasi oligopolistic production and an initial level. The adjustments necessary for a CO<sub>2</sub> protocol will be much more extensive, as many technologies, products and economic branches are at stake. The industrial countries may bargain their own absolute reduction duties against the relative reduction duties (rate of growth of CO<sub>2</sub> emissions) of the developing countries. Apart from disparities in current emissions, the developing countries might also point at the historical emissions accumulated in the Earth's atmosphere. The more such allocation arguments (and others) are brought into the arena, the higher the probability that no common (mutual) reduction formula can be agreed on. This may make a criterion

of equal treatment attractive. One that could be accepted as fair by the developing countries is *equal CO<sub>2</sub> emissions per capita of population*. This is the

*Allocation criterion III:*

*Every country has a right to emit, resulting from the fixed (reduced) global limit of emissions per capita of the world's population, multiplied by the country's population number.*

According to this criterion, countries exceeding the fixed limit of emissions per capita (the industrial countries) would have to reduce emissions drastically; countries falling below this limit (the developing countries) could emit additionally. This criterion is geared to fairness, not legitimizing the present emissions situation but requiring considerable redistribution in the North-South-context.

By introducing this criterion, peculiarities like the geographic situation, size of the country, resource endowment, differences in costs, etc. would not be taken into consideration. This, in turn, might open up corridors for bargaining in the negotiations on a CO<sub>2</sub> protocol.

Applying the distribution criteria I to III on the three scenarios presented in *Table 3*, reveals quite different magnitudes of the reduction duties and, respectively, the resulting *redistribution* between industrial and developing countries, as summarized in *Table 7*.

Technically speaking, there exists a wide range of possible measures to reach a reduction of current CO<sub>2</sub> emissions (cf. Goldemberg, *et al.*, 1987; Kats, 1989; Enquête-Kommission, 1991); the most important of them are probably the following:

- Reduction in the use of fossil fuels by way of energy saving, or increase in the efficiency of energy use, especially with regard to transport, electricity, heating;
- substitution of high-emission fuels by low-emission fuels;
- installation of new power generating technologies, like co-generation, district heating, district cooling, gas turbines;
- substitution of fossil fuels by renewable energy, like biomass, wind energy, photovoltaics, solar hydrogen;
- technical improvement or refitting of fossil fuel based power plants and engines.

**Table 7: Distribution of admitted CO<sub>2</sub>-emissions from fossil fuels between industrial and developing countries: Three Scenarios, three distribution criteria**

	Global emissions billion tons	Allocation of emissions			
		Industrial countries billion tons	(percent)	Developing countries billion tons	(percent)
<i>Scenario A: Bach, 1988</i>					
Departure point 1982:	17.4	12.6	(72.4)	4.8	(27.6)
Target 2100:	0.008				
Allocation according to					
Criterion I		0.0054	(72.4)	0.0021	(27.6)
Criterion II		0.0022		5.3 <sup>a</sup>	
Criterion III <sup>b</sup>		0.0019	(25.3)	0.0056	(74.7)
<i>Scenario B: EPA, 1989</i>					
Departure point 1982:	17.4	12.6	(72.4)	4.8	(27.6)
Target 2100:	12.2				
Allocation according to					
Criterion I		8.8	(72.4)	3.4	(27.6)
Criterion II		6.9	(56.5)	5.3 <sup>a</sup>	(43.5)
Criterion III <sup>c</sup>		3.1	(25.3)	9.1	(74.7)
<i>Scenario C: Mintzer, 1987</i>					
Departure point 1982:	17.4	12.6	(72.4)	4.8	(27.6)
Target 2075:	34.6				
Allocation according to					
Criterion I		25.1	(72.4)	9.5	(27.6)
Criterion II		19.0	(54.9)	15.6	(45.1 <sup>e</sup> )
Criterion III <sup>d</sup>		8.7	(25.3)	25.9	(74.7)

**Notes:**

a = absolute increase of 10%; b = 1.6 kilogram CO<sub>2</sub> per capita; c = 2.5 tons CO<sub>2</sub> per capita; d = 7.2 tons CO<sub>2</sub> per capita; e = increase of share by 100%.

Source: Compiled from Hartje, 1989

That is to say, more is needed than just a relative decoupling of energy consumption from the GNP, what actually has already happened in several industrial countries. For ecological reasons, economic growth in the medium and long term should be possible only if the reduction in energy consumption and in environmental damage is *absolute*. (It's not in the range of this chapter to address these basic questions of changes in economic structure, technology, and lifestyle.)

Up to now, only CO<sub>2</sub> emissions from *fossil fuels* have been dealt with. In their case, *freezing* and *reduction* are the issues. With CO<sub>2</sub> emissions from *biotic sources*, however, *phasing out* and a *reversal of trends*, i.e., negative growth rates must come into the picture.

To strive only for a reduction in emissions would be too modest in view of a possible net-assimilation of carbon in the biomass. Even the introduction of distribution criterion III mentioned above would not make sense here, as positive emissions fall very much behind the possibility of negative per capita emissions (by enlarging carbon-sinks through reforestation, for instance). An *additional* criterion might therefore consist in linking the obligation to stop deforestation in the developing countries with the obligation of afforestation in the industrial countries.

Another possibility consists in a direct link with the right to CO<sub>2</sub> emissions from fossil sources: *Biotic* emissions (resulting from slash-and-burn agriculture, deforestation, changes in land use) reduce the right to per capita emissions of CO<sub>2</sub> from *fossil* sources—and *vice versa*: reforestation and afforestation increase it.

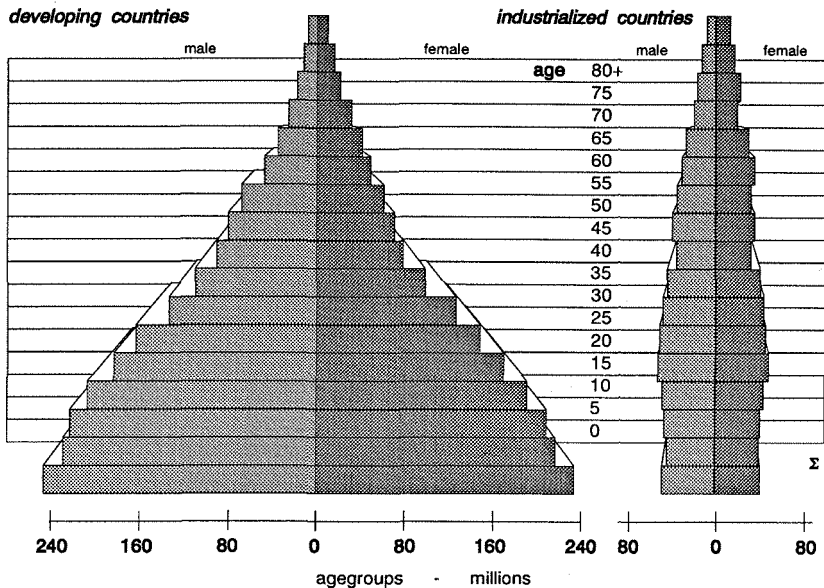


Figure 2: Population pyramid, mid-1980s

Source: United Nations

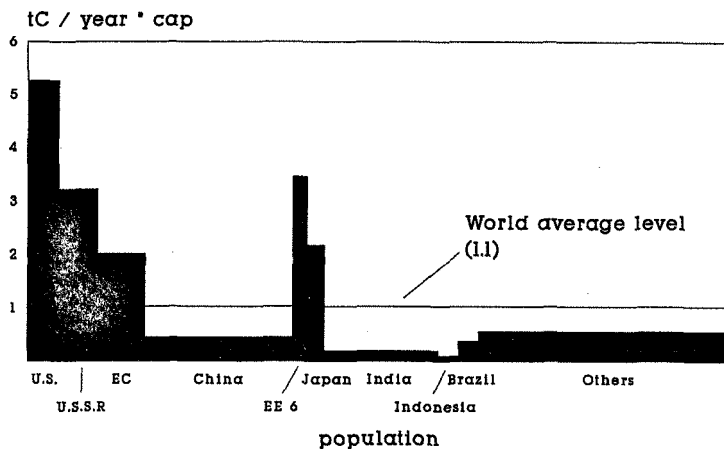
There is *another* allocation criterion which might come into prominence in the process of negotiating the CO<sub>2</sub> protocol, i.e., an *age criterion* (cf. Grubb, 1989). As is well known, the population structure of the developing countries differs widely from that of the industrial countries; *Figure 2* shows the dimensions involved. In view of the fact that the population of the developing countries in average is much younger, an equal per capita emission right might prove ecologically counterproductive, i.e., giving an incentive to keep a high level of population growth. The industrial countries might, therefore, tend to introduce a *minimum age criterion* ("adults emission right"), by which their CO<sub>2</sub> reduction duties could be reduced, or their per capita emission rights be increased. *Figure 3* gives an impression of the dimensions that are at stake if an age criterion is to be considered in the negotiations of a CO<sub>2</sub> protocol between North and South.

Similarly, it could be arranged that the emissions of 1970 and not 1992 should be taken as the basis for defining the reduction duties, so that the incentive for keeping high population growth rates is neutralized.

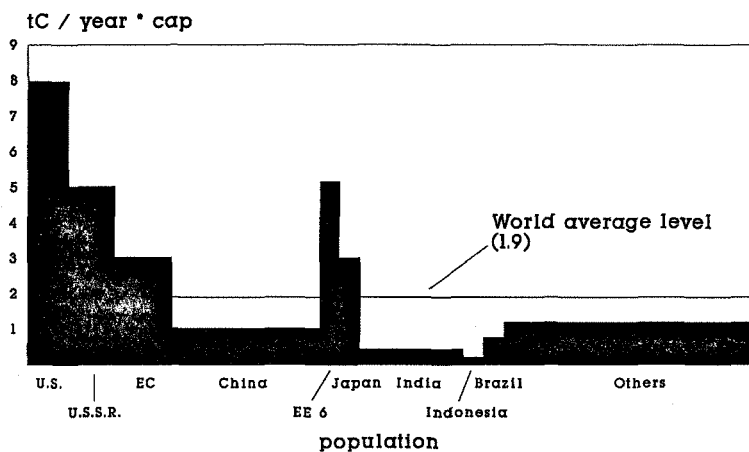
Of course, distributional questions are political questions that require the exercise of social values beyond the individual preferences expressed in the market place. The problem of climate change is so complex that debates on allocation may never come to an end. Therefore it seems to me that a guiding criterion has to be postulated that is as simple as possible and, at the same time, can win a majority in the international political arena. The respective options have been presented above. Some of them seem easier to implement than others. But how to get from here to there?

### **From here to there: confrontation or cooperation**

With regard to global environmental problems, Peter M. Haas recently formulated a "theory of epistemic consensus" (Haas, 1990, pp. 347 ff.). According to his (and my) view, substantial changes have occurred in the process of negotiating international agreements. This evolution of environmental policy competence can be understood as a collective learning process, an evolution that might refute Hardin's thesis of the "*tragedy of the commons*" (Hardin, 1968). Within this process, "*epistemic communities*" have formed transnational networks which are politically relevant because of their authoritative knowledge. If such networks develop, and if they get



(a) No minimum age restriction



(b) Minimum age 21

Figure 3: Per capita emissions, permit ratios and the effect of a minimum age restriction

Source: Grubb, 1989, p. 38

and maintain access to policy makers, global conventions and protocols might have an "efficiency guarantee." Neither "common interests" *per se* (upon which the Brandt Report was based), nor the notion of "sustainable development" (the Brundtland Report), nor "responsibility for our own future" (the Nyerere Report) alone will sufficiently enlarge the chances for international cooperation. Rather, cooperation depends upon the kind and strength of consensus within the "epistemic" community, and that consensus can be strengthened through improved cooperation among the community members.

This theory, it seems, has been verified by the Montreal Protocol process: Political action was prompted by an ecological crisis ("ozone hole"); international experts established the scope of political alternatives, then negotiated by diplomats; and when the members of this *community* had consolidated their position with the national governments, the latter supported the agreements.

Whether this theory will hold true for the "greenhouse effect," and whether it can be verified by the formulation and implementation of a CO<sub>2</sub> protocol, remains to be seen. While a loosely cohering *epistemic community* does exist, the internal consensus is not (yet) nearly as strong as in the ozone case. There even is a rift within the *greenhouse community*: There are (1) the preventionists, pleading for precaution and immediate action in order to avoid or at least confine climate change, and there are (2) the *adaptationists*, arguing for slow and gradual adaptation to a climate change which cannot be avoided anyway. Who will win, who will have the final say? And, to what extent are the elite *epistemic communities* dependent from and/or can rely on vernacular popular understanding of and will for, sustainable development?

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