AN EQUITY AND SUSTAINABILITY-BASED ASSESSMENT OF THE KYOTO PROTOCOL

JOHN BYRNE, LEIGH GLOVER, VERNESE INNISS, JYOTI KULKARNI,
YU-MI MUN, NOAH TOLY, AND YOUNG-DOO WANG

This paper contains our intial ideas and is a work in progress prepared for the International Experts Meeting on Climate Change and Sustainable Development, held in Seoul, South Korea, November 19-20, 2002. The authors intend to publish a subsequent version of the paper.

Acronyms and Abbreviations

AOSIS	Alliance of Small Island States
BAU	Business as usual
CER	Certified Emissions Reduction
CDM	Clean Development Mechanism
CEEP	Center for Energy and Environmental Policy
COP	Conference of Parties
EE	Eastern Europe
EIA	Energy Information Administration
$ESCO_2$	Equitable and sustainable carbon dioxide emission
FSU	Former Soviet Union
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LULUCF	Land use, land-use change and forestry
MtC	Million tons carbon
$MtCO_2$-e	Million tons carbon dioxide equivalent
OECD	Organization for Economic Cooperation and Development
RPS	Renewable energy Portfolio Standards
tCO_2-e	Tons of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organization

Abstract

To date, climate change policy has largely focused on the problem of designing market-based tools to encourage efficient adjustments in the carbon intensity of the global economy. However, participation of developing countries in future stages of the treaty process are likely to hinge on demonstrable equity and sustainability commitments. A method of evaluating the equity and sustainability implications of current climate change policy is offered in the paper, as well as an alternative policy scenario that is believed to better satisfy these criteria of global social and environmental performance.

1. Introduction

The Conference of the Parties[1] (COP) process has promoted market-based policy instruments as the primary means to facilitate cooperation in the reduction of greenhouse gas (GHG) emissions and is now focused on establishing rules for the emerging international emissions market. Major operational uncertainties of the Kyoto Protocol[2] emissions targets and flexibility mechanisms were largely resolved with the COP-7 Marrakech Accord (COP-7).

The COP process may rightly claim success in realizing a treaty of targets and commitments to lower the release of one of the most ubiquitous chemicals associated with human activity. But it is not clear if activity under the auspices of the treaty will in fact reduce emissions. Further, there is a reasonable basis for concern that the treaty may shift the burden of action for greenhouse gas (GHG) reductions to countries with little or no responsibility for the problem. The absence of a penalty for withdrawal by the world's largest GHG emitter – the U.S. – likewise raises doubt about the efficacy of the treaty.

Below we offer an assessment of the possible sustainability and equity implications of the treaty under certain assumptions (also described below). While he UNFCCC contains language pledging an interest in equity and sustainability, these criteria are not given operational definition in the framework. This is not surprising since the research community has found it difficult to realize consensus on both criteria. Our strategy is to adopt a per capita entitlements approach to the question of equity (while also recognizing the need for "common but differential responsibilities") and to utilize an IPCC-based estimate of mitigation action necessary to achieve relative climate stability. Our methodology leads us to conclude that the Kyoto Protocol-Marrakech Accord is unlikely to improve climate equity or sustainability. However, we also find that there are specific

---

[1] The Conference of Parties is comprised of the 161 signatories of the United Nations Framework Convention on Climate Change and is charged with negotiating revisions to the treaty and procedures for its implementation.

[2] The product of COP-3 in 1997, this Protocol set specific greenhouse gas emission reduction targets for Annex B countries (which include nations of the Organization for Economic Cooperation and Development (OECD) and those of the Former Soviet Union (FSU) and Eastern Europe (EE). Membership of the Organization for Economic Cooperation and Development has expanded since 1992 when the UNFCCC was signed. New entrants include South Korea and Mexico, neither of whom has been assigned GHG reduction targets under the Kyoto Protocol. Therefore, in this paper all references to the OECD designate the composition of the organization at the time of the signing of the UNFCCC.

policy changes that could result in the treaty enhancing global prospects for sustainability and equity.

2. Negotiating a Future Climate: An Overview of the COP Process

The Kyoto Protocol (framed at COP-3) sets binding emission targets for 25 developed countries and 13 countries in transition, which are listed in Annex B[3] of the Protocol. Individual Annex B countries were assigned different targets under the principle of "common but differentiated responsibility." Their collective GHG emission reduction target was set at 5% below their aggregate 1990 level. This collective reduction is to be achieved during the Protocol's first budget period (i.e., between the years 2008 and 2012 – see Article 3.1 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997).

At COP-4 in Buenos Aires and COP-5 in Bonn, great attention was given to a range of market-based policy instruments (called "flexibility mechanisms" in the Kyoto Protocol) that would assist wealthy countries in lowering emissions. Under the flexibility mechanisms, Annex B countries are allowed to purchase emission permits from other Annex B countries that presently release GHGs at a rate below their Kyoto targets, or have lower-cost CO_2 reduction options that can be more rapidly realized through emissions trading. Annex B countries may also receive credits toward target reductions through project-based emission reductions or sink expansions in other Annex B countries through Joint Implementation (JI). Finally, Annex B members can earn certified emission reductions (CERs) from project activities in developing countries and apply them in order to comply with GHG reduction targets through the Clean Development Mechanism (CDM).

COP-6 (held in The Hague and Bonn) produced a number of decisions that further shaped national strategies and options under the Kyoto Protocol. The most influential of these was the permission of essentially unrestrained emissions trading. As a result, Annex B participants can take full advantage of available emission permits beyond their borders to meet national commitments (this is a particular problem for efforts to achieve effective emissions reduction, as explained below). One option created with these negotiations was the purchase of emission credits from Russia and other economies in transition whose current releases are well below their 1990 levels. In effect, an Annex B member can assist economies in transition to upgrade technology efficiency and then claim the difference in the resulting GHG emissions at the same time that economies in transition *increase* their emissions to 1990 levels. This so-called 'hot air' is sizable (we estimate it to be 1,160 $MtCO_2$-e, or 34% of OECD reduction commitments, including those for the U.S. and Australia).

COP-6 also allowed national carbon 'sink' enhancements to offset GHG emissions in national GHG accounting. The methodology for calculating sink improvements (for example, through reforestation) is provided in Article 3.3 of the Kyoto Protocol to the

[3] The Annex B nations of the Kyoto Protocol are identical to the Annex 1 nations of the UNFCCC, except for Turkey and Belarus, which are not included in the Annex B group, and Kazakhstan, which voluntarily joined Annex B.

United Nations Framework Convention on Climate Change, 1997. Any claimed activities must have occurred since 1990 and have been the outcome of human activity. COP-6 revisions enabled countries to count changes in all sources of carbon sinks, most notably, land use, land-use change, and forestry (LULUCF), but restricted the level of claims against forest sinks.[4] Inclusion of carbon sinks makes the Kyoto Protocol comprehensive, covering all known elements of the carbon cycle immediately affected by human activity,

Rules were articulated in the 2001 Marrakech Accord (COP-8) that reflect significant compromises thought to be necessary to secure ratification by key countries (e.g., Russia and Poland), the cooperation of which is necessary to bring the Protocol into force. A key consideration at this stage is the potential effectiveness of the policy mechanisms adopted and refined between COP-4 and COP-7 in addressing problems of unsustainability and inequity associated with the current range and level of national emissions of the Parties.

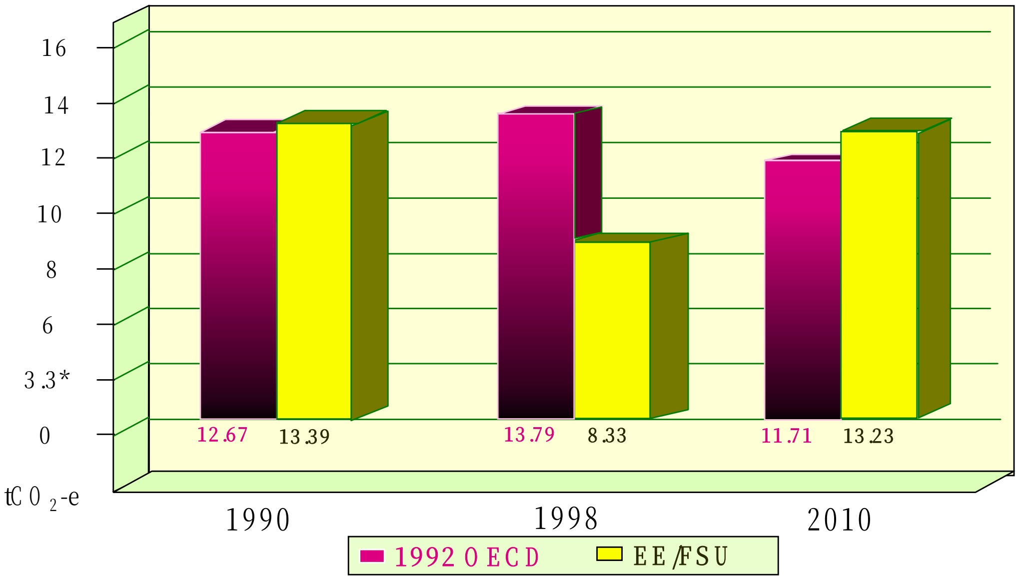
Despite acquiescence to its demands for unlimited trading and a liberal interpretation of LULUCF opportunities, the U.S. withdrew from the UNFCCC negotiations before continuation of the COP-6 meeting in Bonn (2001). Voicing nearly identical economic concerns to those of the elder President Bush in 1992 (at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil), the younger President Bush indicated that the U.S. would follow its own 'voluntary' GHG reduction policy, setting in motion what has become a unilateralist orientation in international affairs. Australia has now also withdrawn.

Several key uncertainties and problems in the Kyoto Protocol were resolved at COP-7 in the Marrakech Accord, chief among them being the measurement of emissions and emissions reductions, questions of compliance and enforcement, and further refinement of regulations governing the deployment of flexibility mechanisms. Despite talk of enforcement, however, the Protocol remains a non-binding agreement. Its legal status will not be decided until after its entry into force, and it is quite possible that both compliance and enforcement will remain entirely voluntary.

COP-7 also continued to polish regulations that govern the Protocol's various flexibility mechanisms and sink allocations. However, many of these decisions have the effect of reducing the level of emissions abatement necessary through domestic measures in developed nations by allowing purchase of foreign emission credits, accreditation for foreign investments that reduce emissions and enhance carbon sinks, and inclusion of an array of domestic carbon sinks as offsets to domestic emissions. For example, through the CDM, Annex B nations can purchase credits from non-Annex B nations for afforestation and reforestation projects, but according to a limit of 1% of a country's target emissions. Emissions trading between Annex B nations can be pursued apart from any supplementarity restriction, and full use can be made of surplus emission credits. Credits earned by any of the above methods can be used immediately, banked for future use (in the Protocol's second budget period, for example), or sold in the emerging emissions permits market.

[4] Forest sink limits for Annex B nations are listed under COP-6's Appendix Z. While most quotas are relatively small, a few nations were allocated significant sinks (notably, Canada – 12 MtC, Japan – 13 MtC, and the Russian Federation 33 – MtC).

Each signatory to the Protocol listed under Annex B has an individual national target for emissions reduction, which amounts to collective reduction of 5.2% below the collective 1990 level of emissions. We converted these national targets into the OECD and FSU/EE groupings and derived the Kyoto Protocol target for each on a per capita basis: 11.71 tCO_2-e for the OECD and 13.23 tCO_2-e for the FSU/EE (see Figure 1). Reasons for the use of per capita emissions are offered below in Section 4.



* Equitable and Sustainable CO_2 Emissions Rate

Sources: 1990, 1998 Emissions Marland, et al., 2001; 2010 Emissions Targets Kyoto Protocol; Population World Resources Institute, 2001; ES CO_2 Rate Byrne, et al., 1998

Figure 1. Actual and Target Per Capita Annex B GHG Emissions Under the Kyoto Protocol

3. Loopholes in the Kyoto Protocol

Faced with the prospect of increasing emissions by the Annex B group, COP negotiators have focused on policy tools acceptable to members of the group that might reverse this trend. Annex B has steadfastly voiced concerns that improper policy actions could harm the group's economies and, for this reason, has been least interested in high domestic emission reduction targets. Instead, the group has preferred 'practical,' 'realistic' targets and market-sensitive policies that enable individual countries to tailor their reduction strategies, including the ability to trade with other nations for the most efficient actions to reduce GHG emissions.

Led by the U.S., Australia, and Japan, Annex B has promoted the view that the transition to a low-carbon future is largely an economic and technological question best handled (with the proper incentives and enforceable rules) in the global marketplace. This shared belief in markets as guides to national action on a global environmental problem reflects Annex B's core commitment to a policy paradigm in which priority is given to resolutions of environmental conflicts that are least-cost and, where possible, conducive to economic growth. While pursuing economic rationality, unfortunately, the Kyoto mechanisms have created significant loopholes in terms of sustainability, two of which are critically reviewed below.

Hot air trading

As a consequence of economic recession in the FSU and Eastern Europe since 1990, GHG emissions have generally fallen below 1990 baselines for assessing national performance in meeting UNFCCC objectives. This means that the FSU/EE bloc need not undertake any domestic GHG abatement programs. Instead, members are in the interesting position of being able to sell emissions *growth* to other Annex B nations whose releases are above the 1990 baseline.

The inclusion of the EE/FSU in Annex B has thus produced an opportunity for 'virtual reductions' (Byrne et al, 2001) that may be substituted for actual decreases in GHG emissions. Specifically, it is possible under the Kyoto Protocol for OECD members to assist EE/FSU members of Annex B to 'efficiently' increase their GHG emissions, while counting this effort as a deduction to OSC members' national emissions accounts. This widely known implication of the trading mechanism permitted under the Kyoto Protocol has created what is now commonly termed 'hot air.'

Under BAU projections by the U.S. Energy Information Administration (EIA), the OECD countries are expected to increase their emissions by 15.8% over the 1998-2010 period, while total GHG emissions in the EE/FSU nations are anticipated to grow by 13.9% during the same period (Marland et al, 2001). In other words, under a business-as-usual (BAU) scenario, OECD countries (including the U.S. and Australia) will exceed their collective Kyoto target by approximately 3,400 $MtCO_2$-e in 2010; while the EE/FSU bloc will release 1,160 $MtCO_2$-e less than their Kyoto target. Thus, 'hot air' is estimated to meet 36.5% of the total GHG reduction requirement for the OECD countries.[5] Of course, 'hot air' availability will increase further if the EE/FSU emission forecast by EIA happens to be high, which is possible since the prospect of additional economic problems for this bloc is considerable.

It is reasonable to expect that 'hot air' will provide the lowest cost emissions credits, after sinks, for Annex B traders. Compared to trades with non-Annex B countries, transaction costs and infrastructure incompatibilities are likely to be lower, and commercial relations more extensive and longer lived for Annex B-to-Annex B trading.

Sinks

In theory, accounting for sinks as an element of the carbon cycle is unimpeachable. Some environmentalists and those seeking to bolster an array of developmental objectives embraced the inclusion of sinks in the UNFCCC as additional support for laudable objectives such as habitat and catchment protection, agro-forestry development, rainforest

[5] This assumes that the U.S. and Australia participate in the Kyoto Protocol. As discussed later, the withdrawal of the U.S. and Australia means that 'hot air' can provide more than 80% of the target reduction for the remaining OECD participants. While most FSU and East European nations in Annex B have some 'hot air' to sell, about 95% of 'hot air' would likely be provided by Russia, Ukraine, and Romania.

preservation, prevention of land clearance, and so on. Indeed, COP-6 reiterated that these activities contribute to the conservation of biodiversity and sustainable use of natural resources and therefore should be included as a means for nations to meet Protocol targets. Climate change policy under this provision offers the opportunity to support other environmental and development objectives while also being responsive to the need for building a 'low-carbon' future. Further, it seemingly offers a way in which climate policy can emphasize domestic action (instead of trading away national responsibility) and at the same time economically meet reduction targets.[6]

A broad array of land-based activities is admissible as sinks and credits for them are largely unrestricted (only sinks resulting from forest management are limited under Appendix Z from COP-6). COP negotiations have only limited sink CDM activities to afforestation and reforestation in this first commitment period (i.e., 2008-2012), and capped available credit by these means to 1% of a country's target reductions.

Since the principle of crediting carbon storage as a means to meet Kyoto targets has been adopted by the COP, the race has been on to register national sinks and to partner with other nations to expand sink capacities and then take credit for them through JI and CDM. The magnitude of available sink credits through these two mechanisms is sufficient to enable certain Annex B members to avoid domestic emissions reduction entirely.

Efforts to incorporate LULUCF into the Convention have been fraught with basic uncertainties in the measurement of sequestration and fluxes, compounding efforts to construct an effective sinks policy. Production of the national GHG inventories, as required under the UNFCCC, has highlighted how indeterminate the LULUCF component is, even for those nations with the best data and research bases. The IPCC's Special Report on the subject provided a sound description of the current state of knowledge, but further highlighted just how few generalizations could be made about sequestration for any given location (IPCC, 2000).

Even if the aforementioned difficulties with the measurement of these factors were resolved, there are a number of ecological concerns that raise doubts about the efficacy of LULUCF measures. For example, the most effective species for optimizing carbon sequestration are fast-growing trees with short rotations, yet this plantation practice will reduce biodiversity. Reconciling the Kyoto Protocol's intention that LULUCF contribute to broader ecological goals with practices to enhance sequestration could prove difficult.

Climate change policy can only be effective if there are permanent reductions in global GHG emissions. At present, the rules that allow carbon sequestration to offset emissions encourage only a temporary reduction of global emissions. Any number of events, such as fire, disease, or climatic factors, can release sequestered carbon into the atmosphere. In a sense, carbon sinks are simply deferred emissions and are therefore incomparable to actual reductions in GHG emissions, because they fail the test of

[6] Research (noted in IPCC, 2000) has suggested that domestic sequestration can offer low-cost emission offset options.

permanence. Sinks allow GHG emissions to be greater than would otherwise be permitted and pass to future generations an increased burden.

Notwithstanding concerns raised by the IPCC, the COP is proceeding on the basis that quantification, measurement, and verification of sequestration is now possible. This policy appears to be driven less by accurate knowledge than confident expectations of profit. Techniques for objectives measurement of long-term changes in soil carbon have yet to be established and would require medium- to long-term monitoring if the aim were an evidence-based policy.

4. Equity and Sustainability in the Greenhouse

In principle, it would seem that a treaty with commitments to sustainability and equity would not include hot air trading and might postpone the inclusion of sink offsets until firmer evidence for their measurement was available. However, this raises the broader question of defining what is meant by 'sustainability' and 'equity.' The controversy in this matter is substantial and we do not presume that a consensus has been found. Still, we are prepared to offer operational definitions of these two criteria for the purpose of allowing an assessment of the treaty's likely effects. Hopefully, in this way a constructive debate of the treaty's current and, perhaps more important, future implications can be engaged.

With respect to sustainability, we suggest an operational definition that limits global GHG emissions to levels consistent with the known properties of the carbon cycle. With respect to equity, we propose a definition that determines country-specific emission targets in a manner that is broadly consistent with an assignment of per capita entitlements. Both definitions have been discussed elsewhere (see, e.g., Byrne et al, 1998).

To establish a numerical benchmark for sustainability reflecting the above definition, we turn to the work of the Intergovernmental Panel on Climate Change (IPCC). The reduction necessary to achieve long-term stabilization of atmospheric GHG concentrations has been reported by this body to be more than 60% of 1990 CO_2 (and CO_2 equivalent) emissions (IPCC, 1992, 1996). With the emissions reduction target for the first commitment period under the Kyoto Protocol set at 5.2% reduction for Annex B, it is clear that the Kyoto Protocol's target reductions are not sufficient to arrest the process of climate change. Yet, if the UNFCCC is conceived as a process of continuous actions and increasing commitments, it is possible to consider whether the treaty is making progress toward sustainability by evaluating the likely extent of reductions in the first budget period and comparing them to the long-term goal.

A frequently cited equity approach to allocating the global burden of emissions reduction among nations is per capita responsibilities. Each nation's climate action responsibility is established on the basis of a 'global atmospheric commons regime' to which all peoples have equal access and share equal responsibility. Using 1990 world population, it is possible to assign carbon 'budgets' by country.

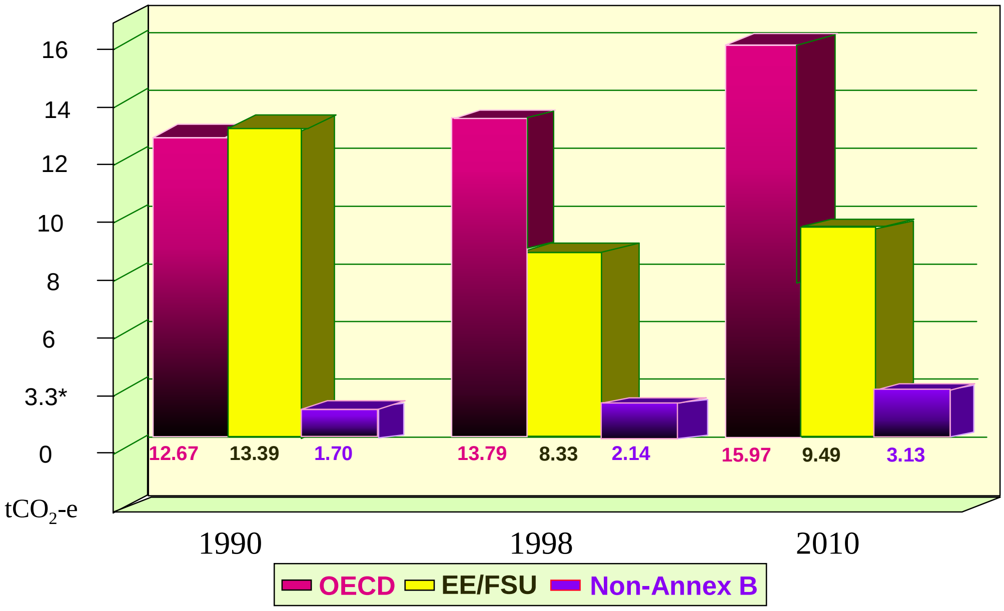
Combining these two norms – a sustainability commitment based on the IPCC's estimate of a 60% emissions reduction requirement and a democratic commitment of per capita emissions equality, an equitable and sustainable GHG emissions rate, or $ESCO_2$, can be estimated as 3.3 tons of carbon dioxide and equivalents (tCO_2-e) (see Byrne et al, 1998). We use a longer-term 2050 stabilization target year for per capita equity to be realized. Progress in the first budget period of the UNFCCC (2008-2012) can then identified. The emissions of transitional economies and developing countries may be expected to rise above 3.3 tCO_2-e in the first budget period, but these nations would eventually be asked to arrest this trend and begin a steady decline to the $ESCO_2$ rate.

5. Identifying Greenhouse Debtors

By an $ESCO_2$ standard, emissions trends of Annex B nations are troubling. Since signing the UNFCCC in 1992, GHG emissions from the OECD countries have posted steady annual increases. Of this group, only a few can claim to be on a path of emissions reduction (arguably Germany, the United Kingdom, and Sweden). Other countries such as Australia, Canada, Greece, Ireland, Portugal, and Spain increased their emissions by more than 10% between 1990 and 1998. Most obvious in its continued emissions growth is the U.S, which posted a 13.1% increase over the same period.

Neither the economic nor GHG profile of the Annex B group is uniform. The OECD bloc has seen substantial economic growth over the decade since the Earth Summit, while the economies of the former Soviet Union and Eastern Europe have languished. This bifurcation in economic paths has its parallel in GHG emissions. While emissions of the OECD group have grown by 8.8% between 1990 and 1998, those of the EE/FSU have actually declined by 37.8%.

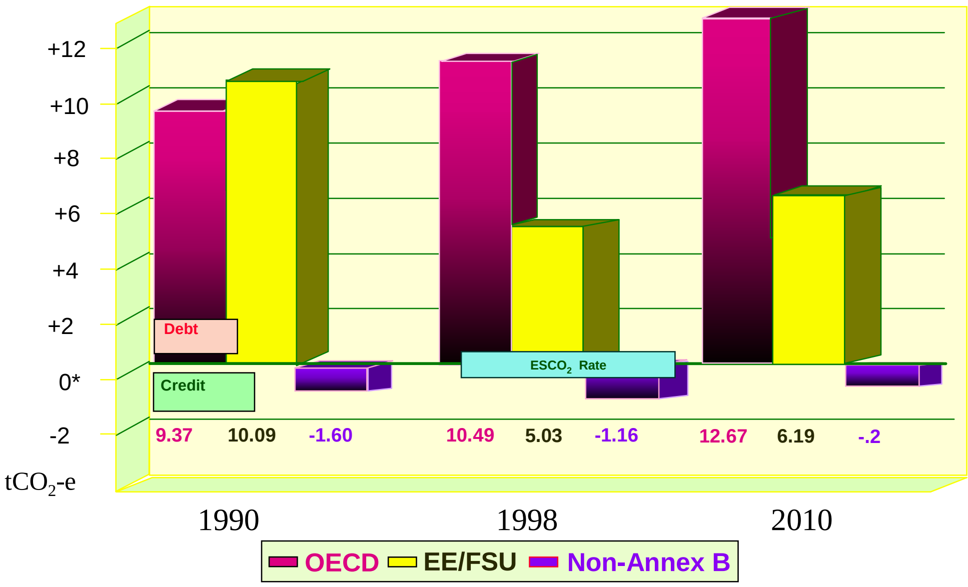
With collective GHG emissions from the OECD group still rising, global emissions are also growing. Unfortunately, the current policy architecture based on unrestrained flexibility mechanisms and the inclusion of sink measures further augments this unsustainable trend. Using current and forecasted emissions data, it is possible to consider the implications of the decisions of the COP for the task of meeting the Kyoto Protocol targets for the first commitment period in 2010. Converting national emission rates to per capita releases for the OECD, EE/FSU, and non-Annex B country groups, an inequitable and unsustainable GHG emissions trend is evident (see Figures 2a and 2b). Per capita emissions from the OECD grew from 12.67 tCO_2-e in 1990 to 13.79 in 1998, and are forecast by the EIA to continue increasing to 15.97 tCO_2-e by 2010 (EIA, 2001). In contrast, the per capita emissions of developing nations (non-Annex B under the Kyoto Protocol) will rise to only 3.13 tCO_2-e by 2010. Economic recovery within the EE/FSU will boost emissions, but at 2010 these are projected to remain substantially below their 1990 total. In Figure 2b, these developments are shown in relation to the $ESCO_2$ rate of 3.3 tCO_2-e per capita, which furnishes a portrait of environmental debtors living well beyond the sustainable rate deduced from the earth's carbon chemistry. Bars in this graph that extend upward from the $ESCO_2$ rate demonstrate the amount of environmental 'debt' incurred by the OECD and EE/FSU blocks, and the bars below the $ESCO_2$ rate show 'credits' maintained by non-Annex B societies.



* Equitable and Sustainable CO_2 Emissions Rate

Sources: 1990, 1998 Emissions – Marland, et al, 2001; 2010 Emissions Projections – EIA, 2001; Population – World Resources Institute, 2001; $ESCO_2$ Rate – Byrne, et al, 1998

Figure 2a. Projected Global Per Capita GHG Emissions Under Business-as-Usual Assumptions



* Equitable and Sustainable CO_2 Emissions Rate

Sources: 1990, 1998 Emissions – Marland, et al, 2001; 2010 Emissions Projections – EIA, 2001; Population – World Resources Institute, 2001; $ESCO_2$ Rate – Byrne, et al, 1998

Figure 2b. Projected Global Per Capita GHG Debtors and Creditors Under an $ESCO_2$ Standard

6. An Equity and Sustainability-Based Assessment of the Kyoto Protocol

A comparison of current and forecasted Annex B emissions with the $ESCO_2$ emissions rate offers a ready means to assess the sustainability and equity implications of the Kyoto Protocol. At present, there is a substantial disparity in national per capita releases of GHGs by region and income. For example, average annual per capita emissions of OECD countries were 13.79 tCO_2-e in 1998, nearly four times the $ESCO_2$ rate. Whereas average non-Annex B 1998 per capita emissions were 2.14 tCO_2-e, roughly 36% below the $ESCO_2$ rate of 3.3 tCO_2-e. A policy response described as "contraction and convergence" (Meyer, 2000) would seem logical, whereby countries that exceed sustainable per capita emissions rates would be obliged to undertake reductions, while those below this rate are permitted increases, so that both groups 'converge' on the same sustainable emissions level. Through this process, total emissions contract to achieve climate sustainability.[7]

Instead of realizing the goal of contraction and convergence, however, the Kyoto flexibility mechanisms – made even more flexible at Marrakech – have introduced the possibility of worsening inequality between Annex B and non-Annex B countries and slower progress toward sustainability. The application of unlimited emissions credits trading will allow OECD countries to increase emissions to the level of BAU projections, and offset the increase with 'hot air,' sink allotments and CDM and other trading. If Annex B, including the U.S. and Australia, takes advantage of the low-cost options of the flexibility mechanisms, per capita CO_2-e emissions will escalate to 12.67 tons per year above the $ESCO_2$ rate by 2010 (see Figure 3a). The forecasted rise in OECD emissions is likely to be the largest contribution to international unsustainability in 2010. At the same time, non-Annex B emissions might increase less quickly if CDM investments actually transfer the promised clean energy technology envisioned in the Kyoto Protocol.

In 1990, OECD per capita emissions were nearly 9.5 tons above the $ESCO_2$ rate. Rather than decreasing per capita emissions by 5% by 2010 (i.e., the Kyoto target for Annex B), OECD countries could increase per capita emissions by 26% and comply with the treaty. 'Hot air' would probably be the largest offsetting factor, accounting for 36.5% of the 'virtual' GHG reduction requirements for OECD countries (assuming that the U.S. and Australia are participants). Sink accounting will benefit both the OECD and EE/FSU blocs, with 6.4% of the OECD's 'virtual' reduction possibly derived from this source. CDM projects could furnish the remaining 'virtual' reductions.[8] In one plausible scenario (see Figure 3a) the OECD group, on net, *increases* its per capita emissions under Kyoto. The ironic result is that a measure of burden shifting could ensue in which Annex B releases grow while non-Annex B emissions slow.[9]

---

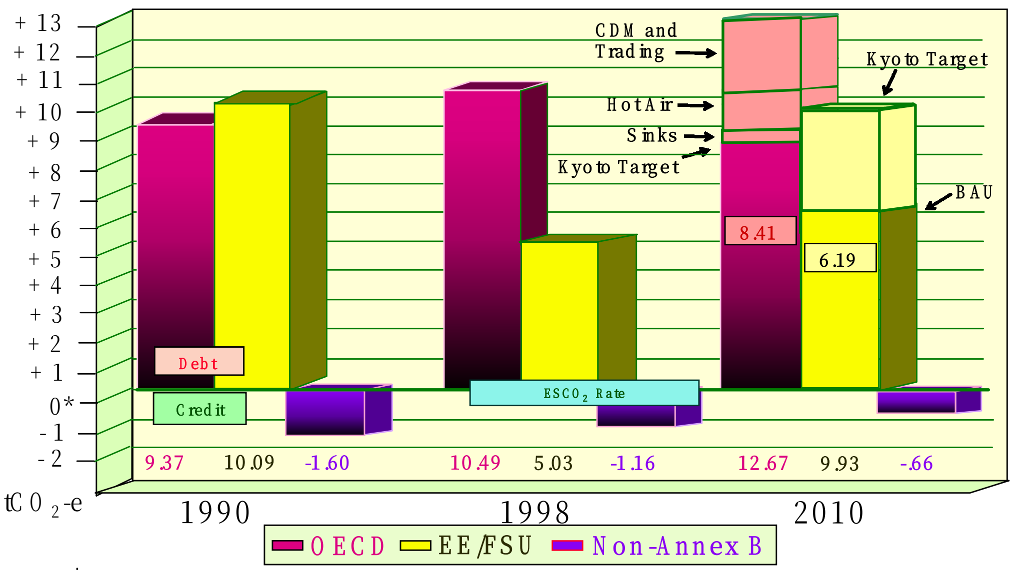
[7] However, near-term Annex B emissions will likely be allowed to climb above the $ESCO_2$ rate. It can be argued that it would be unfair to force change in carbon intensity among non-Annex B countries at a rate that the Annex B bloc has yet to experience.

[8] This and other policy projections in the paper assume that CDM will account for 100% of the remaining reduction obligations of OECD countries after the purchase of 'hot air.'

[9] Whereas anticipate increased GHG emissions, Nordhaus projects modest reductions of 1.5% from BAU projections in 2010; if forestry offsets are included, he expects a decrease of only 0.8% (Nordhaus, 2001).

After CDM and Annex B-to-Annex B trading credits are generated and transferred to OECD countries to offset BAU growth, the average annual per capita emission of the non-Annex B countries is projected to remain below the $ESCO_2$ rate. Thus, the likely result of the Kyoto Protocol is for the non-Annex B group to contribute to lower emissions while the Annex B bloc maintains unsustainable emissions rates.

Figure 3b depicts the case where the U.S. and Australia fail to participate. In this case, the remaining Annex B participants in the Protocol would realize a smaller per capita deficit, with emissions above the $ESCO_2$ rate reaching 10.85 tons per capita per year. Non-Annex B per capita emissions rise faster in this scenario because more than 80% of the Annex B reduction target (with the U.S. and Australia not participating) is met with the purchase of 'hot air.' As a result, a very small amount of CDM trading is expected. In this case, the OECD group is expected to exceed the $ESCO_2$ rate by 12.67 tCO_2-e in 2010, while the EE/FSU is not likely to surpass their 1990 levels (we expect 9.93 tCO_2-e beyond the $ESCO_2$ rate). By contrast, non-Annex B nations are likely to remain below the equitable and sustainable emissions rate of 3.3 tons per person per year. In effect, uncapped flexibility mechanisms are likely to nullify any substantial claim on the part of the Protocol to sustainability or equity, abandoning the need for the OECD to reduce emissions, substituting instead a 'virtual reality' of 'efficient' emissions adjustments that disguises a 'real' reality of actual emissions expansions (Byrne et al, 2001). Figure 3b demonstrates the likely outcomes of a policy regime that does not include the United States or Australia, both of which have reneged on any commitment to the Kyoto Protocol.



* Equitable and Sustainable CO_2 Emissions Rate
Sources: 1990, 1998 Emissions Marland, et al., 2001; 2010 Emissions Projections EIA, 2001; Population World Resources Institute, 2001; $ESCO_2$ Rate Byrne, et al., 2001

Figure 3a. Possible Per Capita Global GHG Emissions When Kyoto Flexibility Mechanisms are Fully Employed and the U.S. and Australia Participate

The emissions inequity of the Protocol is only part of the problem. While OECD countries are the least vulnerable to pernicious effects of climate change, developing countries are often directly exposed to the phenomenon's harmful consequences (such as sea-level rise, intensified storm seasons and drought cycles). The Protocol's architects may defend the package as a 'first step' and the only practical pathway politically available at this time. But even if it is supposed that an efficient allocation of resources will prevail because of the flexibility mechanisms, and emissions reductions will therefore occur at considerably more cost-effective levels, this may represent an untenable tradeoff. The scenarios depicted in Figures 3a and 3b suggest deepening social and ecological risk, especially for the least advantaged two-thirds of the world's population.

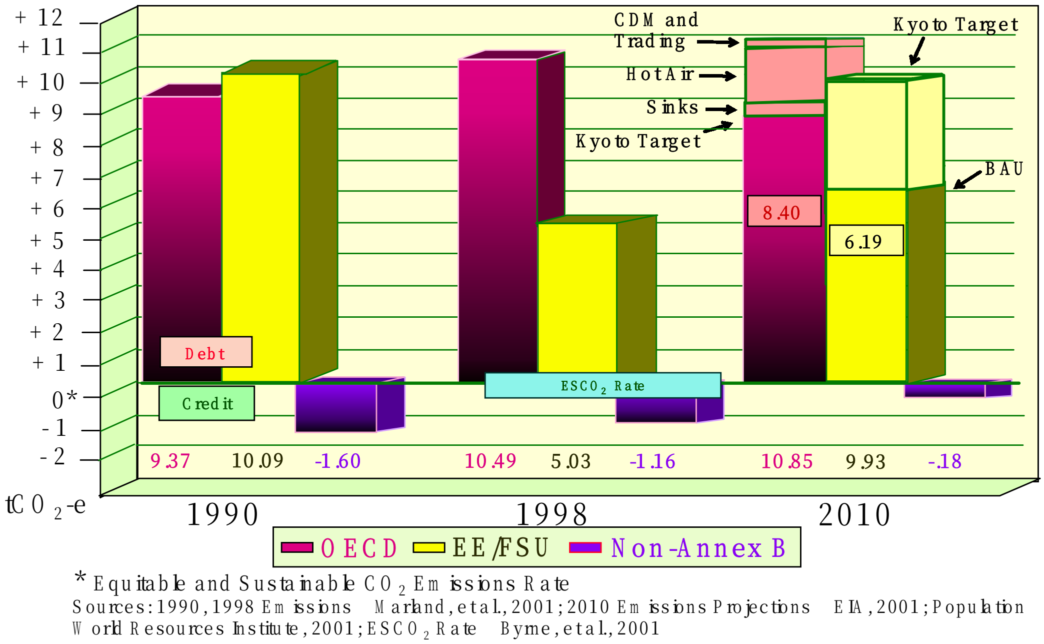


Figure 3b. Possible Per Capita GHG Emissions of the Treat Parties When Kyoto Flexibility Mechanisms are Fully Employed and the U.S. and Australia Withdraw

7. A Failure to Govern: U.S. Withdrawal and the Kyoto Protocol

COP-7's major contribution to future climate change governance was arguably its establishment of a compliance regime for the Kyoto Protocol. While it remains a voluntary treaty, the legal status of which will not be decided until the first Meeting of the Parties to the Kyoto Protocol after its entry into force, the basic elements of an enforcement system were delimited in Marrakech, including an effort to penalize nations failing to meet their emission reduction commitments in the first commitment period. Countries that exceed emissions quotas in the first budget period (2008-2012) will be required to compensate for the excess in the second period, 2013-2017, while assuming a penalty equal to 30% of the shortfall and being excluded from emissions credits trading until compliance is realized. A basic institutional design for overseeing the compliance system was also agreed, featuring committees, expert reviewers, voting procedures, appeals, and other matters. Several commentators have commended the efforts at COP-7, some proclaiming the compliance system a breakthrough in international environmental policy (see Dessai, 2001; Ott, 2002; Wiser, 2002).

Despite COP-7's successful design of a compliance system, a basic flaw remains – there is no guidance on a key problem facing climate change governance today, namely the withdrawal of the U.S. and Australia from the Kyoto Protocol. In this respect, the Protocol is fundamentally weakened by not having devised a penalty for the instance of the refusal of major GHG emitters to participate in the emissions reduction regime.

U.S. President George W. Bush marked his incoming foreign policy stance with an immediate decision to withdraw the U.S. from the Protocol prior to the Bonn COP-6 meeting. Further, the Administration has since proposed a new national energy plan that gives priority to increasing energy supply from fossil fuel use. Two reasons were advanced for the Administration's foreign policy decision: the threats to the national economy in responding to the Protocol; and the supposed inequity of only requiring wealthy nations to reduce emissions in the first budget period.

The absence of the U.S. and Australia from the UNFCCC process is possibly temporary. Abundant low-cost opportunities for U.S. emissions reduction through energy conservation and improved energy efficiency have been identified by leading U.S. research institutions (e.g., IWG, 1997; 2001) and it is likely that Australia has similar cost-effective, energy efficiency based alternatives. Moreover, the market-based policy mechanisms developed under the Kyoto Protocol will spur a new and sizable global market of GHG emissions trading, creating many opportunities for the economies of both countries, and their corporations, to profit from carbon trading. Indeed, the world's first carbon trade in London was executed by the local office of the U.S. corporate giant, DuPont (Cormier and Lowell, 2001). Far from being an aberration, U.S. firms can be expected to participate in the profits available in the emerging carbon trading market to the extent possible under U.S. foreign policy. Firms will lobby both governments to be allowed to participate without restraint, an activity doubtless already underway. Indeed, trading with the former Soviet bloc was anticipated by the Clinton administration to provide as much as 56% of its Kyoto commitments (Kopp and Anderson, 1998). Through such trades and other market-based policies available under the Protocol, there is the arresting possibility that the U.S. could meet its Kyoto obligation for reducing emissions by actually increasing its carbon emissions by 10% (Flavin and Dunn, 1998; Pearce, 1998).

COP-7's failure to deal with the withdrawal of the U.S. and Australia has several consequences that the global community needs to contemplate. Because COP-7 demurred on a domestic reduction obligation, the world has greater assurance of a burgeoning global carbon market than of real GHG emissions reduction. The U.S. and Australia will be uniquely advantaged by their decision to withdraw from this global agreement because of the weakness of the COP-7 decisions on the compliance system. Although no longer required to incur the costs of emissions reduction that all other major economies have agreed to undertake, there are no provisions in the Kyoto Protocol to prevent the two withdrawn parties from profiting in the global carbon market. At the same time, the U.S. and Australia can market products at higher carbon intensities, and *lower prices*. Clearly, the circumstance represents a failure of governance.

8. Incentivizing Participation

Not unexpectedly, the prospect of advantages accruing to the U.S. and Australia because of their withdrawal from Kyoto has drawn sharp criticism and some efforts to prevent its occurrence. Members of the European Commission have publicly expressed their anger over the action. For example, EU Commissioner for the Environment, Margot Wallstrom, has said that President Bush's declaration is a "very, very serious statement and totally unacceptable to the outside world and I think this is what we have to make absolutely clear" (Castle, 2001).

Several civil organizations have filed a class action suit in a U.S. district court against the U.S. Export/Import Bank and the Overseas Private Investment Corporation, citing violation of the U.S. National Environmental Policy Act over the global warming consequences of their loans for fossil fuel energy projects (EV World, 2001). The island nation of Tuvalu announced it would take legal action against the U.S. and Australia on their responsibility for global warming and the consequences of the inundation of their homelands (Reuters News Service, 2002).

There is a pressing need to reform the compliance system so as to prevent the U.S., Australia and other nations from undermining the integrity and effectiveness of policies aimed at restoring the atmosphere to commons status. Several precedents exist for cases where nations are in contravention of international environmental agreements and offer lessons in considering penalties for U.S. intransigence.

Under the Montreal Protocol, nations who are party to the agreement may not trade with non-Parties in substances controlled by the Protocol. Similarly, the Basel Convention on the Transboundary Movement of Hazardous Wastes prohibits the movement of waste between Parties to the Convention and non-Parties without special agreements being in place. And the Convention on International Trade in Endangered Species of Flora and Fauna imposes strict limits on relations between participating nations and non-parties. Researchers have considered ways of applying such restrictions to countries electing not to participate in the Kyoto Protocol (see Dannenmeier and Cohen, 2000).

9. Proposals for Increasing Equity and Sustainability

The Kyoto Protocol cannot resolve the problem of rising emissions and lacks the substantive commitments needed to reach climate stabilization in a sustainable and equitable manner. Attempts to limit the use of the flexibility mechanisms to fulfill the commitments of the Parties have repeatedly been thwarted. What remains of these efforts is included in the Marrakech Accords under the principle of supplementarity, consistent with Articles 6.1 (d), 17 and 12.3 (b) of the Kyoto Protocol.[10] While this decision rhetorically supports some measure of sustainability and equity, the effectiveness of the

[10] Decision 15/CP.7 stipulates that "the use of the mechanisms shall be supplemental to domestic action and that domestic action shall constitute a significant element of the effort made by each Party included in Annex B to meet its quantified emission limitation and reduction commitments under Article 3, paragraph 1" (UNFCCC, 2002).

principle is likely to be minimal since there is no quantitative definition of "significant element," but there are decisions approving unlimited trading.

We conclude that a different policy strategy is necessary. Below we present analyses of two approaches to bring the international policy response to climate change closer to the goals of equity and sustainability. Table 1 summarizes the policy mechanisms used in a 'Reforming Kyoto' scenario, intended for near term consideration, and 'Beyond Kyoto,' a proposal that is more aggressive, and costly. In the first approach, the basic architecture and targets of the Kyoto Protocol are maintained, with revisions made to those existing policy initiatives in order to promote equity and sustainability. Under the 'Beyond Kyoto' approach, all nations pursue the goal of contraction and convergence consistent with IPCC findings and the principles of equity and sustainability advocated by Agarwal and Narain (1991) and our own previous work (CEEP, 2000; see also Byrne, 1997). Both policy scenarios assume that a penalty structure is found that is sufficient to persuade both the United State and Australia to ratify the Protocol.

Table 1. Characteristics of Two Equity and Sustainability Policy Approaches

Features	**Reforming Kyoto**	**Beyond Kyoto**
Nations involved	Annex B	All nations
Emission target	As per Kyoto Protocol	$ESCO_2$ rate
'Hot air' trading	Not used	Not used
Joint Implementation	Not used	Not used
Sinks (national and other party)	Not used	Not used
Clean Development Mechanism	Capped at 25% of Kyoto Protocol national per capita reduction target	Capped at 25% of $ESCO_2$ per capita reduction target
Renewable Energy Portfolio Standard	Not used	Included

Reforming the Kyoto Protocol

The effective 'expansion and divergence' generated by the current architecture of the Kyoto Protocol can be reduced to some degree by prohibiting or capping the use of flexibility mechanisms and obliging Annex B countries to adopt domestic emission reduction measures. Excluding 'hot air' trading, JI, and carbon sinks would require OECD nations to reduce emissions largely through effective domestic actions. Capping CDM's contribution to national emissions reduction at a quarter of the national emissions reduction target necessitates that 75% of activity to reduce greenhouse gas emissions is undertaken domestically. This is the percentage promoted by CEEP in its 2000 position paper.

Under the 'Reforming Kyoto' approach, genuine GHG emissions reduction from BAU levels can be achieved, as the results shown in Figure 4 indicate. OECD per capita

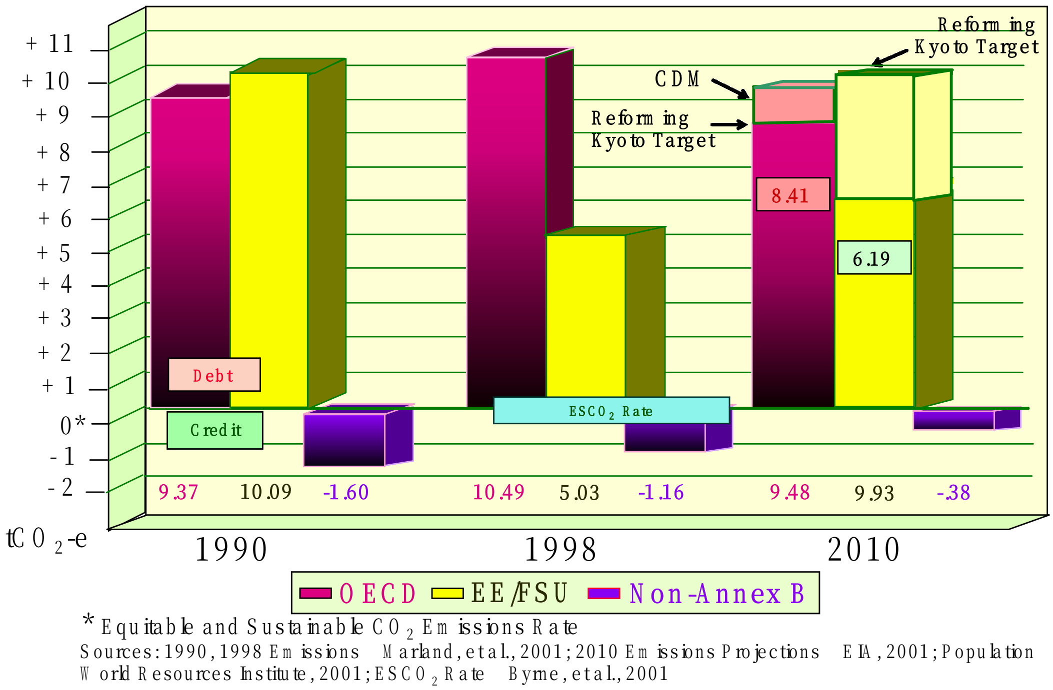


Figure 4. Projected Per Capita Global GHG Emissions Under a 'Reforming Kyoto' Scenario (1990 – 2010)

emissions under this approach are stabilized at 9.48 tCO_2-e above the equitable and sustainable rate, an improvement over the Kyoto Protocol, but far short of the $ESCO_2$ target. EE and FSU nations, which under the Kyoto Protocol will have per capita emissions of 6.19 tCO_2-e above the $ESCO_2$ rate at 2010, are held steady under the reformed Kyoto Protocol approach. Developing countries experience some increase in emissions, but remain greenhouse creditors.[11]

Beyond the Kyoto Protocol

A more aggressive approach can be illustrated that features equity and sustainability using IPCC's estimate of required reduction for climate stability. This approach sets higher emissions reduction targets (at both aggregate and individual levels) than the Kyoto Protocol and allocates national emission reduction targets according to a per capita principle of equity.

In this approach, global GHG emission targets are set to achieve stabilized atmospheric concentrations by 2050 and are allocated nationally on per capita levels established on the basis of equity, according to the approach and levels in Byrne et al (1998). Nations whose per capita emissions exceed the allocation necessary to reach the global stabilization goal must reduce emissions, while nations whose per capita allocations are below target levels are permitted to increase theirs. We utilize a transitional per capita

[11] The higher emissions rate for non-Annex B countries under 'Reforming Kyoto' than under our projections in Figure 3 is due to a cap on CDM. However, this presumes that emissions in Southern countries will only fall if technology transfer from the North occurs. Recent experience in China suggests that this assumption may be false (see, e.g., Dunn, 2002). In this regard, the projection for developing countries should be regarded as conservative.

equity and sustainability target for the year 2010 of 20% below the 1990 national baseline for principal greenhouse debtors.[12] There is a differentiation of responsibility expressed by the requirement for wealthy nations to greatly lower emissions and for developing nations who are currently below the $ESCO_2$ rate to be able to increase their emissions. In CEEP's 2000 position paper, exceedance of the $ESCO_2$ rate is anticipated through 2020, before convergence by Southern nations is expected.[13]

In order to facilitate this transition, several Kyoto mechanisms, and their expansion under the Marrakech Accords, would be dropped. Most notably, our 'Beyond Kyoto' scenario cancels the trade of surplus GHG emission credits, abandons JI, and places a restriction on the use of CDM by Annex B Parties. As to the latter, Annex B nations are able to use CDM for only 25% of the emissions reductions claimed in the commitment period. An additional policy initiative is the requirement of a Renewable Energy Portfolio Standard (RPS) for Annex B nations that establishes an obligatory level of renewable energy development equal to 15% of domestic use in 2010. A given country may exceed the 25% CDM allowance, provided it has matched the excess percentage with an equal increase in their RPS, thereby quickening the pace of renewable energy's entry into the global energy system.

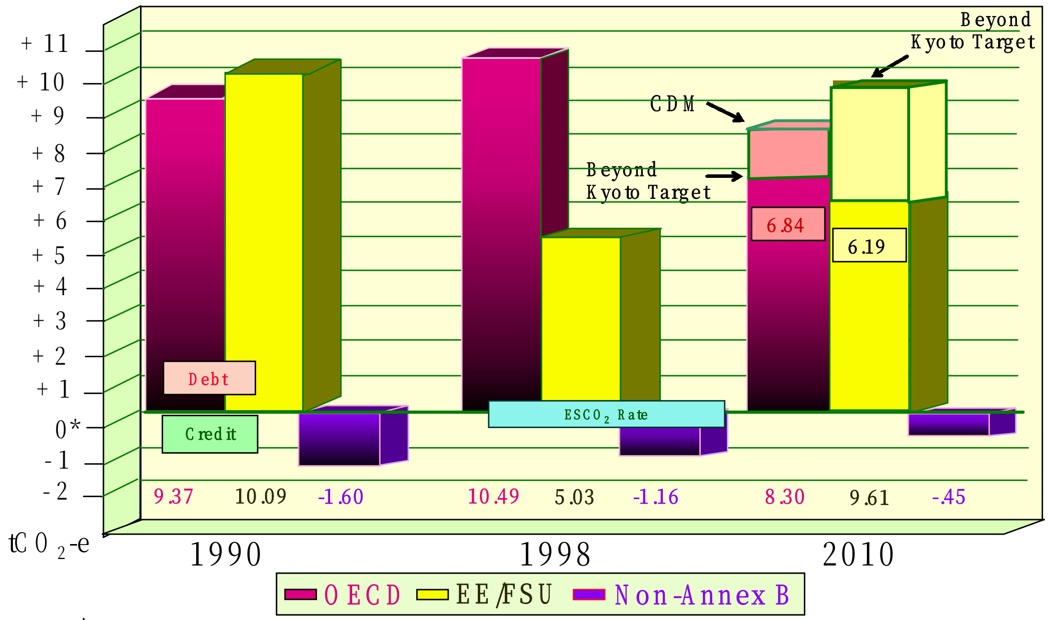
Results of the 'Beyond Kyoto' approach are presented in Figure 5. Before the CDM offset, per capita emissions targets at 2010 for OECD nations under the 'Beyond Kyoto' architecture represent a 20% reduction from 1990 levels. After the offset, OECD emissions remain 8.5% below 1990 levels, assuming full use of the 25% offset allowed for CDM. For the EE/FSU group under the same target, per capita emissions meet a goal of proportional effort to that required of the OECD bloc. Just as the OECD bloc is expected to reduce emissions at roughly three times the Kyoto reduction requirement, we have set the 'Beyond Kyoto' target for the EE/FSU at three times their original Kyoto obligation.

It is possible to compare progress in meeting the goals of equity and sustainability among the policies analyzed here by considering the ratio of per capita emissions of the wealthy and developing nations. Termed an 'Inequality Ratio,' comparisons using this metric are reported in Tables 2a and 2b. While the Kyoto-Marrakech Protocol actually exacerbates inequality, the 'Reforming Kyoto' scenario would represent a 15% reduction in per capita inequality. However, emissions reduction among OECD nations would be modest (only 5% for the OECD bloc before the CDM offset). Our 'Beyond Kyoto' proposal fares much better, reducing inequality by 20%, and lowering OECD emissions by nearly 20% from the 1990 baseline before the CDM offset. These results are consistent with the goals of equity and sustainability.

---

[12] This represents a slight departure from the AOSIS position that requires a 20% reduction by 2005, which was based on the Toronto Targets called for at the 1988 meeting of scientific experts and ministers of government, held in Ontario, Canada (Byrne and Inniss, 2000).

[13] This pathway of sustainability and equity adjusts for historical patterns of overuse of the atmosphere as a carbon store by the Annex B nations. While some may argue that the adjustment is insufficient, our scenarios assume that the South is likely to pursue a non-imitative development path, and therefore the emissions profile of this bloc need not be projected as a copy of the Annex B.



* Equitable and Sustainable CO_2 Emissions Rate
Sources: 1990, 1998 Emissions Marland, et al., 2001; 2010 Emissions Projections EIA, 2001; Population World Resources Institute, 2001; $ESCO_2$ Rate Byrne, et al., 2001

Figure 5. Projected Per Capita Global GHG Emissions Under a 'Beyond Kyoto' Scenario (1990 – 2010)

Table 2a. Allowable Per Capita Emissions under the Existing Kyoto Protocol and Two New Policy Scenarios (assuming U.S. and Australian participation) (tCO_2-e)

Country blocs	**BAU**	**Kyoto Protocol**	**Reforming Kyoto**	**Beyond Kyoto**
OECD	15.97	15.97	12.78	11.60
EE/ FSU	9.49	13.23	13.23	12.98
Non-Annex B	3.13	2.64	2.92	2.85
Inequality Ratio**	**5.10**	**6.05**	**4.37**	**4.07**

Table 2b. Allowable Per Capita Emissions under the Existing Kyoto Protocol and Two New Policy Scenarios (assuming U.S. and Australia do not participate) (tCO_2-e)

Country blocs	**BAU**	**Kyoto Protocol**	**Reforming Kyoto**	**Beyond Kyoto**
OECD	10.85	10.85	9.01	8.21
EE/ FSU	9.49	13.23	13.23	12.98
Non-Annex B	3.13	3.12	3.05	3.01
Inequality Ratio**	**3.47**	**3.48**	**2.96**	**2.73**

* Allowable emissions are those that would be possible given a policy scenario's targets.
** The Inequality Ratio is formed by dividing an OECD emissions rate by a corresponding non-Annex B rate. Perfect equality would be represented by a 1:1 ratio.
Note: These per capita figures are not adjusted for $ESCO_2$ conditions and, therefore, should not be directly compared with rates reported in Figures 2b – 5.

10. Conclusion

Decisions at COP-7 finalized the Kyoto Protocol as a market-based policy regime for addressing climate change. Our analysis suggests that the Protocol's implementation could lead to a further aggravation of inequity and unsustainability. In order to address the complex issue of climate change, international policy must demonstrate an ability to encourage contraction of GHG emissions and global convergence upon a sustainable per capita level.

Table 3. Total Global Emissions Under Various Policy Scenarios in 2010 ($MtCO_2$-e).

	BAU	Kyoto Protocol	Reforming Kyoto	Beyond Kyoto
Policy Regimes without U.S. and Australian Participation	28735.00	28735.00	27429.33	27004.12
Policy Regimes with Full Participation	28735.00	28735.00	25336.95	24082.87
Sustainable Emissions Level	17437.20	17437.20	17437.20	17437.20

Our 'Beyond Kyoto' scenario satisfies this criterion. Per capita emissions equity is advanced. Reductions along a path of sustainability are achieved without unusual or untested policy options (see Table 3). In sum, a new policy regime can redress flaws in the existing Protocol and establish a new GHG emissions trend toward equitable and sustainable rates.

REFERENCES

Agarwal, A., and Narain, S. (1991). *Global Warming in an Unequal World: A Case of Environmental Colonialism*. New Delhi: Centre of Science and Environment.

Byrne, J. (1997). *Equity and Sustainability in the Greenhouse: Reclaiming our Atmospheric Commons*. Pune, India: Parisar.

Byrne, J., and Glover, L. (2000). Climate Shopping: Putting the Atmosphere up for Sale. *Tela: environment, economy, and society*(5). from http://www.acfonline.org.au/publications/tela/intro.htm

Byrne, J., and Glover, L. (2002). A Common Future or Towards a Future Commons: Globalization and Sustainable Development Since UNCED. *International Review for Environmental Strategies, 3*(1), 5 - 25.

Byrne, J., Glover, L., Alleng, G., Inniss, V., Mun, Y.-M., and Wang, Y.-D. (2001). The Postmodern Greenhouse: Creating Virtual Carbon Reductions From Business-as-Usual Politics. *Bulletin of Science, Technology, and Society, 21*(6), 443 - 455.

Byrne, J., and Inniss, V. (2000). Island Sustainability and Sustainable Development in the Context of Climate Change. *Proceedings: International Conference on Sustainable Development for Island Societies, 20 - 22 April 2000, Taiwan*. Chungli, Taiwan: National Science Center and National Central University.

Byrne, J., Wang, Y.-D., Lee, H., and Kim, J.-d. (1998). An equity- and sustainability-based policy response to global climate change. *Energy Policy, 26*(4), 335 - 343.

Castle, S. (2001, March 19). European Union Sends Strong Warning to Bush Over Greenhouse Gas Emissions. from http://www.ecoline.ru/automail/enwl-eng/200103/010320034448.txt

Center for Energy and Environmental Policy (CEEP). (2000). Ecological Justice in the Greenhouse: A Position Paper Presented at the Sixth Session of the UNFCCC Conference of the Parties, The Hague, Netherlands. J. Byrne, Y.-D. Wang, G. Alleng, L. Glover, V. Inniss and Y.-M. Mun. Newark, Delaware: Center for Energy and Environmental Policy.

Cormier, L., and Lowell, R. (2001). DuPont and Marbeni Execute First UK Greenhouse Gas Emission Allowance Trade. New York: Natsource Environmental Division. from http://www.natsource.com/print.asp?n=69&s=2

Dannenmeier, E., and Cohen, I. (2000). *Promoting Meaningful Compliance with Climate Change Commitments*. Arlington, VA: Pew Center on Global Climate Change.

Dessai, S. (2001). *The Climate Regime from the Hague to Marrakech: Saving or Sinking the Kyoto Protocol. Tyndall Centre for Climate Change Research Working Paper No. 12*. Norwich, UK: Tyndall Centre for Climate Change Research. from http://www.tyndall.ac.uk/publications/working_papers/wp12.pdf

Dunn, S. (2002). Reading the Weathervane: Climate Change Policy from Rio to Johannesburg, Worldwatch Paper 160. Washington, D.C.: Worldwatch Institute.

EV World. (2001, August 31, 2001). Class Action Law Suits Filed Against Two U.S. Government Agencies. *EV World*. from http://www.evworld.com/databases/storybuilder.cfm?storyid=402

Flavin, C., and Dunn, S. (1998). Responding to the Threat of Climate Change. In *State of the World*. New York: W. W. Norton and Company.

Intergovernmental Panel on Climate Change (IPCC). (1992). Climate Change: The IPCC Scientific Assessment. In J. T. Houghton, J. G. J and E. J. J (Eds.). New York: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (1996). *The IPCC Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change*. New York: United Nations Environment Program.

Intergovernmental Panel on Climate Change (IPCC). (2000). Land Use, Land Use Change, and Forestry: Special Report of the IPCC. R. T. Watson, I. R. Noble, B. Bolin, N. H. Ravindranath, D. J. Verardo and D. J. Dokken. Cambridge, UK: Cambridge University Press.

Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies (IWG). (1997). *Scenarios of U.S. Carbon Reductions: Potential Impacts or Energy Technologies by 2010 and Beyond*. Washington, DC: United States Department of Energy.

Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies (IWG). (2001). *Scenarios of U.S. Carbon Reductions: Potential Impacts or Energy Technologies by 2010 and Beyond*. Washington, DC: United States Department of Energy.

Kopp, R. J., and Anderson, J. W. (1998). *Estimating the Costs of Kyoto: How Plausible are the Clinton Adminstration's Figures?* Washington, DC: Resources for the Future.

Kyoto Protocol to the United Nations Framework Convention on Climate Change. (1997). from http://unfccc.int/resource/docs/convkp/kpeng.html

Marland, G., Boden, T., and J, A. R. (2001). *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751 - 1998*. Oak Ridge, TN: Oak Ridge National Laboratory. from http://cdiac.esd.ornl.gov/ftp/ndp030/nation98ems.htm
Meyer, A. (2000). *Contraction and Convergence: The Global Solution to Climate Change*. Foxhole: UK: Green Books for the Schumacher Society.
Nordhaus, W. D. (2001). Global Warming Economics. *Science*, *294*(November, 2001)
Ott, H. (2002). *Climate Policy after the Marrakesh Accords: From Legislation to Implementation*. Wuppertal, Germany: Wuppertal Institute for Climate, Environment, and Energy. from http://www.wupperinst.org/download/ott-after-marrakesh.pdf
Pearce, F. (1998). Playing Dirty in Kyoto. *New Scientist, 157*, 48
Reuters News Service. (2002, August 30). Tuvalu Seeks Help in U.S. Global Warming Suit. from http://www.planetark.org/dailynewsstory.cfm/newsid/17514/story.htm
U.S. Energy Information Administration (EIA). (2001). *Annual Energy Outlook 2001*. Washington, DC: United States Department of Energy (DOE). from http://tonto.eia.gov/ftproot/forecasting/0383(2001).pdf
United Nations Framework Convention on Climate Change (UNFCCC). (2002). *Report of the Conference of the Parties on its Seventh Sessions, Held at Marrakesh 29 October to 10 November 2001: FCCC/CP/2001/13/Add.1, Add. 2 and Add 3.*
Wiser, G. (2002). *Kyoto Protocol Packs a Powerful Compliance Punch*. Washington, DC: The Bureau of National Affairs, Inc. from http://www.ciel.org/publications/inter_compliance.pdf
World Resources Institute (WRI). (2000). *Earth Trends: The Environmental Information Portal, Demographic Indicators*, from http://earthtrends.wri.org/pdf_library/data_tables/hd1n_2000.pdf