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Improving Information for Policy Makers**

Estimating Non-Market Impacts of Climate Change and Climate Policy

by

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FOREWORD

This paper was prepared for an OECD Workshop on the *Benefits of Climate Policy: Improving Information for Policy Makers*, held 12-13 December 2002. The aim of the Workshop and the underlying Project is to outline a conceptual framework to estimate the benefits of climate change policies, and to help organise information on this topic for policy makers. The Workshop covered both adaptation and mitigation policies, and related to different spatial and temporal scales for decision-making. However, particular emphasis was placed on understanding global benefits at different levels of mitigation -- in other words, on the incremental benefit of going from one level of climate change to another. Participants were also asked to identify gaps in existing information and to recommend areas for improvement, including topics requiring further policy-related research and testing. The Workshop brought representatives from governments together with researchers from a range of disciplines to address these issues. Further background on the workshop, its agenda and participants, can be found on the internet at: www.oecd.org/env/cc

The overall Project is overseen by the OECD Working Party on Global and Structural Policy (Environment Policy Committee). The Secretariat would like to thank the governments of Canada, Germany and the United States for providing extra-budgetary financial support for the work.

This paper is issued as an authored "working paper" -- one of a series emerging from the Project. The ideas expressed in the paper are those of the author alone and do not necessarily represent the views of the OECD or its Member Countries.

As a working paper, this document has received only limited peer review. Some authors will be further refining their papers, either to eventually appear in the peer-reviewed academic literature, or to become part of a forthcoming OECD publication on this Project. The objective of placing these papers on the internet at this stage is to widely disseminate the ideas contained in them, with a view toward facilitating the review process.

Any comments on the paper may be sent directly to the authors at:

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1. INTRODUCTION

A number of studies over the past few decades have attempted to estimate the potential impacts of climate change and climate policy. For reasons related to, *inter alia*, our incomplete understanding of the workings of many natural and social systems, the tremendous spatial and temporal variability in these systems, and the long time frames over which the issue of climate change will play out, there are large degrees of uncertainty in these estimates.

Some of the most rancorous debates, however, have focused on those studies that have attempted to place economic values on these impacts. This should not be surprising as the outcomes of these studies have played an important role in the debates over climate policy. Rightly or wrongly, the estimates presented in these studies are often held up against similar estimates of the costs of mitigating against climate change.

The process of economic valuation of environmental and social issues is still relatively young, much less its application to the potential impacts of climate change and climate policy. Issues such as climate change push existing techniques to their limits, and possibly beyond. Among the topics that have raised the most concern are the choice of the proper baseline against which to make comparisons, the treatment of uncertainty in human and natural systems, incomplete accounting, the actual valuation of specific impacts, and the aggregation of impacts over time and across widely differing societies. Some of the more recent studies have tried to address these issues, albeit not always satisfactorily.

One aspect that makes the economic valuation of environmental and social issues difficult is that it requires addressing impacts that are not typically associated with economic markets, so called non-market impacts. In addition to not being traded in markets, many of these impacts affect goods and services that have the characteristic of being public goods, i.e. it is not possible to restrict their use to a single individual or group and their use by one person does not reduce their use by others. This makes their valuation even more problematic.

Most studies agree that non-market impacts make up a significant, if not the dominant, share of the potential impacts of climate change. In the IPCC's Second Assessment Report, Pearce et al., (1996) noted that non-market costs accounted for "between 30-80% of the total" in existing estimates of the costs of climate change. In a review of more recent estimates, several of the same authors state that whereas market impacts may be lower than initially thought, non-market impacts may be more pronounced (Tol, Fankhauser et al. 2000). Still, there remain a number of questions about how properly to account for non-market impacts.

In this paper we will not reiterate or provide new estimates of the value of non-market impacts and the potential benefits from climate policies. Rather, we will focus on a number of issues that we see in the existing studies as presenting the potential for confusion in understanding these impacts and benefits. The need to account for non-market impacts is fundamental to a number of these concerns. The specific issues to be addressed are the context in which climate impacts and policy options have been considered, the definition and classification of impacts, the question of value paradigms, and the limitations of economic valuation techniques. The principle argument we wish to make is that we need to pose our

research questions more carefully and be more clear and consistent in order for the results to be considered credible, transparent, and relevant for policy.

2. COMPARING POLICY OPTIONS – PLACING THESE IN THE PROPER CONTEXT

In this section we address the coherence and transparency of the contextual frameworks that are used to analyze the impacts of climate policy. We argue that the framework used in existing analyses is problematic because the assumptions about policy actions and their effects cannot be distinguished clearly from assumptions about the behaviour of natural and social systems. When interpreting results, it is very difficult or even impossible to determine whether differences in outcome are due to policy measures or to different representations of the natural and social systems. Too often, we are not comparing apples to slightly different apples, but rather apples to oranges. This point obviously goes beyond the concern about non-market impacts, but we feel it is necessary to make clear before discussing these impacts. Furthermore, a proper framing of the estimation of (non-market) impacts is necessary to avoid conceptual errors, as highlighted in the recent debate over the value of ecosystem goods and services (Bockstael, Freeman III et al. 2000; Balmford, Bruner et al. 2002).

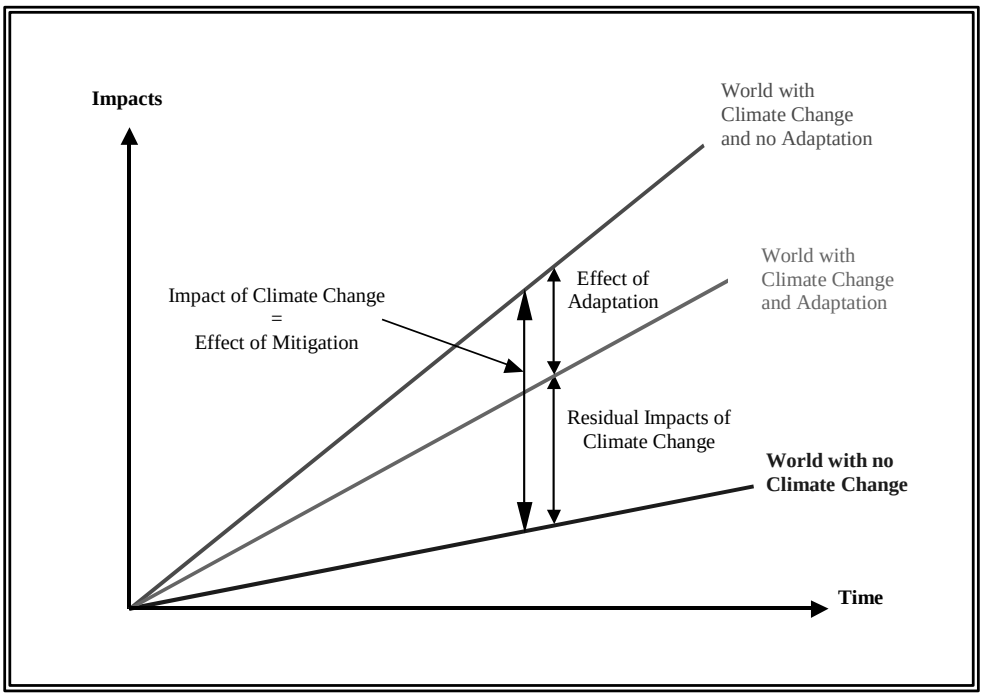
In analyses to date we are often presented with something like the following:

1. World with no climate change
2. World with climate change
3. World with climate change and adaptation

The representations of each of these types of world have evolved somewhat in the past decade. The world with no climate change has moved from simply being the present world to a projection of a future world in which climate change does not occur and no policy actions are taken. Whereas the world with climate change has traditionally been a world in which equilibrium has been reached with a doubling of atmospheric CO_2, more recent studies have tried to consider transient worlds in which the levels of greenhouse gases are rising and climate is responding over time. Finally, efforts to consider adaptation have moved in the direction from the dumb farmer, i.e. no adaptation, to the clairvoyant farmer, i.e. optimal adaptation, to more realistic levels of adaptation. Furthermore, some distinction has been drawn between autonomous and policy-driven adaptation.

Even with this gradual evolution of the framework within which climate policies are considered, we argue that there remains some potential confusion. As shown in Figure 1, the impacts of climate change, or alternatively the effects of mitigation, are measured as the difference between the world with climate change and the world with no climate change. The effects of adaptation are taken as the difference between the world with climate change and the world with climate change and adaptation. In this case, there may remain some residual impacts of climate change.

Figure 1. Traditional representation of climate impacts and adaptation



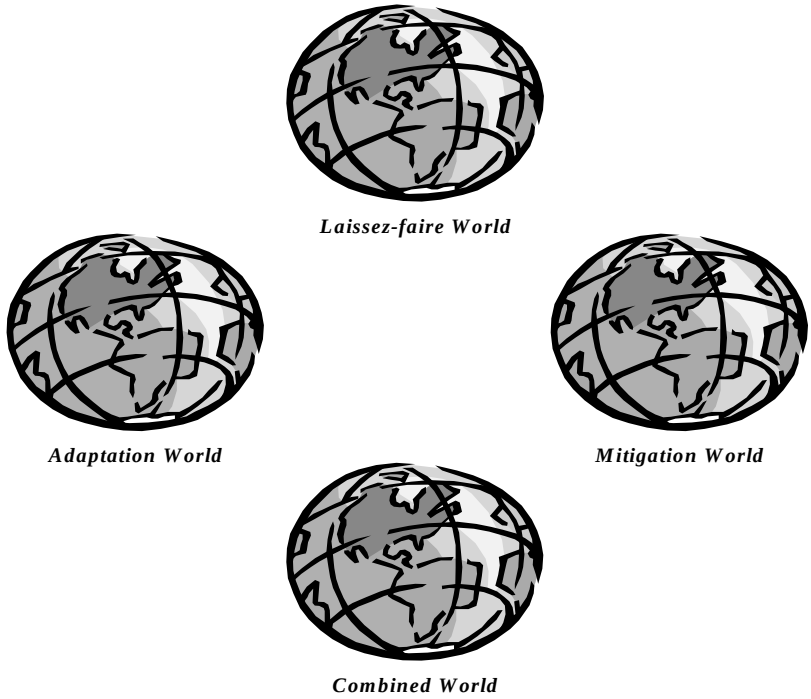
Notwithstanding the merits of the traditional framework, its practical usefulness is limited because it lacks clear policy levers. From a policy perspective what we want to compare are different states of the world that differ as a result of policy choices. It is important, therefore, not to confuse differences due to assumptions about policy choices and differences to assumptions about other factors, such as the behaviour of the climate system. Unfortunately, this is exactly what is done in the three worlds described above.

As an alternative, consider the four archetypal worlds are shown in Figure 2:

1. Laissez-faire world (no policy to address climate change);
2. Mitigation world (only mitigation policy);
3. Adaptation world (only adaptation policy); and
4. Combined world (both mitigation and adaptation policy.

Obviously, we can imagine any number of such worlds. The ultimate goal would be a complete mapping of the relative impacts of different levels of adaptation and mitigation and combinations thereof, including uncertainties around these estimates. We could them compare this to a similar mapping of the costs of the mitigation and adaptation policies, and from this choose an optimal policy. Unfortunately, such a complete mapping is probably not feasible, for reasons that go beyond the scope of this paper.

Figure 2. Alternative representation of climate impacts and adaptation



Turning back to the four worlds depicted in Figure 2, what we are interested in are the differences between these worlds. The comparison can be made between any of the worlds and any can be taken as a reference. If we were to take the Laissez-faire world as our 'reference' world, we can talk about the differences in the other worlds vis à vis the Laissez-faire world as follows:

1. Mitigation world – (avoided) climate-related impacts + non-climate-related impacts from mitigation policy. $\Delta CI_{M,L} + \Delta NCI_{M,L}$;

2. Adaptation world – (reduced) climate-related impacts + non-climate-related impacts from adaptation policy. $\Delta CI_{A,L} + \Delta NCI_{A,L}$; and

3. Combined world – (avoided and reduced) climate-related impacts + non-climate-related impacts from mitigation and adaptation policy. $\Delta CI_{C,L} + \Delta NCI_{C,L}$.

There are a couple of key points to note here:

- The different worlds are distinguished specifically in terms of the policy actions chosen; any differences in climatic, other bio-geophysical, or socio-economic processes should be considered to have occurred as a result of these policy actions. The assumptions about the fundamental underlying behaviour of these systems, i.e. those aspects unrelated to specific responses to the climate policies, should be consistent across the worlds. This should include assumptions about non-human induced climate change;

- It is the differences between the different worlds that are important, i.e. the impacts are always defined in relation to the 'reference' world, e.g. $\Delta CI_{M,L}$; if the choice of the reference world changes, so will the impacts;

- Due to potential interactive effects, the differences in the climate-related and non-climate-related impacts in Combined world will likely not be a simple sum of the impacts in the other two worlds, i.e. $\Delta CI_{C,L} \neq \Delta CI_{M,L} + \Delta CI_{A,L}$ and $\Delta NCI_{C,L} \neq \Delta NCI_{M,L} + \Delta NCI_{A,L}$;

- We have purposely separated out those impacts that can be characterized as climate-related from those that are non-climate-related. The latter are what have been referred to as ancillary impacts, i.e. impacts that result from factors other than realized or reduced changes in the climate. This is a useful conceptual distinction, but in reality, it may be very difficult to divide impacts between these two categories. Furthermore, ignoring these impacts would imply an incomplete assessment of the potential benefits and/or costs of any climate policy

We feel this alternative framing provides a more accurate and appropriate contextual framework in which the impacts of climate change and climate policies are to be estimated. At the same time, it raises questions about the ability to treat mitigation and adaptation policies separately and the partitioning between direct and ancillary impacts.

3. DEFINING IMPACTS: CATEGORIZATION

A second point of potential confusion related to current analyses of the impacts of climate policies comes in the definition and classification of impacts. Once again, we will argue that this can lead to comparing apples and oranges.

For a well-structured treatment of the aggregate impacts of climate change, a complete and coherent categorization of these is essential. What we have tended to do has been to emphasize particular categories of impacts. Table 1 list the sectors in the IPCC's Second Assessment Report (Pearce, Cline et al. 1996) and a more recent review by Smith and Hitz (this volume). These categories reflect assumption about what are some of the major concerns related to climate change and are quite suitable for individual studies. From the perspective of trying to estimate the aggregate impact of climate change and climate policy, however, these look to be somewhat haphazard groupings. For example, it is not clear at all what it means to add impacts on agriculture, an economic sector, and impacts on the coastal zone, a spatial category. This can lead to problems including double counting, on one hand, and the omission of impacts, on the other.

Table 1. Sectors of Climate Change Impacts

Pearce, et al.	Smith and Hitz
Agriculture	Agriculture
Forest	Forestry
Sea level	Coastal (sea level rise)
Energy	Energy
Water	Water
Human life	Health
Migration	Terrestrial ecosystems
Extreme events	Biodiversity
Recreation	Marine ecosystems
Species loss	
Urban	
Air pollution	

Source: Pearce et al., (1996) and Smith and Hitz (this volume)

Various approaches can be taken to attempting to classify the impacts of climate change in a way that allows for the full coverage of impacts while keeping a clear distinction between the categories. Three are considered here, moving progressively from a purely physical perspective to one that emphasizes the ultimate effects on human well-being

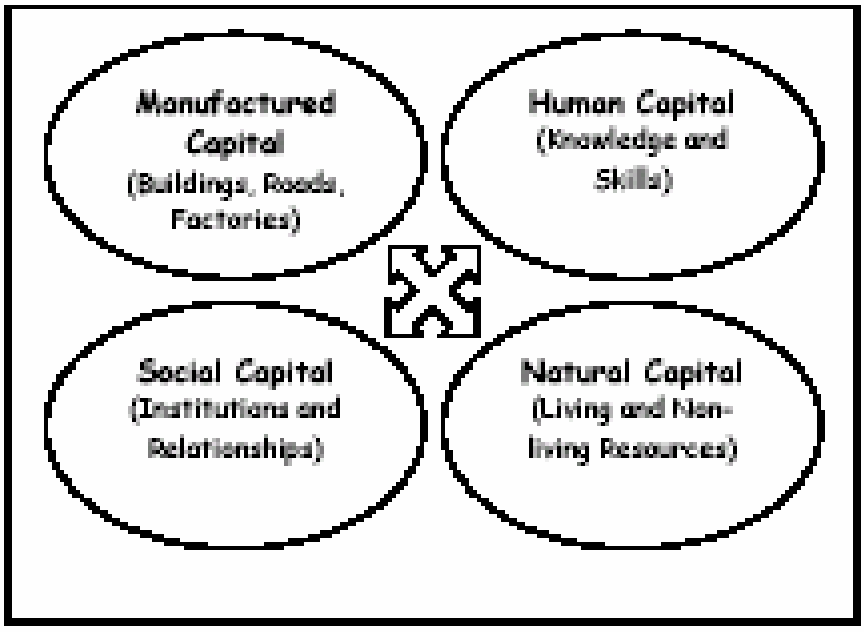
From a purely physical standpoint, and at the highest level, we can talk about 5 major systems, which interact, but are essentially distinct:

- Atmospheric systems;
- Aquatic systems;
- Geologic systems (especially soils);
- Biological systems (including humans); and
- Built environment (including buildings, machinery, infrastructure etc)

It is possible to specify the impacts of climate change and climate policy on these systems. For example, Füssel (2001) and Leemans and Eickhout (this volume) have estimated indicators of the change in biome area as a result of climatic changes.

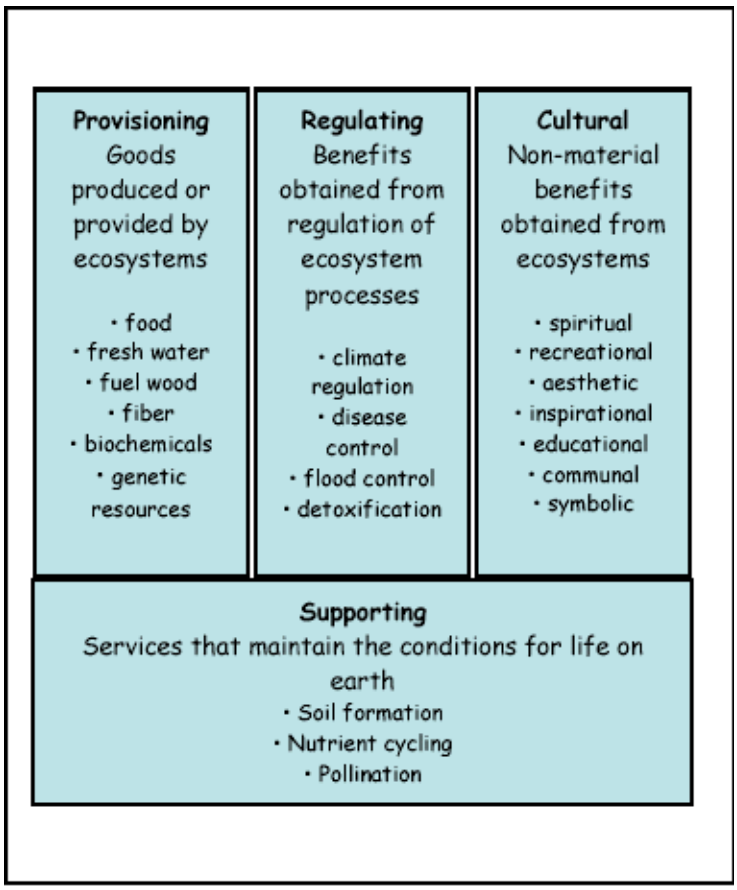
A second approach emphasizes the different forms of capital that make up the productive base of society: natural, manufactured, human, and social capital (see Figure 3). It is from these forms of capital that all goods and services are derived. Within this approach, we can focus on the stocks of capital themselves, as discussed in many recent attempts to develop indicator systems (Meadows 1998; United Nations 2001). Alternatively, we can focus on the goods and services the stocks of capital provide. For example, there have been a number of recent efforts to classify the goods and services associated with ecosystems, an example of which is shown in Figure 4 (de Groot, Wilson et al. 2002; ATEAM 2003; Millennium Assessment 2003).

Figure 3. A society's productive base is comprised of four types of capital: manufactured, human, social, and natural



Source : Millennium Assessment (2003)

Figure 4. Ecosystem Goods and Services

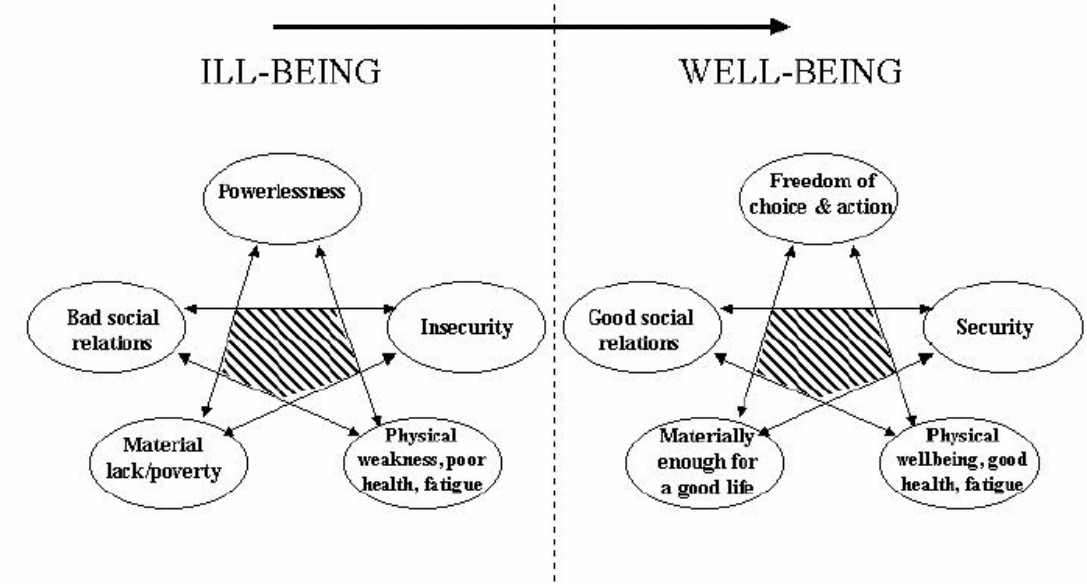


Source: Millennium Assessment, (2003)

Finally, the ultimate goal may be, and some would say should be, to measure impacts in terms of their effect on human well-being. Recently, authors have distinguished determinants of, or *means* to, well-being from its constituents, that is, aspects of well-being as an *end* (Sen 1999; Dasgupta 2001). Various elements of well-being can be both determinants and constituents; education and health, for example, are seen as both ends and means. From Narayan et al., (2000), we have the following six linked components of well-being (see Figure 5):

- the necessary material minimum for a good life;
- health and bodily well-being;
- good social relations;
- security;
- freedom and choice; and
- peace of mind and spiritual experience

Figure 5. Components of ill-being and well-being



Source: Millennium Assessment (2003)

Regardless of the approach taken, the key point is that there should be more care taken to structuring the set of impacts considered. This is particularly important when aggregating impacts across different categories. The choice of which approach should be adopted is closely related to question of value paradigms and valuation methods, which we will address in the following sections.

4. GOING FROM IMPACTS TO VALUES

In making the jump from impacts to values, it is important to first define what is meant by value. Following Costanza (2000), value can be taken to mean the contribution of an action or object to user-specified goal, objective, or condition. Valuing a specific impact of climate change or climate policy, such as a change in species distribution, implies valuing the degree to which the change affects the contribution of that object to the specified goal, objective, or condition. Thus, the specification of the goal, objective, or condition of interest is of fundamental importance. The value of any specific impact can, therefore, differ significantly depending upon the choice made.

In the IPCC TAR (Markandya and Halsnæs 2001, p. 459), it is stated that (t)he conceptual foundation of all cost estimates is the value of scarce resources to individuals. Thus, values are based on individual preferences . . . distinguish(ing) it from value systems based on ecological criteria, which give certain ecological goals a value in themselves, independent of what individuals might want, now or in the future." In this statement, he distinguishes two possible notions of value. In the Millennium Ecosystem Assessment (2003), these two notions of value are described using the terms utilitarian and non-utilitarian, or intrinsic value. Farber, et al., (2002) refer to them as economic and. ecological concepts of value. Unlike Markandya (2001, p. 459), though the latter two do not restrict themselves to considering only the first notion of value.

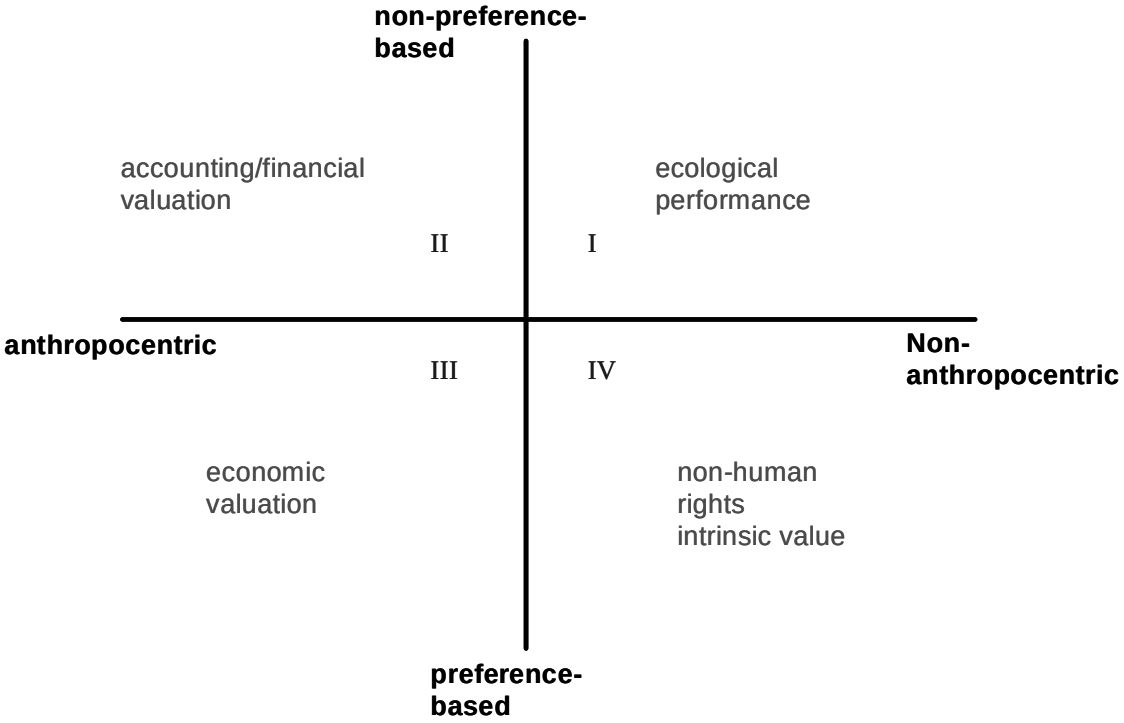
It is apparent that these two notions of value differ at a fundamental level. Therefore, it should not be surprising that if their differences are not clearly communicated, the result is likely to be confusion and strong disagreement, which will preclude meaningful dialogue and make decision making more difficult. In an attempt to add additional structure to this discussion, we argue that useful insights can be gained by classifying notions of value according to their positions on two dimensions. First, we distinguish between anthropocentric and non-anthropocentric, or holistic, approaches. While anthropocentric notions take the human species as their starting point, holistic notions are not centred on one particular species. Second, there are preference-based and non-preference-based notions of value. Preference-based notions are centred on subjective opinions, while non-preference-based notions are built upon more objectively measurable phenomena. Drawing on the discussion about well-being in the previous section, we can say that the non-preference-based notions address the determinants of well-being, whereas the preference-based notions address the constituents.

The juxtaposition of both dimensions results in Figure 6. Quadrants III and I reflect the two notions of value discussed above. Quadrant III reflects the economic notion of value, i.e. the contribution to the satisfaction of human preferences. Quadrant I covers the directly measurable contribution of an action or object to the performance of an ecological or other natural system. For example increased rainfall can be valued in terms of its contribution to the net primary productivity of an ecosystem? In quadrant II, directly measurable aspects are handled that are specifically important for human society. An example of this is the value of a bridge in terms of its construction costs. The distinction between this and the notion of value in Quadrant III is akin to the difference between measures of economic activity, e.g. GDP, and measures of societal welfare.[1] Finally, Quadrant IV contains notions of value that are holistic, but still

[1] Of course, since GDP is measured in market prices, which are determined in part by human preferences, there is a connection between these in practice. Still, it is important to keep these notions of value distinct.

preference-based. It is very difficult, if not impossible to make this category of value notions operational, because it requires knowledge about other species' preferences and experiences. We argue that the notion of 'intrinsic value' properly falls inside this quadrant. It is the value of life to a living being.

Figure 6. Distinguishing different notions of value



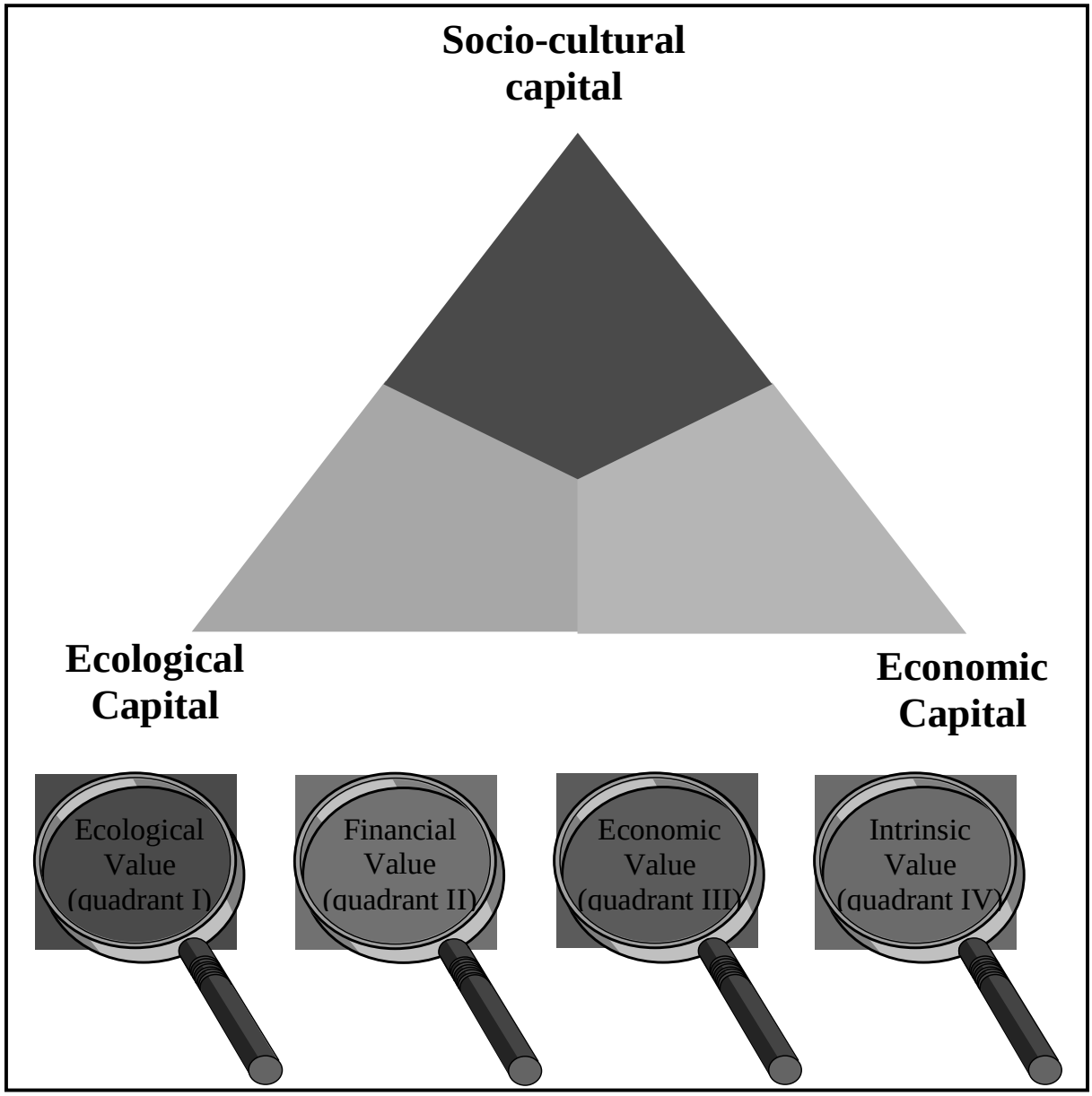
There are some important further points that need to be made concerning these axes or boundaries. We have just hinted at one in our definition of the notion of 'intrinsic' value. This is not the same as the concept of 'existence' value, which reflects, for example, the value to a person of knowing about the continued existence of another species, which is captured in Quadrant III. The second is in relation to the difference between quadrants II and III. For example, many public decisions are heavily based on cost information (quadrant II), without paying much attention to, for example, issues of willingness-to-pay (quadrant III). This kind of decision-making is based on what is more properly called a financial notion of value and not on an economic one.

Coming back to the point that different notions of value can imply quite different valuations, consider quadrant I vis à vis quadrant III. A high value in one of the quadrants does not at all guarantee a high value in the other hemisphere. Diamonds may be very valuable in the human system, both instrumentally in certain industrial process and directly as objects that give pleasure, but they may be quite irrelevant from an ecological point of view. On the other hand, some species of insect may be very valuable to an ecosystem, but not have any obvious significance to human systems. However, the two are of course closely related. The natural system provides the basis for human existence and thus, if some ecological condition is violated, human society will face the consequences sooner or later.

It is important to remember that these quadrants are a function of the paradigm of value chosen and not what is being valued. This can be illustrated with the use of Figure 7. The top portion of the figure shows a system represented by various stocks (domains) of capital: socio-cultural, ecological, and economic. Below this are 4 lenses, one for each quadrant of the previous figure. The person interested in the value of this system or the value of a change in the system can choose to use any or all of the lenses.

Each of these will show something different, even when the same part of the system is being looked at. For example, consider a tree. Through the ecological value lens, it may appear as a key actor in nutrient cycling; through the financial lens, it may appear as a source of stumpage fees for the government; through the economic lens, it may appear as a source of income and thereby material well-being for a logger; finally through the intrinsic value lens, it will appear in a way only understandable to the tree itself.

Figure 7. All notions of value should consider all domains of capital



Irrespective of the lens chosen, it is important that the full system be considered for a complete accounting to be made of the impacts of a climate change or a climate policy. This was stated in the previous section, but deserves reiteration. If only a subset of the impacts are considered, for example because of uncertainties in their nature, timing, or extent, because they do not lend themselves easily to conversion to a common metric, then the information provided to decision makers will be incomplete and potentially misleading.

Finally, we must point out that this section has hidden one other very important dimension of value – the individual vs. collective dimension. As Toman (1999) points out, many values are better described as community values, which are not simply the sum of individual values. Drawing from Wilson and Howarth (2002) it is possible to see a paradox between the public nature of many of the impacts of climate change and the measurement of their economic value through individual expression. One of the authors of this paper (Rothman 2000) has further elaborated on this question, both in terms of the existence of values that exist only in the context of a society and in the problem of interpersonal comparisons of utility required for the aggregation of individual values to social values.

5. METHODS OF VALUATION AND THE ISSUE OF NON-MARKET VS. MARKET IMPACTS

The different notions of value discussed in the previous section imply different measures of value and different means of valuation. Whereas we feel that it is valuable to use more than one notion of value in evaluating climate policies, an argument can be made that the economic notion of value should take precedence in that we are ultimately interested in human welfare. It is imperative, however, that the full system be considered for a complete accounting of the various contributions to human welfare. If only a subset of the impacts are considered, either because of uncertainties in their nature, timing, or extent or because they do not lend themselves easily to conversion to a common metric, then the information provided to decision makers will be incomplete and potentially misleading.

The focus on a single notion of value and the issue of a common metric can pose practical problems, however. Measuring changes in human welfare is a notoriously difficult task. This begins with the difficulties in measuring the actual physical changes in natural and human systems, which is then compounded by the need to translate these into changes in human welfare. Referring back to Figure 6, this latter step implies somehow converting measures of impacts using ecological and financial notions of (Quadrants I and II, respectively) into a metric representing the economic notion of value (Quadrant III).

In their review of global impacts studies, Smith and Hitz (this volume) cite a number of different metrics in which impacts have been measured. These are listed in Table 2. Most of these are measures of changes in physical systems or risks to people. Notably, for only three of the studies do they associate the word ‘welfare’ with the metric(s) cited. It needs to be remembered here that even when the same metric, e.g. money, is used, it does not always reflect the same notion of value. Changes in income and GDP, for example, are at best proxies for changes in welfare. This is perhaps most clearly seen in the notion of the marginal value of income, which is generally assumed to be diminishing, i.e. an extra dollar is worth less to a rich person than a poor person. This comes into play in aggregating across both time and individuals. In the first case, one argument given for the use of a positive rate of discount is that individuals will generally be better off in the future, so an extra dollar of income in the future will provide less utility than an extra dollar today. For the latter case, the notion of diminishing marginal utility of income has been the fundamental principle used to argue for applying equity weights in calculating aggregate impacts across individuals or regions (Azar 1999; Tol, Fankhauser et al. 2000).

Table 2. Metrics used in climate change impact studies

Area of Potential Transmission (of Infectious Disease)
Carbon: Vegetation, Soil
Change in Forest Area, Ecoclimatic Classes in Biosphere Reserves
Change in GDP, Income, Output
Cost of Protection (against sea level rise)
Loss in $: Dryland, Wetland
Mortality: Malaria, Vector-borne diseases
NEP, NPP
People at Risk: Hunger, Coastal Flooding, Malaria
People Living: under Water Stress Conditions, in Countries Experiencing Water Stress
Prices: Food, Forest Products
Production: Agricultural Commodities, Cereal, Food, Timber, Marine Export
Stock: Biomass, Softwood and Hardwood
Welfare (from Forestry)

Source: Smith and Hitz (this volume)

The practical difficulties of translating changes in natural and human systems into changes in human welfare are especially true for non-market impacts but not limited to these. Economists have devised several methods to attempt to capture the monetary values associated with non-market goods and services by using 'implicit' or 'surrogate' markets, or to creating 'constructed' markets,. A number of these are summarized below (Kopp, Krupnick et al. 1997; Munasinghe 2000; Farber, Costanza et al. 2002):

- Hedonic Pricing: These methods are based on the assumption that the value of non-market goods and services is, to some extent, reflected in the price paid for goods and services, e.g. housing and land, or income received, e.g. wages, which are associated with the non-market goods and services of interest.

- Travel-Cost: These methods focus on expenses incurred in travelling to make use of a particular good or service. It has primarily been used to measure the value of recreation.

- Stated Preference: These include methods such as contingent valuation and conjoint analysis. Through interviews or surveys, individuals are either asked to value non-market commodities directly or to choose between different options, from which implicit monetary values can be elicited.

- Factor Income: These methods are based on the fact that certain goods and services directly or indirectly serve as factors of production.

- Avoided Cost and Replacement Cost: These methods focus on the costs to society that are either avoided by the free provision of a good or service or would be required to replacing this service by a man-made system.

- Defensive/Preventative Expenditures: These methods consider expenditures, including insurance, which purpose is to prevent or compensate for certain impacts.

- Cost of Illness/Loss of Income: These methods focus on the income lost to individuals as a result of morbidity or mortality.

- Group Valuation: These methods try to get at the paradox noted above between the public nature of many of the impacts of climate change and climate policy and the traditional approach of valuing these based upon individual preferences. Because of the nature of the group process, any attempt to elicit monetary values would most likely resemble stated preference methods. Several authors, e.g. Jacobs (1997), Sagoff (1998), and Wilson and Howarth (2002) have argued for the use of group methods, and Gregory and Wellman (2001) have actual done so to estimate a social willingness to pay for certain management strategies to address a local environmental issue.

These methods can be difficult to apply and require stringent assumptions for the results to be considered valid (see for example Maddison (2001) on hedonic methods and Kopp et al., (1997) on stated preference methods). Given the difficulties of these tools, it is not surprising that most studies that have avoided putting monetary values on non-market impacts of climate change. Cases where this has been done include Layton and Gardner (2000) who have used stated preference methods to get a sense of how much people would be willing to pay to avoid specific impacts of a potential climate change, in this case the loss of forest area and Maddison and others who have applied hedonic methods to value certain aspects of climate and climate change (Mendelsohn and Markowski 1999; Maddison 2001). Of further concern is that it is not clear that what these methods measure actual reflects an economic notion of value as opposed to a financial or other notion (see for example, Heal (2000) and Bockstael et al. (2000) on replacement cost methods as a measure of welfare). This also raises questions about the existing aggregations of climate change impacts. We would argue that measures of value reflecting different paradigms of value are inherently incommensurable and, therefore, it is inappropriate to aggregate them.

The net result is that for the foreseeable future we will be left with use of multiple metrics for measuring the impacts of climate change and climate policies.[2] This has been recognized, for example, by Schneider et al., (2000) in their call for the use of "five numeraires" for the evaluation of climate policies by Kopp et al., (1997) in their analysis of the proper use of cost-benefit analysis, and among others arguing for the use of multi-criteria decision analysis in evaluating environmental and social policies. To some, this may appear as if we have doomed ourselves to being unable to make decisions. However, our feeling is that rather than having done so, what we have actually done is to clarify better the decisions that are actually being made. If all values could be made commensurable and a single metric achieved, we would be left with the task of making calculations, not decisions.

[2] We do feel that the existing methods can be improved. Give the fundamental recognition of different notions of value and the uncertainty inherent in trying to move from one notion to another, though, it is likely that we will never reach the state of having a single metric.

6. CONCLUSIONS

In this paper, we have addressed what we see as a number of points of potential confusion in addressing issues such as climate policy. We have focused on those studies that have attempted to put monetary values on the impacts of climate change and the benefits of climate policies for the reason that these are the ones that are most likely to be compared against other studies looking at the costs of climate policies.

The first of these concerns is the context in which these impacts have been considered. The most common framework used in existing analyses does not clearly distinguish the assumptions about policy actions and their effects from those about the behaviour of natural and social systems. Thus, when interpreting results, it is very difficult or even impossible to determine whether differences in outcome are due to policy measures or to different representations of the natural and social systems. Furthermore, we feel that the framework has imposed artificial and unrealistic divisions between climate related and non-climate related, or ancillary, impacts and between mitigation and adaptation policies. Future studies should attempt to remove these divisions and be more consistent in their choices of assumptions.

Our second concern is with the definition and classification of impacts used in existing studies. The impacts that have received the most attention reflect assumptions about what are some of the major concerns related to climate change. This is quite suitable for individual studies, but looked at as a whole, these come across as a somewhat haphazard group of entities. From the perspective of trying to estimate the aggregate impact of climate change and climate policies, this is problematic. For a well-structured treatment of the aggregate impacts of climate change, a complete and coherent categorization of impacts should be adopted. This will help to avoid problems of double counting on one hand, and the omission of impacts on the other.

The third concern centres on the different notions of value. Whereas there has been more effort recently to clarify these, there still remain problems of clear communication, which can lead to confusion and misunderstanding, and prevent meaningful dialogue. We argue that it is important to be clear about these different notions of value, and to consider multiple notions of value in looking at the impacts of climate change and evaluating climate policy. Furthermore, although tempting, it is not proper to try to aggregate or compress these into a single measure.

Finally, there is the process of valuation. Even if it is agreed that we should focus on a single notion of value, e.g. the economic notion, it is highly unlikely that we will be able to express all of the impacts, particularly non-market ones, of climate change and climate policy in a single metric. The push to do so should be avoided as this most often leads to the neglect of significant impacts, the loss of important information, and the aggregation of fundamentally different entities.

For these reasons, we conclude that many of the existing analyses of the impacts of climate change and the benefits from climate policy are potentially misleading. They should certainly not be used in isolation in making decisions about mitigation and adaptation. We have also made some suggestions for how to improve on these in future studies. By posing our research questions more carefully and being more clear and consistent, our results will, hopefully, exhibit greater credibility, transparency, and relevance for policy.

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