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A transdisciplinary methodological tool for evaluating when climate change is dangerous

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Abstract

Although a global climate regime has been developed, decisions regarding dangerous climate change have been postponed in the political arena because impacts are not uniform globally, while the issue of what is dangerous has until recently not been seen as a scientific question by the IPCC. This leads to the research question: How can a methodological approach be developed for defining dangerous climate change?
The methodology developed to address this question is a participatory integrated assessment, consisting of a macro level design and a micro level design. The macro level design consists of an iterative set of science-policy dialogues within countries, within regions and between regions. The micro level science-policy design consists of steps involving a focus on climate change impact indicators, short-listing of such indicators, clustering such indicators in terms of their communicative value and scientific robustness, identifying threshold levels of acceptable and unacceptable impacts, and then back-calculating to greenhouse gas concentration levels. This method, applied in the Netherlands, yielded some interesting results and some consensus knowledge among the stakeholders who participated.

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1. Why define dangerous climate change?

A destination is important for any project undertaken by humans. Where one wants to get to defines how one develops one's strategy and tactics to arrive there. The use of well-established means per se does not guarantee that one will reach the end goal aimed at. This in brief is the crux of the problem: why define dangerous climate change?

The climate change agreements are focused on meeting the ultimate objective as expressed in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC, 1992). This Article states:

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

The problem with this Article is that the text is indeterminate. As a result, it conveys some degree of the substance of the long-term goal while carefully avoiding any quantitative expression of it (cf. Bodansky, 1993, p. 451). A legitimate reason for having done so is that although the state of climate science is relatively clear in terms of possible causal factors, quantifying concentration levels and impacts is often a task that poses major challenges to the conscientious scientist. However, the policymaker needs a

straight answer. The policymaker needs to know how much is too much, in other words where the threshold levels are.[1] This eternal science-policy gap is particularly frightening for environmentalists and social scientists in the climate change field because the consequences of not being able to articulate accurately at what levels climate change becomes dangerous to people, might put the lives of millions of people at risk while affecting both ecosystems and economic infrastructure. The uncertainty with regard to certain aspects of climate science should not undermine the nature of the precautionary policy that needs to be applied (Hare and Meinshausen, 2004). Furthermore, Article 2 needs to be specified because only then can political determination be made of how to achieve the goals of the climate change process (Ott et al., 2004, p. 27; Oppenheimer and Petsonk, 2004, p. 91).

This brings us to the research question of this paper. How does one define dangerous climate change?[2] How does one bridge the science-policy gap embedded in the climate change problem given the various dimensions of the problem? Is there an objective definition for dangerous climate change? Is there an objective method for of identifying what is dangerous climate change?

In order to address the above questions, this paper first explores some theoretical issues before embarking on an explanation of the methodological approach developed (section 2). It then explains how the approach has been applied in the context of different regions (section 3). It goes on to explore how the method was applied within the Netherlands (section 4). Finally, it draws some lessons from the entire exercise (section 5).

2. How? A transdisciplinary methodology

2.1 The theoretical underpinnings

The theoretical ingredients that underpin the macro methodology include the discussions on problem definition, science-policy interface, theories on the negotiating challenges facing developing countries, negotiation theory, and theories on dialogue versus negotiation.

The issue of defining dangerous climate change is one that can be defined as an unstructured problem (Hisschemöller, 1993) in that both the science and values underlying the issue are contested. In addition, it is an unstructured problem – international (Gupta, 1997) – in that there is neither consensus among states nor within most states on how to actually deal with the problem of climate change. The problem is wicked in that the costs of the impacts and the costs of taking measures are not evenly distributed all over the world (cf. Cunningham and Cunningham, 2002).

As a consequence, the term dangerous interference is a social construct. This means that science cannot objectively ascertain what "dangerous" is. Some form of value judgement is inevitable (see, for example, Dessai et al., 2004). However, these value judgements will be context specific. This is not only because the impacts differ from place to place, but also because the risks are perceived differently by different people.

Thus far, scientists have refused to engage in discussions on what is dangerous climate change on the grounds that that is not a scientific question but a political one (cited in Gupta, 1997). It is only in the fourth assessment report (AR4) of the IPCC that the issue will be explored in terms of the scientific literature.[3] Recently, the interest from

scientists in the subject has increased (Brooks et al., 2004; Dessai et al., 2004; Gupta et al., 2003; Hare, 2003; IPCC, 2004; Keller et al., 2005; O`Neill and Oppenheimer, 2002; Oppenheimer and Petsonk, 2003; 2005; Ott et al., 2004). Thus far, politicians have been careful about tabling the issue at the international level, precisely because it is an unstructured, wicked problem.[4] However, within the European Union and some of its Member States there are ongoing discussions on the issue (e.g. in the UK, Sweden, France and the EU Commission), although it is far from certain if negotiations on Article 2 will be initiated as a result of this renewed attention.[5] The key way to deal with unstructured problems at the national or international level is to engage in dialogue and discussion. The purpose of such dialogue is to engage in scientific and social learning and to understand the problem from the different perspectives, yet in a non-politicised setting (Hisschemöller and Gupta, 1999). Private initiatives, making use of state of the art science and with limited government participation, could form an incentive for government action (Oppenheimer and Petsonk, 2003; 2005).

However, any effort to actually analyse the problem implies that one has to look at the available science and see how it can be made more communicative vis-á-vis the recipient policymakers so that there is a firm basis for decision-making. Science-policy gaps are not new in theory. While the two cultures theory predicted that this problem would be an enduring problem in the relationship between scientists and policymakers (Caplan, 1978; Rich, 1991), and there already is a vast literature on the trends in science-policy communication (cf. Hisschemöller et al., 2001), what is increasingly clear is that if scientists remain true to the canons of scientific criteria, and do not make an effort to translate the available knowledge and science to the users, users will not be in a proper

position to make decisions. This is especially the case in catch-22 situations where once the impacts of climate change begin to manifest themselves in serious forms, it may be too late to halt the most devastating impacts of climate change due to inertia in the climate system. Prior to the explicit manifestation of the impacts, it is possible to argue that the visible impacts are not attributable in scientifically certain terms to greenhouse gas emissions or that that these impacts do not justify action because they are experienced in other parts of the world. These problems call for the use of a participatory integrated assessment (PIA), where scientists and social actors engage together in a discussion about the nature of the science and the nature of the decisions that need to be taken on the basis of an informed dialogue.

The methodology presented below has been developed in a systematic manner into its current form over the last two years. The methodology has two dimensions –a macro and a micro dimension.

2.2 The macro methodology

The macro dimension focuses on how at the national, regional and global level an iterative and interactive system of dialogues should be undertaken. The underlying principle behind this system is the idea that unless countries invest in preparing a national and a regional position, it is no point endeavouring to undertake an international dialogue. This is because unless countries have a clear idea of what is at stake for them, they will tend to negotiate in terms of rhetorics and will be unable to go beyond simplistic assertions. This is predicted by the theory of the hollow mandate of developing countries, leading to the defensive negotiating position at the individual level and that of the

handicapped coalition building power, leading to collectively brittle, threadbare, handicapped negotiating power (Gupta, 1997; 2001). The recent UNU project on Disenfranchisement of developing countries illustrates this point in considerable detail (UNU Disenfranchisement project: forthcoming in 2005). Negotiating power shows that most developing countries negotiating on these issues will probably not have adequate opportunities to develop science-policy discussions within the domestic context to prepare them for discussions in the international arena. By extrapolation from past research, the articulation of Article 2 can be seen as a very challenging problem, and it would most likely not suffice to assemble a couple of experts and send them to an international discussion.

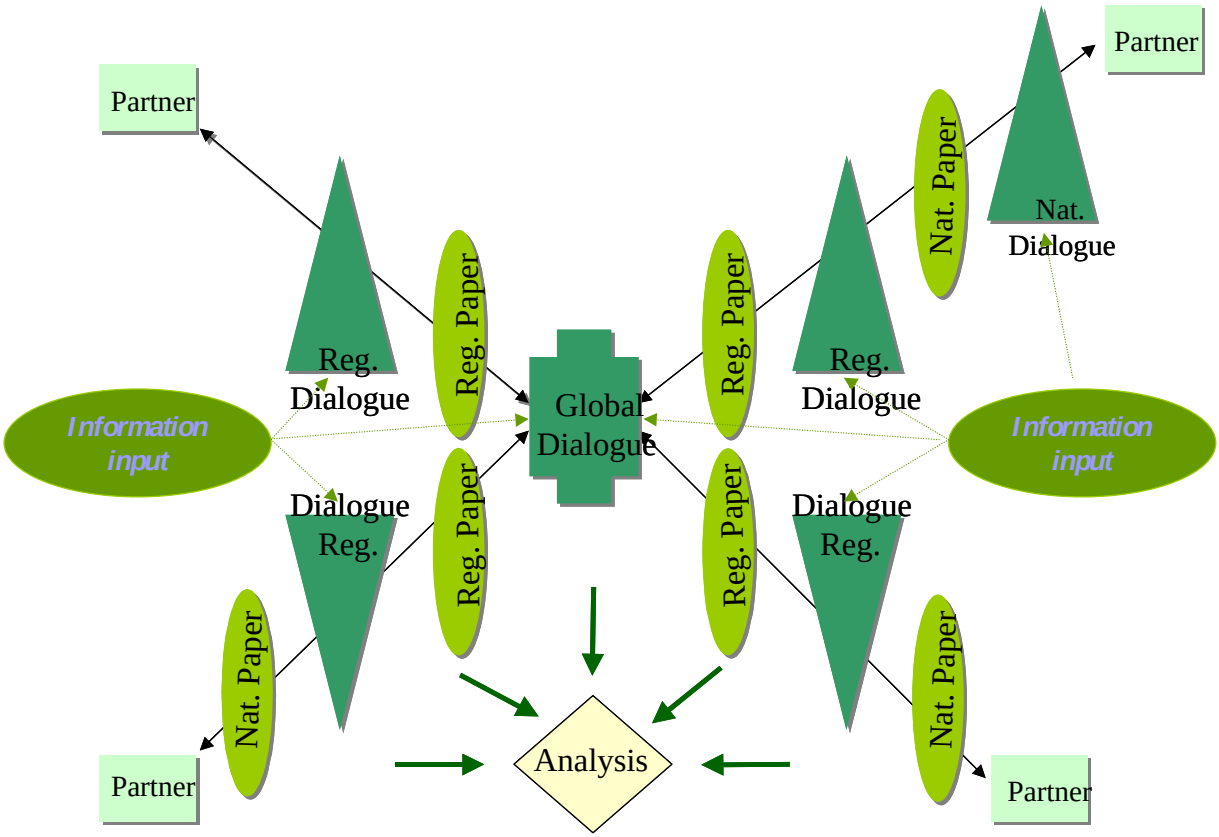
Furthermore, negotiation theory indicates that if countries are inadequately prepared for international negotiations and there are discussions with other countries that are better prepared on the subject this can lead to a situation where either symbolic decisions or 'forcing' decisions taken (Gupta, 2001). Such negotiation situations are unlikely to lead to problem solving. Hence, it is vital that if negotiations are to succeed on these issues, that all parties are prepared as well as possible for undertaking the discussions. This explains the need for dialogues at the national and regional levels.

The macro dimension envisages an iterative series of national and regional dialogues leading to global dialogues which would in turn feed into regional and national dialogues, after which the process could repeat itself. This is shown in Fig. 1 below. The process does not end in a global dialogue but with regional and/or national dialogues. This is because the purpose of the dialogue is not so much to reach consensus but to reach understanding of each other's position and a better understanding of one's own

position. This is also to ensure that the dialogue does not in any way morph into a negotiation process because that would compromise the atmosphere for such a dialogue.

The macro methodology also endorses the notion of non-interference with the process of national and regional dialogues. This is based on the idea that the project should not be engineered or stage managed from outside. Instead, the focus would be on communicating the logic of the process, the theoretical framework, and the way we would undertake such research. However, the actual design of the national and regional workshops was left to the local partners, allowing them to develop their own dialogue without external participation or interference (Gupta et al., 2003).

Fig. 1. The iterative dialogue process.



2.3 The micro methodology

The micro methodology focuses on how the science-policy dialogue within each setting could be actually designed. This methodology includes two approaches – the cognitive mode and the back-calculating mode.

The cognitive mode takes a top-down approach and has six steps. It begins with an examination of Article 2. Stakeholders are asked to read and *interpret* the meaning of the text. The different interpretations are then *clustered* into manageable groups. The following step focuses on identifying the *arguments* for and against such an interpretation within each cluster of interpretations. This is inspired by the analysis of Fisher and Ury (1978) on how to get to yes. The next step is to examine the potential for common ground in terms of the arguments underlying the interpretations. Anticipating that the room for such common ground will be limited, the following step is to examine the values and world views that create the frame through which the text is seen. The final step is to examine if there is any common ground or consensus through the exploration of values and world views. The cognitive mode in its most abstract sense will lead to a theoretical discussion of how dangerous climate change should be defined, and in its most specific sense could lead to an identification of the levels of stabilisation of greenhouse gas concentrations that are perceived to be dangerous for society.

The back-calculating mode takes a different approach. It is based on the theory that people have no emotional affinity with abstractions such as global temperature rise and concentration levels. Instead people can only at best relate to indicators that are likely to affect them. Hence, this model calls for an input - process - output approach. For the input, we ask scientists to identify the key impacts for a country from their perspective.

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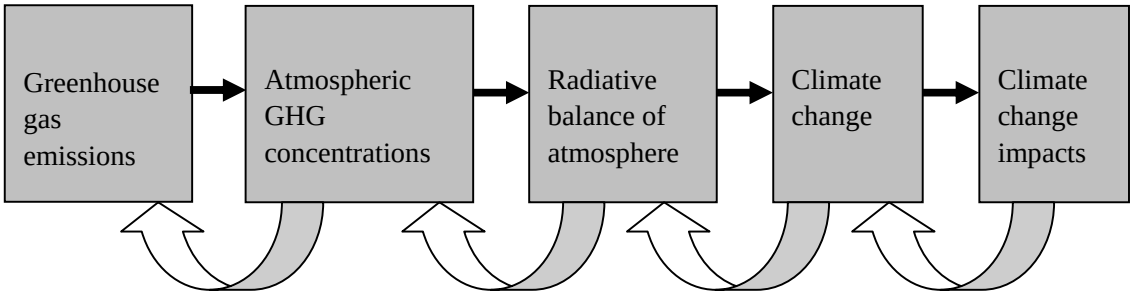
Following the identification of an impact, the scientists are asked to prepare fact-sheets based on the best available science, which should then be presented in an understandable manner to the general public. This is followed by a participatory process, consisting of four steps. First, interviews with stakeholders lead to the accumulation of basic information that help in the design of a first workshop. The second step is to organise a workshop with several key stakeholders who think in a representative manner (but do not formally represent any sector). We argue that having a small number of stakeholders in such a discussion is key to the promotion of a good discussion, and aims at abstracting the maximum information from the stakeholders. The first workshop should lead to an identification of key indicators on the basis of the scientific information collected and could also lead to a request for new information or an identification of new indicators. Third, following the first workshop, the research team needs to evaluate the explicit elements and conclusions, and then the implicit elements of the discussion. The implicit elements of the discussion are the points raised by individuals that have been lost in the discussion, but that could be important for an analysis of the issues. Lastly, all this information is then used in structuring a second workshop which should try and present the results of the first workshop, as well as the new scientific evidence that has emerged. On the basis of that, the second workshop focuses on identifying thresholds for the key indicators. Following the second workshop, an explicit and implicit analysis should be undertaken to distil the key indicators and threshold levels identified by the group of stakeholders. This information should then be used for back-calculating from impacts to climate change, from climate change to the radiative balance of the atmosphere, from that

to atmospheric concentrations of greenhouse gases, and then to greenhouse gas emissions.

Fig. 2. Back-calculating through the cause-effect chain of climate change.



A further step is to link the cognitive mode with the back-casting mode to see if the results are mutually compatible and to check if some elements are not missing in both processes.

It would not be out of order here to mention that researchers need to play a very active role in the process. For most stakeholders, this will probably be the first time that they are thinking about, if not reading, Article 2. Most stakeholders have never actually gone beyond the general information about climate change to think about the possible impacts at the local level and what it might mean to society. For most stakeholders, the process of trying to understand what an indicator is and how the indicators need to be identified is a difficult task. Many will need considerable time to actually grasp the nature of the climate problem, and learn how to deal with uncertainty. Many will then need time to understand the logic behind identifying indicators. Identifying thresholds is itself a task that sometimes defies comprehension, because it entails decision making in an information vacuum. The time constraints in such dialogues do not allow frequently for

prolonged discussions. However, it is of vital importance to the process that all comments of stakeholders are written down and analysed in order to try and deal with the issues involved.

The purpose of the micro methodology is not to develop consensus on the subject as such, but to force people to think in terms of indicators and thresholds and to make a first hypothesis. Once that is done, there need to be iterative rounds of discussion to test the indicators and threshold levels and to conduct research on these issues.

2.4 Some precautionary notes: Neither census nor consensus

The methodology described above is essentially experimental in nature. We are dealing with two types of uncertainties; uncertainty in scientific results at the global through to the local level, as well as uncertainty in how people will perceive risks. We are dealing with a highly controversial issue where the range of opinions is likely to be large.

The methodology does not aim at undertaking a census or creating consensus in society; it aims at putting the key scientists together with key social actors and forces them to think together about the impacts and thresholds. It aims to develop first conclusions that are written in clear terms that can then be tested several times over. This makes the gaps in science-policy communication visible.

The methodology has to contend with the fact that in the back-calculating process there are great gaps in knowledge, and it takes a leap of faith into the dark and tries to make assertions on the best available science. The logic for doing so is that if one remains constrained by the canons of scientific quality, one will never be able to develop

communicative approaches that can provide policymakers with the justification for action.

3. Where? Macro-level applications[6]

Thus far, we have applied the macro methodology in a limited sense. We have supported the organisation of regional workshops in Asia, Africa and the OECD countries, and two national workshops in Brazil (all part of Phase 1 of the project) and the Netherlands (Phase 2 of the project) were held. The workshops in the other regions of the world were designed and conducted by partner organisations.[7] The OECD workshop was organized in the Netherlands.[8]

Although each of the Phase 1 workshops undertaken in 2003 had its own internal dynamics, and tended to focus more on using the cognitive approach rather than the back-calculating approach, there were remarkable similarities. The key conclusions of the first phase of the workshops revealed that many of the stakeholders had never really either read or thought about Article 2, until they were confronted with this project. The stakeholders in the OECD workshop were relatively more aware. The degree of awareness was reflected in the way people responded to the interviews. Almost all of the workshops concluded that it was necessary to take time out to think about how Article 2 should be articulated since that would, among other things, set the time-frame for international action and could help address the catch-22 problem. While most of those participating in the OECD workshop were convinced that climate change was a serious problem, those participating in the developing country workshops were not always

convinced of the seriousness of the problem. This reflects possibly to some extent the lack of convincing scientific data of the regional impacts, which made some of the developing country participants question the seriousness of the climate change problem in comparison to other more pressing priorities. This result was in stark contrast to the discussions in the OECD workshop where there was a clear acceptance that it would be mostly developing countries that would face the brunt of the problem. In most of the workshops there was discussion about whether in general the environmental and developmental aspects of the climate change problem could be dichotomised. There was a tendency for the participants to focus on developmental issues over environmental issues. In the developing country workshops in particular there was latent fear that if climate change was a serious problem, they would have to take action themselves and that such action may compromise economic growth.

Participants argued that the key challenges in the articulation of Article 2 were the issue of monetisation of physical impacts which almost always implies that impacts in the developed countries would be valued higher than the impacts in the developing countries even though the nature of the physical impacts would be more severe in developing countries. The impacts on ecosystems tended to get externalised in the discussions. It would be difficult to prioritise the impacts because of competition from other environmental and developmental goals.

Participants argued that three types of negotiation outcomes would be unacceptable. The first was serious adverse environmental impacts, the second was a disproportionate policy burden on developing countries, and the third was unfavourable policy impacts on all countries, resulting in unsustainable emission pathways. But in the

discussions, it appeared that there may be room to find common ground between the participants by finding key areas in the domestic contexts that countries wish to protect at all costs and which are vulnerable to the impacts of climate change. It was thus agreed that it might be necessary to identify indicators of climate change and threshold levels for what constitutes dangerous climate change. Some initial indicators were developed but participants were not able to go beyond an initial selection.

Many of the participants claimed that they had learnt much through the dialogue process, thereby realising how complicated Article 2 was and why the international scientific and political community were shying away from a discussion. Many called for the study of values and principles in determining where responsibilities lay in such important environmental problems.

The participants also commented on the nature of the stakeholders who attended the discussion. Many felt that only those seriously interested in the issue had come, implying that there was a sort of self-selection in the process. Stakeholders likely to be affected by the discussions had not shown up. This both hampered the discussion process and the outcomes. Two categories conspicuous by their absence were the industry and commercial sector and indigenous people.

The developing country as well as the OECD workshops concluded that they needed much more information on the potential impacts at the local and regional level. They in particular needed information on the relationship between the direct impacts (e.g. change in precipitation) and the indirect impacts (e.g. effects on agriculture, industry, trade and economy), whether climate change policy threatened development policy, and whether climate change impacts threatened development policy.

They recommended the development of types of indicators and types of threshold levels; policy guidelines on how science can communicate with politics; policy guidelines on how to deal with uncertainty; advice on how to develop and democratically select indicators and the development of indicators on sustainable development.

In terms of process, the chief recommendations include the need to continue such dialogues, to find ways to attract the missing stakeholders; and to split the discussions on what can be considered fair and what is reasonable and feasible.

The first set of workshops showed what an incredibly difficult challenge we had embarked on. What was clear is that countries were not ready for a global dialogue. With such little information available, the workshops were only able to identify gaps in knowledge. There was less than a critical mass of information available to make informed decisions, which made the stakeholders nervous; but this realisation made the stakeholders also more appreciative of the process.

4. Case study of the Netherlands[9]

In contrast to the first round of workshops, the second phase began with a single and much more detailed use of resources to identify what could be seen as dangerous within the Dutch context. Extensive research on climate impacts in the Netherlands had already been undertaken, which ensured that a critical mass of information was available even though there was no full certainty with regard to its contents. In the Dutch context, we applied the micro methodology. This methodology focused on a number of systematic steps.

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The first step was to bring scientists together to identify key impacts for the Netherlands and to develop fact sheets on the impacts on the basis of the best available information. This led to the development of primary fact sheets on the state of climate change science and an analysis of the uncertainties, the key controversies, and expected impacts for the 21st century. The fact sheets focused on the projected impacts on Europe and the Netherlands. Because of the ongoing research on this subject within the Royal Netherlands Meteorological Institute (KNMI), there was information available on the possible impacts of climate change on the Netherlands in the event of a 1, 2 and a 4-6 °C degree rise in temperature. Other fact sheets were developed in relation to targets and emissions, impacts on biodiversity and ecosystems, freshwater, coastal areas, health, recreation and tourism and macro-economic effects. The degree and nature of information provided in the fact sheets differed. This is because in some areas, there has been more intensive debate about the available data and the need to say something, however risky, in order to communicate the information to policymakers and also to serve as a hypothesis for further testing. There is nothing dubious with this procedure. A close examination of the IPCC reports over the last decade shows that each report has revised the expected impacts and other data on the basis of the newest data; but that did not imply that the scientists did not attempt to make some predictions on the best available science. However, other fact sheets could not be as developed, simply because the data was very new and there was not yet a strong effort undertaken to find ways and means to communicate the information to the public.

Following the preparation of the fact sheets, 25 interviews were undertaken, followed by two workshops. The first workshop was very consciously designed to lay

bare the key controversies in climate change science by having a debate between a prominent sceptic and a prominent believer. The stakeholders were given the opportunities to ask their own questions and to draw their own conclusions. The debate led the majority of the stakeholders in the room to conclude that there is uncertainty in the scientific data, but that there is nevertheless overwhelming data about the seriousness of the problem. Following that, the results of the interviews on the interpretation of Article 2 and on the fact sheets were presented. This led to considerable discussion about the problem itself, the lack of sufficient information on the basis of which to make informed decisions, and yet the need to identify indicators in the face of such uncertainty. The participants then engaged in a discussion on indicators (both in terms of why and how, and in terms of naming them). The key problem that many stakeholders faced at the end of the first workshop was the nature of the economic information given to them. It was clarified that the chances are likely that the economic impacts of taking strong policy action will be low over a century, but that given the interlinked nature of international policy, it is impossible to say with certainty how much exactly the policies will cost. In other words, decision-making with respect to climate change for a small country like the Netherlands would have to be based on a general conviction that in the long-term the costs would be small, but cannot be based on any more reliable figures. The first workshop also raised the point that the indicators selected were not comparable, but were of all types ranging from global problems to local ones, from reversible to irreversible indicators, from serious issues to more seemingly flippant ones (e.g. the Dutch need for a major ice-skating competition at least once every ten years), and from measurable to non-measurable indicators.

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Between the workshops, we worked on designing the follow-up workshop to deal with the issue of multiple indicators and to prepare the ground for identifying thresholds. Some simplistic models were developed to promote discussion.

In the second workshop, the process focused much more on classifying indicators and identifying thresholds. While the workshops were able to cull a range of varying positions and arguments about how to classify the indicators, the group could not agree on any possible method. Nevertheless, they agreed to halt their classificatory attempts to try and see if they could identify thresholds for emissions. This proved to be also a fairly challenging task, but once the working groups came to grips with the logic behind the process they were able to define some perceived thresholds. Using these perceived thresholds, a presentation was made trying to link the available data to concentration levels and emission levels. Clearly, this process too was fraught with uncertainty, but the scientists present attempted to make the link on the basis of the best available knowledge. Finally, the plenary group met to discuss what would be an acceptable level of risk within the climate change process.

Following the workshop, we looked at all the implicit material collected in the project to see if we could derive a process for analysing the information. Systematically going through the lists of indicators and clustering them where necessary, we arrived at a list of 24 indicators of climate change relevant for the Netherlands. We then decided on the basis of the suggested criteria for evaluating indicators to develop a system of clustering the criteria as scientific and as social. Scientific criteria would be used to examine the information on the basis of important scientific attributes, while the social criteria would be used to examine the information on the basis of issues that society

might perceive to be of importance. We developed a ranking system and through an elementary multi-criteria analysis were able to rank the criteria as shown below in the following figure.

In reading this figure, some issues are of importance. First, there is nothing permanent about this classification. It is based on a transparent ranking procedure and the procedure can be discussed and modified to improve the robustness of the results. Second, the ranking does not indicate that the indicators that come last are not important, but merely that they are considered to be the least important of the important indicators as perceived by the Dutch stakeholders. Third, we believe that while some of these indicators may be seen as less or more important by different groups of stakeholders, the results will probably be fairly robust for the Netherlands; but this belief will be tested in future research.

Fig. 3. Classifying and ranking criteria.

	Ranking of scientific criteria				
Ranking of social criteria	**1**	**2**	**3**	**4**	**5**
1		Death from heat waves (A)			
2	Access to clean drinking water; Rate of sea-level rise Allergies (length pollen season) (A)	Water quality (number of weeks one cannot swim) Spread of infectious disease; Floods (B)	Disappearance of species (C)	Change in biodiversity (D)	Social instability (North vs South) (E)
3	Navigability of rivers; Water temperature. (B)	Productivity of land; Effect on work and sectors; No. of ice-skating events (*Elfstedentochten)* (C)	Effect on income (D)	Rate at which the beach disappears (E)	Storms (F)
4	Absolute sea-level rise (C)		Impact on Gulf Stream (E)	Disintegration of Antarctic; Global access to drinking water (F)	Access to food (G)
5	Melting of glaciers (D)				

The question is why one would undertake such a classification process? The answer is that such a classification process helps in terms of the taxonomy of the indicators, especially since these indicators are so different in nature and will be perceived differently and be given different weights by various people. Therefore, classifying indicators helps in mapping the problem. Second, some of these indicators may be more scientifically robust and some may be more appealing to society and Fig. 3 attempts to make that differentiation.

The next step was to look at the thresholds supplied by the stakeholders. As mentioned earlier, the working groups were able to identify only a few thresholds each. We then re-examined all the implicit information provided and tried to identify the lines of argument behind each statement or threshold level identified. We then extrapolated this information to try and identify acceptable and unacceptable risks for all indicators. The following table shows the final list as prepared by the project team.

Table 1. List of indicators and perceived threshold levels in the Netherlands: Results of workshops and extrapolation.

Indicator	Acceptable risk	Unacceptable risk
Access to clean drinking water	Temporary ban on washing cars; or watering gardens	Children cannot take baths; or impossible to drink water from the tap
Death from heat waves	Mortality remains stable	Increase in mortality
Allergies and other chronic sicknesses due to longer pollen season		Structural increase in chronic sicknesses
Water quality (number of weeks one cannot swim)	Increase of 50% from current levels; on a local basis and only incidentally	An increase of 200%; Structural effect annually
Navigability of rivers	Incidentally less load	Over four weeks less load Over two weeks less load
Water temperature	Incidental rise leading to fish mortality	Structural rise leading to loss of biodiversity; Code red: Electricity is rationed, because of the impact on electricity production
Rate of sea level rise	20 cm per century	> 50 cm per century; > 3 mm per year, because of the devastating effects on the Wadden sea
Spread of infectious disease	Twice the chance of falling ill	If adaptation is no longer possible, or if the costs for adaptation are out of proportion
The number of Elfsteden tochten (skating events)	Less than current levels	Less than once every 10 ten years
Productivity of land	Incidental losses	Structural losses
Absolute sea level rise	Marginal increases	> 0.5 m too costly
Effect on work and sectors	Marginal changes	Income inequality increases
Disappearance of species	Incidental losses	Where the legal norms are exceeded and structural losses
Effect on income	Incidental loss of income	No growth as result of impacts for one year; If Netherlands competitiveness is affected
Rate at which the beach disappears	When the beach can be easily replenished	When replenishment is too expensive affecting tourism
Floods	Incidental increases	Structural increases affecting property values
Change in biodiversity	Incidental changes	Loss of key species and ecosystem functions
Melting of glaciers	Incidental changes	Structural large-scale
Impact on the gulf stream	0%	Increase of probability
Global access to drinking water	Should meet Millennium Development Goals	Should not become worse than today
Instability through North-South impacts	At current levels	Should not increase structurally
Disintegration of the Antarctic	0%	Increase of probability
Storms	Current levels	Should not increase structurally
Access to food	Current problems	When this leads to international instability and significant increase in financial inequality

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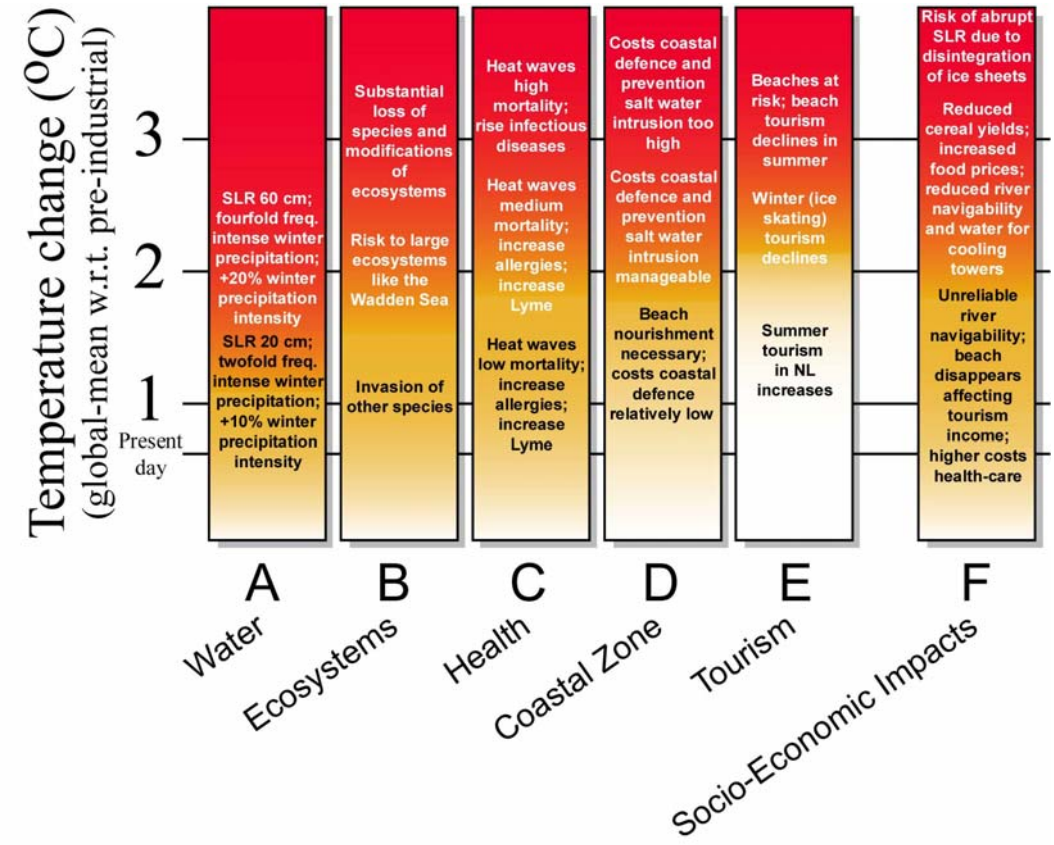
What should be clear is that we forced ourselves to think of possible thresholds based on the arguments made by the participants. This list of thresholds will then serve as a basis of discussion for follow-up discussions of thresholds where its robustness can be tested on the basis of new research that examines these impacts.

Finally, the project team spent considerable time trying to find a way of communicating the information available to the team in an easy manner to the public. Inspired by ongoing IPCC work[10], the project developed a figure to communicate the perceived impacts of climate change on the Netherlands associated with temperature levels. This is shown in Fig. 4.

Fig. 4. A first attempt at correlating temperature with impacts in the Netherlands.



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This exercise forced some of the Dutch scientists to try and present their information in a strongly communicative way, rather than being highly nuanced and non-communicative. Some scientists were afraid that such an exercise was irresponsible while others argued that it was very important for scientists to try and create usable knowledge and that if and when more information becomes available, the figure can be improved.

The Dutch stakeholders argued that a 2 °C rise in global mean temperature is the maximum level to which temperatures should be allowed to rise in order to protect Dutch society on the basis of the perceptions of key actors. This is line with some of the political views expressed in some European Union Member countries like France, Germany, Sweden and the UK.

5. Conclusion

This paper has tried to show how we developed a methodology for analysing what is dangerous climate change at the macro level and at the micro level. The purpose of the paper was also to share the initial results of the methodology as applied in Asia, Africa, the OECD countries and in Brazil and the Netherlands. Some of the conclusions emerging are:

Think local before global: The application of the method shows that indeed national and regional preparations are necessary before such a dialogue is engaged at global levels. There must be at least a critical mass of information available about (a) local and regional impacts, and (b) about how that information can be communicated to local and regional stakeholders, before such a participatory process at the global level can

be engaged in. Such critical mass of information was not available in most of the regions and countries, and even in the Netherlands, the level of information differed from impact to impact.

Catch-22 situation: Climate change policy is in a catch-22 situation. If one waits for the impacts and the evidence of causal chain, it might be too late to take action because of the inertia in the global climate system. If scientists cling on to their fear that attempting to make bold communicative statements will risk nuance and scientific integrity, we will be locked in our scientific paradigms and may not be able to contribute to a serious and urgent global problem where the stakes are very high.

Thinking out of the box: This project has developed a micro methodology that tries to push scientists and stakeholders to communicate with each other in a way that they understand each other and thereby attempts to bridge the gap between them. The communicative tools devised have led to initial results in the Dutch project which need to be tested further by scientists and stakeholders for accuracy and robustness. The data in the tools can be revised once more information has been collected. This is a risky endeavour in that there is so much uncertainty involved. But only time will tell if the benefits outweigh the costs.

Neither census nor consensus: Furthermore, the participatory integrated assessment method developed does not aim at seeking for a census of opinions in society, but merely to identify an expert working group of social stakeholders and scientists and to let them debate with each other on the impacts on society to develop a communicative model. Neither does the method aim at consensus. It aims at increasing knowledge in

society and at providing information about how the experts think of the issue and to let others then draw their own conclusions accordingly.

De-politicisation before politicisation: The dialogue process attempts to depoliticise the discussions in a way that allows for fruitful exchange of thoughts. This is a necessary starting point before entering into a process of politicisation in an issue that is highly unstructured and wicked. Furthermore, such a process may make many countries realise that although they can afford to deal with the impacts, they may not want to have to be pushed into a situation where they have to deal with the impacts.

A cautionary word: Finally, although the Dutch government may wish to temporarily accept the 2 °C target as its threshold, and the European Union too may support this goal, such a target is not necessarily strong enough to protect the most weak and vulnerable states and ecosystems from the wrath of climate change (cf. Baer and Athanasiou 2004; Hare, 2003; Parry et al., 2001).

Learning to simplify uncertainty will be the biggest governance challenge of the 21st century. This small experiment is a contribution towards that end.

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Notes

[1] Parry et al. (2001) also note the importance of the identification of critical impacts for discussing climate change mitigation targets.

[2] This paper does not discuss the pros and cons of the various ways to express a long-term climate change target (through temperature, concentration, emission targets, etc.). For an overview of the various possibilities, see Pershing and Tudela (2003).

[3] It was agreed at the twentieth session of the IPCC in 2003 to include key vulnerabilities (including issues related to Article 2 of the UNFCCC) as one of the cross-cutting themes for AR4 (IPCC, 2003; Patwardhan et al., 2003).

[4] A different, yet not incompatible explanation is given by Yamin and Depledge (2004, p. 65). They argue that the lack of discussion on long-term targets prior to the adoption of the Kyoto Protocol is due to the time-consuming Kyoto negotiations, a lack of scientific understanding of the issues at hand of many delegates, and an inadequate institutional setting for dealing with complex, value-laden issues.

[5] Even if these negotiations would start, it is very doubtful whether agreement would be reached in the end, especially if a stringent target is pursued (Pershing and Tudela, 2003).

[6] This section draws to a great extent from Gupta et al., 2003.

[7] These are for Africa: ENDA-TM, Senegal, for Asia: The Energy and Resources Institute (TERI), India, and for Brazil: COPPE Climate Centre, Brazil.

[8] By the National Institute for Public Health and the Environment (RIVM).

[9] This section draws to a great extent from Gupta and Van Asselt, 2004.

[10] One will notice the resemblance of Fig. 4 with the “burning embers” figure of the IPCC’s Third Assessment Report (Smith et al., 2001). This resemblance is no coincidence, and is intended to strengthen the messages contained in the figure.