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Working Paper 1999:9

Making climate change negotiable

The development of the Global Warming Potential index

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ISSN: 0804-452X

CICERO Working Paper 1999:9

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27 May 1999

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Introduction

One important contribution from science to environmental negotiations is the provision of scientific models, methods and concepts that may serve as decision-making tools and that hence may assist policy-makers in developing adequate solutions to environmental problems. In the context of climate change, the Global Warming Potential index has served a significant role in the process of making climate change negotiable. The Global Warming Potential index, which is a methodology for comparing the climate effect of a set of greenhouse gases and for transforming their emissions into a common measure, currently constitutes the foundation for implementation mechanisms adopted in the Kyoto Protocol, such as emissions trading, joint implementation and the clean development mechanism.

The topic of this trial lecture is the development of the Global Warming Potential index, the GWP index, and the political role of this methodology in the development of the climate regime. The history of the GWP index, the political context within which this methodology was first introduced and the political role this methodology has acquired is an interesting case of science–policy interaction which is illustrative of the mechanisms at work in such processes and the possible implications they may have both for the scientific and the political process.

After an introductory note, in which I introduce you to some of the essential characteristics of the problem of a human induced climate change and the political conditions that led to a strong political demand for the GWP methodology, I will discuss the more general notion of solution design models in negotiations, and requirements to their adequacy. In the third part of the presentation I will discuss the GWP index in more detail, and focus particularly on some of the more problematic aspects and shortcomings associated with this methodology. In the fourth part of the lecture, I will return to the political process on climate change, and discuss some implications for the adequacy of the solution design model adopted in the climate regime. In the last and final part of the lecture, then, I will draw some conclusions from this discussion.

The lecture is based on previous and current research at my own institute, CICERO, and secondary literature, in particular work by Simon Shackley and Brian Wynne as well as Steven Smith and Tom Wigley.

Acknowledgements

This publication is a trial lecture, held as part of my oral exams for the dr.polit. degree at the University of Oslo, 27 May, 1999. I am grateful for comments to earlier drafts of the lecture from Arild Underdal, Kristin Aunan, Sjur Kasa, Jan S. Fuglestvedt, Terje Berntsen, Knut H. Alfsen, Jon Birger Skjærseth, Jørgen Wettestad and Steinar Andresen. I also gratefully appreciate technical assistance with figures from Odd Godal and Bård Romstad.

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1 The political demand for the GWP methodology

The problem of a human induced climate change refers to the possible enhancement of the natural greenhouse effect that may result from emissions of a set of greenhouse gases from human activities. Although the problem often is referred to as a problem of emissions of CO₂, it is actually a set of greenhouse gases that may cause the enhanced greenhouse effect. Given that the enhanced greenhouse effect is caused by a set of gases, the relative contribution of each gas to future warming is an interesting research topic. According to Smith and Wigley, the concept of a numerical index to compare the relative contribution of various greenhouse gases to future global warming was introduced by Rogers and Stephens in 1988 (Smith and Wigley, 1997).

When the climate problem surfaced on the political agenda, climate change was one major research topic within the atmospheric sciences. This research community, moreover, was also involved in science–policy interaction in the development of the ozone regime. In the ozone process, the calculation of Ozone Depleting Potentials set an important precedent for the climate process. Within this research community, the climate problem was already defined as a global problem concerning a set of greenhouse gases, for which a comparative methodology was in the pipeline.

This mode of framing the climate problem was accentuated by the emerging political concern for a human induced climate change, and particularly in preparation for negotiations on reductions of greenhouse gas emissions. It soon became clear that abatement costs could vary significantly, both across countries and across gases.

The definition of climate change as a *global* problem was important to developing as well as developed countries. The climate system itself is global, and CO₂ as well as many other greenhouse gases have long lifetimes or adjustment times in the atmosphere. That means that some of the greenhouse gases stay in the atmosphere for a long time after their emission. The impacts of climate change, therefore, will affect countries quite independently from where the gases that cause this effect are emitted. This feature, therefore, was important to developing countries since they could experience significant adverse effects from a climate change they were not responsible for.

This feature was equally important to developed countries, moreover, since it was soon perceived to imply that the *mitigation* of climate change also is independent of where greenhouse gas emissions are *reduced*, and hence that a commitment to reduce such emissions, in principle, can be implemented anywhere. Given that abatement costs would vary significantly across countries, this implied that reductions did not have to be restricted to within a country's own borders, they could be implemented anywhere where reduction costs were lowest and still be equally environmentally effective.

Abatement costs do not only concern the *location* of emission reductions, however, they also concern which *gases* that are reduced. If climate change is seen as caused by a set of gases whose relative contribution can be measured on a common scale, the actual composition of the gases that are reduced becomes unimportant. Abatement costs, however, may vary significantly since some emissions may be less important to the national economy than others.

The definition of climate change as a global problem concerning a set of greenhouse gases that are interchangeable at least when their relative contribution is taken into account, thus emerged as a problem definition with significant political merit. To all developed countries it was important that emission reductions could be implemented wherever such reductions were least costly. It was particularly important to the United States, which is one of the largest contributors to increased atmospheric greenhouse gas concentrations and where emission reductions can be expected to be costly, not least in political terms.

The political feasibility of viewing all greenhouse gases as equal and interchangeable is also easy to understand given the very central role of CO₂ emissions in the national economy. CO₂ emissions represent the heart of any industrialised and industrialising society. Any decision that implies that CO₂ emission reductions can be replaced by reductions in other greenhouse gases that do *not* to the same extent affect the national economy are welcomed by industrialised as well as industrialising countries. In fact, this formulation may seem to represent a crucial element in the process of making the climate change problem negotiable: This understanding of the problem meant that accepting the climate change problem did not imply an acceptance of CO₂ reductions – it meant an acceptance of reductions of *greenhouse gases*. This mode of framing the problem, therefore, served, in important respects, to enlarge the settlement range of the issue.

This mode of framing the problem, however, and the solutions envisaged by this problem definition, also generated a strong political demand for a methodology whereby emissions of different greenhouse gases could be transformed into a common measure. As mentioned, such a methodology, namely the GWP index, was already in the pipeline, and was introduced to the political community in the 1990 IPCC report.

Given the strong political demand for a methodology of this kind, the GWP concept was almost immediately endorsed by the political community. From here on, the close science–policy interaction associated with the GWP methodology takes on its own dynamics and becomes the foundation for a robust solution design model for the emerging climate change regime. The rapid and relatively uncritical political endorsement of this concept also seems to imply, however, that a political meaning for the concept is generated, and that the scientific community thus in a sense loses its control over the concept. In its turn, this also seems to imply that research for the generation of more robust GWP values accelerates, while research on the applicability of the concept as a measure for climatic response, which also includes the more critical perspectives, is marginalised.

Before I introduce you to the details of the GWP methodology and its more problematic features, however, we need to look more closely at the notion of solution design models in negotiations and requirements to their adequacy. What is a solution design model, which function does it serve in negotiations, and what are the requirements for a solution design model to be considered adequate?

2 Solution design models; Requirements to their adequacy

As pointed out by Underdal, one major obstacle to negotiation success is inadequate solution design models (1983). A politically inadequate solution design model is one in which requirements to political feasibility are not included or misinterpreted. Underdal defines a politically adequate model as,

“one which requires of a good solution that it can – on the basis of the best theoretical knowledge available – be expected to generate a configuration of party preferences that can produce a positive joint decision, given the basic rules of the decision-making process” (p. 191).

In other words, an adequate solution design model is a formula by which solutions capable of mobilising sufficient political support to generate agreement among parties with asymmetrical interests may be developed.

It is important to recognise that a solution design model is not constant; it may be further developed and refined, and hence mature during the course of the negotiation process. This is particularly true for negotiations taking the form of a sequential process, such as the climate negotiations. The requirements to an adequate solution design model for getting an issue onto the political agenda, and for generating agreement on a framework convention may be significantly different from what would be required of a solution design model for generating agreement on specific targets and timetables.

In addition to the requirement to an ability to generate solutions that are politically feasible, we may also add two further requirements to adequacy: First, an adequate solution design model should be able to produce an agreement that also can be implemented. Second, an adequate solution design model should be able to generate solutions that, when implemented, actually are instrumental towards solving the problem(s) they were designed to solve.

We thus have three requirements for a solution design model to be considered adequate:

- It must be capable of mobilising sufficient political support to produce agreement;
- It must be capable of generating solutions that also can be implemented;
- It must be capable of generating solutions that are instrumental towards solving the problem(s) for which they were designed.

When I discuss the adequacy of the solution design model for the climate regime later in the presentation, I will concentrate my discussion to the first and last of these requirements.

The GWP index constitutes the scientific foundation for the solution design model adopted for the climate change problem. What is the GWP index, and how does this methodology perform both as a tool for decision-making and as a method for transforming emissions of different greenhouse gases into a common metrics expressing their relative climatic effect?

3 The GWP index

The Global Warming Potential index was introduced as a tool for policy-makers to compare the potential of the various well-mixed source gases to affect climate. It is a relative measure since it expresses the climate effect of a gas compared to that of a reference gas. It is derived from the globally averaged net radiative fluxes at the tropopause, and it describes the effect on the global surface-troposphere system. It expresses the cumulative radiative effect of the gases over a chosen time horizon (usually 20, 100 or 500 years) relative to that of the reference gas, which is CO₂. The GWP for a gas multiplied by the emission of the gas gives this emission as “CO₂ equivalents”.

As a tool for communication and decision-making, the GWP method is almost perfect: It is a simple and understandable formula by which to transform emissions of various gases into one measure. These numbers, moreover, may be presented in simple tables that are easily comprehensible and that policy-makers can apply without further scientific input. The qualities of the GWP index as a vehicle for learning has also been emphasised by scientists. Especially during the initial phases of the process, when policy-makers only began to become aware of the climate problem, the GWP methodology was seen by scientists as a useful instrument to sensitise policy-makers to the fact that the climate problem was not only a problem of CO₂ emissions (Shackley and Wynne, 1997).

In terms of its scientific precision, however, the methodology is associated with significant problems – some of which even scientists seem only recently to have become aware of (Skodvin and Fuglestvedt, 1997).

A much-discussed problem with GWP values is that they are associated with significant scientific uncertainty, particularly as a function of chemical interactions in the atmosphere. The global warming potential for some greenhouse gases is not only a function of the direct warming effect of that gas, it is also a function of the indirect effect that gas may have via the chemical reactions and interaction effects emissions of that gas initiates. With uncertain knowledge about the chemical composition of the atmosphere and the various manners in which atmospheric concentrations are linked via chemical reactions, therefore, GWPs may be associated with uncertainty.

Another problematic aspect, which also has received attention, is that the GWP methodology is not capable of handling all gases that may affect climate. In particular, calculations of GWPs for species whose lifetime is shorter than the time for mixing in the troposphere are problematic and controversial. This implies that GWPs can not be calculated for the very short-lived species, even though they are known to have an impact on climate.

While these shortcomings are serious, they are not necessarily sufficiently serious to invalidate the GWP concept. The latter shortcoming can be circumvented, for instance, by at least temporarily accepting that the methodology is not applicable to all greenhouse gases and restrict its use to the most important ones whose lifetimes all exceed the time for mixing in the troposphere. Furthermore, the research community currently spends a great deal of effort and energy on reducing uncertainty and finding methods for including all greenhouse gases.

A third problematic aspect of this methodology, which also is related to the manner in which it is used in policy-making, is the capacity of the methodology to handle the vast range of atmospheric lifetimes of greenhouse gases.

GWPs are given relative to CO₂ as a reference gas and for a specific time horizon. Thus, as pointed out by Smith and Wigley (1997), if a gas has a twenty year GWP of 30, this should imply that a 30 unit reduction in CO₂ emissions would be necessary to achieve the same climatic effects over twenty years as a one unit reduction in emissions of that given gas.

Atmospheric lifetime refers to the period of time that a pulse emission of a gas remains in the atmosphere. Some gases have atmospheric lifetimes or adjustment times that differ substantially from that of the reference gas, CO₂ that is 50-200 years. Some gases have lifetimes or adjustment times of 50 000 years, whereas other gases, that also are considered to be well-mixed and hence appropriate for GWP calculation, may have lifetimes or adjustment times that are significantly shorter. In comparison, methane, which also is a significant greenhouse gas, has an atmospheric lifetime or adjustment time of 10-12 years. Such differences between CO₂ and other greenhouse gases make the GWPs for some gases strongly dependent upon the choice of time horizon. It is illustrative that the total greenhouse gas emission, measured as CO₂ equivalents, from New Zealand which has high methane emissions, is reduced by 70% when the time horizon is changed from 20 to 500 years (Skodvin and Fuglestvedt, 1997). This implies that the choice of time horizon, which is considered to be a political choice, has significant implications for the emphasis that is given to long-lived versus short-lived gases.

The fourth, and perhaps most serious and least discussed problem with the GWP method, is that its ability to transform emissions of different gases into a common scale which expresses the *climatic effect* of each gas is questionable. GWP is a measure for the relative *radiative forcing* of a given gas. Thus, radiative forcing is used as a measure for the climatic response of emissions of greenhouse gases. The relationship between radiative forcing and actual climatic response is, however, unclear. When the GWP concept first was introduced, many scientists believed in a simple linear relationship between forcing and temperature change for the equilibrium case. Transient runs of the more complex Global Circulation Models, however, soon questioned the realism of equilibrium studies and left the relationship between forcing and temperature change unclear (Shackley and Wynne, 1997).

The inability of the GWP method to transform emissions into a common measure which expresses the climatic effect of a gas, is illustrated in a study we are currently working with at CICERO where we have focused on the climatic effect of a trade-off between emission reductions in methane, or other gases with lifetimes of 50 years or less, and CO₂ (Fuglestvedt et al., 1999).

Figure 1 (below) illustrates the scenarios we have developed for our study. In the business as usual scenario we assume that emissions in CO₂ are reduced linearly from the year 2100 to the year 2200 by approximately 60%. This reduction is meant to reflect that fossil fuel reserves are limited and that CO₂ emission reductions are inevitable in the long run. Our reduction scenario is one where the Kyoto target is repeated twice – that is, an approximate 10% reduction in CO₂ equivalents from 1990 levels – after which, emissions are stabilised at that level. The middle figure illustrates this reduction implemented by reducing CO₂ emissions, while the lower figure illustrates this reduction implemented by reducing emissions of methane or other gases with lifetimes of less than 50 years.

When calculated with the same time horizon, which is 100 years and the same as the time horizon adopted in the Kyoto Protocol, our calculations indicate that the climate response to a given reduction target may depend on *how* this target is implemented and the composition of emission reductions, as illustrated in figure 2 (below).

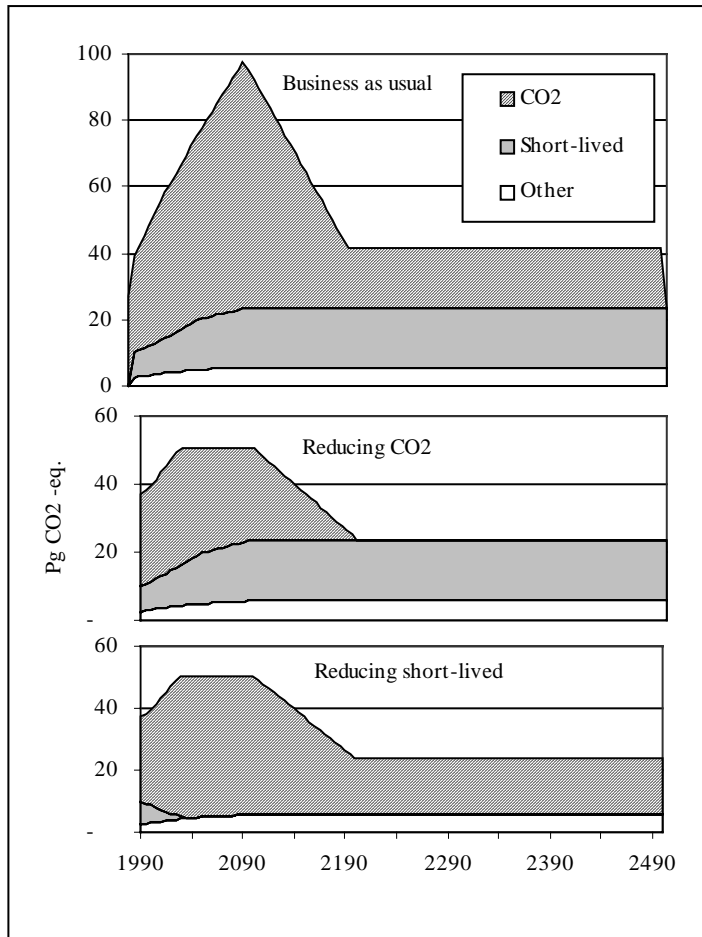


Figure 1: Emission scenarios (Fuglestad et al., 1999).

Figure 2 illustrates that the same reduction in terms of CO₂ equivalents has a significantly different temperature response depending on whether the reduction is implemented by reducing short-lived gases or by reducing CO₂. The figure indicates that there is a difference both in terms of the *rate* of change and in terms of the eventual *magnitude* of change. It is also particularly interesting to note that this is a long-term effect, and that it would not be reflected in the IPCC temperature scenarios, for instance, since they stop at the year 2100.

This may be a serious shortcoming of the GWP method, because it implies that the assumption that the *climatic response* associated with a given reduction in a greenhouse gas on a given time horizon may *not* be the same as the equivalent reduction in CO₂ given by the GWP calculation. This implies further that the manner in which the Kyoto target is implemented, in terms of which emissions that are reduced, is *not* insignificant. One of the basic assumptions underlying the use of GWPs in policy-making may thus be violated.

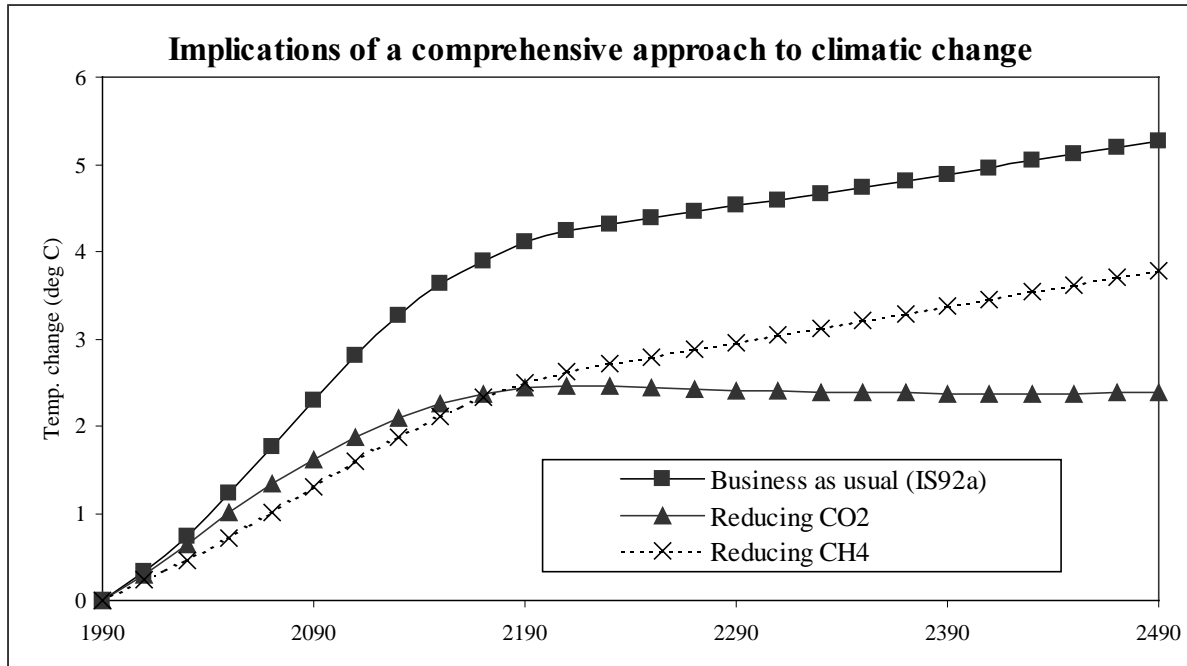


Figure 2: Temperature response (Fuglestvedt et al., 1999).

To an outsider, it is curious that the question of how good a measure of climatic response the GWP method is, has not been addressed by the research community until recently. In a paper dated 16 July, 1996, cited by Shackley and Wynne, Steven Smith and Tom Wigley find that, “the use of GWPs can result in large and potentially serious errors, and we conclude that GWPs should not be used for policy analysis” (1997:105). Again according to Shackley and Wynne, in the view of another scientist the Smith and Wigley paper “nicely brings an end to the GWP saga”. I agree with Shackley and Wynne that “it is fascinating to note that this rigorous validation task for GWPs has only been conducted in 1996, more than 6 years after GWPs began to be promoted”. One explanation to this, suggested by the same authors, is that “the research scientists were so busy developing and calculating new GWP values that they did not have time to conduct proper validation tests for GWPs.”

In supplement to this explanation, is also the very important political role of GWPs. Very early, the climate change problem was defined by the political community, in manners that required a method for comparing gases. The political role and endorsement of the GWP concept thus made it irreplaceable. The rapid acceptance this concept gained in the political community seems to have contributed to a general understanding also within the scientific community that, with all its shortcomings discussed in IPCC reports, this was an acceptable tool for comparing gases. To scientists, moreover, the distinction between radiative forcing and actual climatic response is easier to grasp than for policy-makers. Thus, the most problematic aspect of the GWP concept is linked to its *application* by policy-makers who believe that it is an appropriate measure for climatic response. Also, with the rapid political acceptance of the GWP methodology, the concept acquired a political meaning and a very significant role in the negotiation process. This, in its turn, seems to have marginalised research on the applicability of the measure as a measure for climatic response and the scientific community in a sense lost control over the concept. Most scientists, and not only natural scientists, have experienced that when policy-makers really need a specific kind of

knowledge that scientists are able to provide, they very soon lose interest in the caveats expressed in the fine print.

It should be emphasised that alternatives for the GWP index have been suggested. Some of these alternatives are associated with the same problems, however, Also, many of these alternatives are not characterised by the necessary simplicity to function well as a decision-making tool. In the case of the GWP methodology, moreover, critics have had a serious educational problem in that they have only been able to express their concern and point to the shortcomings associated with the current methodology, they have not been able to present a better alternative which can replace it.

The GWP concept, and the demand from policy-makers for calculations of GWP values, moreover, also generated new and very interesting research topics for the scientific community. So while the research community, as pointed out by Shackley and Wynne, “were busy calculating and developing new GWP values”, this activity also generated new and scientifically interesting research. So perhaps rather than not having the time to do proper validation tests of the GWP methodology, the research community became engaged in other also very interesting research problems, and the research for appropriate validation became marginalised.

The accuracy of the GWP index, therefore, leaves much to be wanted, at least in scientific terms. But what are the implications for the political process on climate change? If we look at some of the requirements to adequacy suggested earlier, for instance, how adequate is the solution design model of the climate regime?

4 The adequacy of the solution design model adopted in the climate regime

The understanding of climate change as a global problem, concerning a set of interchangeable greenhouse gases is reflected in the principle of cost-effectiveness and in the comprehensive approach adopted in Article 3.3. of the Climate Convention.

In the Kyoto Protocol, this solution design model generated the adoption of three main implementation mechanisms; emissions trading, joint implementation and the clean development mechanism. In its different manners, these mechanisms all allow parties to implement their emission reduction commitment by reducing emissions of any of the six substances included in the Protocol (CO₂, CH₄, N₂O, HFCs, PFCs and SF₆) anywhere in the world.

To many countries, including pivotal countries such as the USA, the conception of climate change in these terms was a premise for their acceptance of the climate convention (Nitze, 1994). In this regard, the problem definition adopted in the climate convention served to facilitate agreement in very significant respects. It should be noted that while this mode of framing the climate issue is not the only one possible, it had no real competitors at that time. A problem definition that to a larger extent focused on other aspects of the climate issue, such as for instance land use and land use change and its linkages to sustainable development, were not applicable, not least because of their lack of political feasibility. At that time, moreover, alternative modes of framing the climate problem also lacked support in a firmly established scientific community.

In this regard, the solution design model of the climate regime thus clearly satisfies our first requirement to adequacy, which concerns its capacity to mobilise the sufficient political support to generate agreement.

There seems, however, to be a price to pay for the political feasibility of this solution design model in terms of its capacity to generate solutions that are effective in terms of solving the problem for which they were designed; the mitigation of climate change.

Environmental effectiveness is a difficult and relative concept, because judgements of effectiveness depend upon the measure against which the judgement is made. Even without going into this difficult question, however, it is interesting to take a brief look at what is lost in terms of the development of effective climate measures, by choosing this solution design model.

One problem with this solution design model in terms of its environmental effectiveness is linked to the possible errors associated with the GWP index. The environmental implications of the possible errors associated with the GWP methodology seem to be most significant if the methodology is used as a basis for trade, domestically or internationally, between emissions of short-lived and long-lived gases. As illustrated in the figure I showed earlier, if a given reduction target is implemented by reducing short-lived gases (such as methane) instead of CO₂, the short-term climatic effect may be a reduced *rate* of temperature increase. Since this would imply that CO₂ emissions are not reduced, however, the long-term effect will be a significantly higher magnitude of temperature increase than if this target was implemented by

reducing emissions of CO₂. This effect will only occur, however, if parties systematically choose to regulate short-lived gases instead of CO₂, which perhaps is unlikely. It is still interesting to note, however, that because of this problem with the GWP index, we do not *know* the actual climatic effect, for instance of the Kyoto target, until *after* it has been effectively implemented and we thus *know* the composition of the basket of gases whose emissions are reduced.

A related problem is that the conception of all greenhouse gases – both short-lived and long-lived – as equal and interchangeable removes our options, at a later stage, to use the atmospheric lifetimes of greenhouse gases as an instrument to target climate measures towards different types of climate responses rather than towards atmospheric concentrations in general. The climate responses to radiative forcing show a large range of response times due to the differing nature of the components involved. Due to interactions, moreover, the response time in one component may control the response in another.

Characteristic time horizons for different indicators of climate change:	
Climate change indicator	Appropriate integration time (years)
Maximum change in temperature	~ 100
Rate of change in temperature	~ 20-50
Maximum change in sea level	> 100
Rate of change in sea level	> 50

Figure 3: Integration time (Source: WMO, 1992).

Figure 3 illustrates the appropriate integration time for a set of climate change indicators. Whereas the appropriate integration time for the *magnitude* of change in these indicators is 100 years or more, the appropriate integration time for the *rate* of change is significantly shorter.

This feature implies that the atmospheric lifetimes/adjustment times of the various greenhouse gases may be used as an instrument to target climate measures towards these various types of climate responses: Reductions in emissions of short-lived gases, for instance, are appropriate if the policy emphasis is to help guard against the possibility of abrupt non-linear climate responses in the near future. Also, if the speed of climate change is of the greatest concern, this may be targeted by reducing short-lived gases. If the policy emphasis is to help guard against long-term, quasi-irreversible climate or climate related changes, however, the most appropriate policy measure would be to reduce emissions of long-lived gases.

Since methane has a relatively short lifetime, some scholars have suggested to use reductions in emissions of this gas as an “emergency brake”. If we experience more serious climate

changes than anticipated in the future, significant reductions in methane may slow the temperature increase relatively quickly. Other scholars have suggested to use reductions in methane now to buy time to develop technology, for instance, to reduce the significance of CO₂ emissions in national economies. With the current framing of the climate problem and the solution design model that follows, however, these options are not available. Currently, there is no instrument to target climate measures towards different types of climate responses.

Finally, the understanding of the climate problem in terms of greenhouse gas emissions and atmospheric concentrations has generated a very aggregate picture of the climate problem. Not surprisingly, perhaps, given this strong focus on the potential of different gases to warm the global climate, the problem is usually conceptualised in terms of *global mean temperature changes*.

Moreover, a focus on atmospheric components has implied a strong interest in the physical processes associated with greenhouse gas emissions rather than the underlying social and political structures and processes that cause these emissions.

In a recent thought provoking article, Stewart Cohen and colleagues direct out attention to the possible combined effect of this restricted focus; that greenhouse gas emissions are sought reduced primarily through technical solutions rather than structural changes, and also that the populations that ultimately will pay for these emission reductions have no conception of how climate change may affect them (Cohen et al., 1998). There is a mismatch, therefore, between knowledge about the *costs* of reductions, and the possible *benefits* associated with a mitigation of climate change.

One motivation for not focusing on regional effects earlier may have been a concern for the negotiability of the climate issue if such analyses showed that the countries most affected by climate change were not the same as the countries causing it and hence controlling its solution. The paradox is, however, that without detailed knowledge about regional climate effects, the understanding that it is the developing world that will be most strongly affected has been permitted to disseminate. We do not know very much, however, about how climate change may affect industrialised *or* developing countries. This may constitute a significant problem of democracy, since it may be difficult to mobilise political support for the implementation of GHG emission reductions in a population who do not perceive themselves to be affected by the problem. Regional effects of climate change is currently one major topic for the Third IPCC Assessment Report, so there is reason to believe that this initial global focus is about to be supplemented by a regional focus to address the possible impacts of climate change at a regional level, in developing as well as developed countries.

5 Conclusions

The history of the GWP concept is illustrative of the mechanisms at work in a process of science–policy interaction. In this case, it is tempting to say that both scientists and policy-makers in a sense were trapped in the effectiveness of their own communication. Policy-makers had a strong need for a specific kind of knowledge, which scientists promptly responded to. The knowledge offered was rapidly accepted and endorsed by the political community. It was also integrated and, in a sense, institutionalised in the solutions developed in the negotiation process. This seems, as we have seen, to have had significant implications for the scientific process associated with the development of the GWP methodology, especially as reflected in the marginalisation of research concerned with the applicability of the GWP index as such. In this regard, and as pointed out by Shackley and Wynne, the history behind the GWP methodology “is a vivid illustration of how the perceived policy pressures and needs come to construct scientific tools in a way which closes down reflexive debate and thorough validation” (1997: 105).

It is interesting to note, moreover, that the question of the appropriateness of the GWP index, *as it is used in policy-making*, has not been addressed in this process. The most serious shortcomings of the GWP index are associated with how it is used in policy-making. The time horizon, for instance, may, by policy-makers, be perceived to mean that with a 100 year time horizon, the climatic effect of emission reductions of different gases is the same after 100 years. This is, as amply demonstrated in Figure 2, not the case. Moreover, and perhaps more importantly, it is not at all evident which of the temperature developments illustrated in Figure 2, that are preferable for those who have to live with climate change. At first glance, the CO₂ scenario may seem to be preferable, since this scenario is associated with a lower magnitude of temperature increase in the long run. This scenario, however, is also associated with a much higher rate of temperature increase. And if there are threshold levels in the climate system, this rapid increase in temperatures may initiate changes, for instance in ocean circulation patterns, that both may be serious and irreversible. The point in this context, however, is that these aspects have not been discussed in the political community. The time horizon of 100 years adopted in the Kyoto Protocol, for instance, is arbitrarily chosen. Also, the decision to view all greenhouse gases as equal and interchangeable is not based on considerations of this kind. Thus, the GWP methodology is problematic because its shortcomings are not appreciated and taken into account in its application by policy-makers.

This mode of framing the problem was necessary, however, to make the climate problem negotiable. With the institutionalisation of the climate problem on the international agenda, for instance through a ratification of the Kyoto Protocol, a new political situation may arise which also allows for a redefinition of the problem and an increased policy demand for refined science-based decision-making tools. If policy-makers really want to confront the problem of climate change, moreover, this discussion indicates that they may be well advised to do so.

6 References

- Cohen, S., D. Dermitt, J. Robinson and D. Rothman (1998), Climate Change and Sustainable Development: Towards Dialogue. *Global Environmental Change*, vol. 8, No. 4, pp: 341–371.
- Fuglestedt, J. S., T. K. Berntsen, O. Godal, and T. Skodvin (1999), Climate Implications of GWP-based Reductions in Greenhouse Gas Emissions. Submitted to *Geophysical Research Letters* (July 1999).
- Nitze, W. A. (1994), A Failure of Presidential Leadership. In I. M. Mintzer and J. A. Leonard (eds.), *Negotiating Climate Change: The Inside Story of the Rio Convention*. Cambridge: Cambridge University Press, pp. 187-201.
- Shackley, S. and B. Wynne (1997), Global Warming Potentials: Ambiguity or Precision as an Aid to Policy? *Climate Research*, vol. 8, pp. 89-106.
- Skodvin, T. and J. S. Fuglestedt (1997), A Comprehensive Approach to Climate Change: Political and Scientific Considerations. *AMBIO*, vol. 26, No. 6, pp: 351–358.
- Smith, S. J., and T. M. L. Wigley (1997), The Policy Relevance of Global Warming Potentials. Draft dated 23 September, 1997, submitted to *Nature*.
- Underdal, A. (1983), Causes of Negotiation Failure, *European Journal of Political Research*, 11, pp. 183-195.
- World Meteorological Organization (WMO) (1992), *Scientific Assessment of Ozone Depletion, 1991*. Global Ozone Research and Monitoring Project Report No. 37, World Meteorological Organization (WMO), Geneva, Chapter 7.

This is CICERO

CICERO was established by the Norwegian government in April 1990 as a non-profit organization associated with the University of Oslo.

The research concentrates on:

- International negotiations on climate agreements. The themes of the negotiations are distribution of costs and benefits, information and institutions.
- Global climate and regional environment effects in developing and industrialized countries. Integrated assessments include sustainable energy use and production, and optimal environmental and resource management.
- Indirect effects of emissions and feedback mechanisms in the climate system as a result of chemical processes in the atmosphere.

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