# Are we sure?

*Some thoughts about uncertainty treatment in integrated assessment*

Rob Maas

## Introduction

'Are we sure?' 'Are we right?' 'Do we feel confident?' These questions summarise the feeling of uncertainty that is always nagging at our conscience whenever a policy decision is going to be based on scientific models. A feeling that is not going away when mathematical whizzkids show you the statistical uncertainty margins of model results, because the feeling is only partly about the figures. The feeling is more about the things we didn't look at, either because of time constraints, lack of data or lack of knowledge. Or the things we simply took for granted because most scientists think they are true.

Of course, in integrated assessment modelling there is no complete certainty. The things we know for sure (e.g. that emissions decrease) are hardly politically interesting. And paradoxically many things that are highly unsure such as the effects of climate change policy and of particulate matter are in the focus of public attention. In my view integrated assessors have to try to improve the quality of policy decisions by framing uncertain knowledge in such a way that policy makers become aware of the scientific uncertainties and our lack of knowledge, and can deal with them.

Many people think we have to reduce uncertainties by more data and measurements. They think that the more we measure, the more we know. But does this really help? Even the requirement of validating a theory or model with measurements does not guarantee that such models are true, because the decision on what and how to measure is based on the same theory and thus not objective. Every measurement requires a standpoint. Measurements only give information on the spots we shed light on. And at the same time a solitary measurement gives no information at all, it is the theory that gives the measurements a meaning. It seems like a trap.

*There is more in reality than we can capture in models. We should always be aware that we tend to be looking were the light is. What we don't model can still be!*

Perhaps a more modest view on scientific knowledge is required. To cite Karl Popper: 'A theory is true until it is proven to be wrong'. Or my own thesis: 'The believe in a future scenario (or strategy) is not much larger that the group of people that was involved in constructing it'. A scenario is a social construct, not an objective truth. Thinking along these lines, if absolute certainty in many cases does not exist, wouldn't it be better to improve scientific knowledge and support of policy decisions by investing more time in exploring the possible impact of those things that are <u>not</u> in our framework, or on the political meaning of alternative theories that cannot be falsified. In doing this we could probably better deal with the blind spots in our knowledge, be specific in what we do not know; and sleep better, confident that all is now in the hands of the policy maker. I will come back to the policy maker later.

Annual report 2002, Science for Policy, ASTA International and national abatement strategies for transboundary air pollution, Swedish environmental protection agency and national board of forestry, 2003, p8-11

## Nagging questions

First the scientists. Of course modellers believe strongly in the results of their models. But at the same time they are faced with the problem that the more complex the model has become, the smaller the group of people that understands it and will trust its results. Industry has already complained about the lack of openness and transparency of the RAINS-model, although everything is on the internet and the meetings are open. Does this mean that we have to develop simpler models? I don't think that would be the right approach, because simplified or more reductionistic views would mean that more aspects of a problem will be forgotten: the model will be more transparent, but the system would only describe a part of the relevant reality. And the system boundaries that have been chosen to simplify reality are exactly where some of my nagging questions come from, even with a complex model as RAINS. Instead I think intensified communication is the way to build trust in integrated assessment models.

*In the information age we can no longer convince society by telling the figures came out of the computer. People only trust scientists when they can convince.*

Are we sure we don't base our advise on arbitrary choices in constructing the model? Are we perhaps sometimes selling model-artefacts? What elements of reality are not in the RAINS-model and how do these structural omissions influence the policy decision? We know that the influx of pollutants from North America is increasing and that it thus will be harder to meet air quality targets. But it is not modelled. We know that meteorological patterns will probably change in the future, but we still use the weather pattern of the past. We ignore chemical processes nearby the emission sources because we can hardly model them. We ignore the effects of humidity in estimating ozone damage to plants because of lack of data. We know there will be technological progress and a decrease of abatement costs, but we use historical cost data. We know that EU-enlargement, Kyoto-protocol and liberalisation of electricity markets will influence emission patterns, but we hardly know how to put this into the scenarios. And last but least: in our cost-curves and scenarios we assume that measures will be fully implemented, while in practice this will hardly be the case. How important are these simplifications for our policy advice?

*The future is indeterminable: if we would know the future, we would be rich.*

What would happen if we redefine the problem: e.g. if the acidification problem is not defined as an exceedance of a critical load, but as the depletion of buffering capacity, or as a loss of species, or as monetised damage? Or what if we redefine equity: not as an equal gap-closure, but e.g. as equal net-costs per unit of GDP.

What are the things we don't know or will not know in the coming years? After 50 years of research into the health effects of particulate matter it will come as a surprise to me if in the coming year it would suddenly become certain what species of particulate matter would cause the problem. There will probably also remain fundamentally uncertainty whether it is short term or long term ozone exposure that causes health damage. There will be different theories, that cannot be falsified. Do we choose the one that most likely according to most scientists or because WHO or the US-EPA has already adopted it? Or do we explore also the political meaning of alternative theories?

*New challenging theories will bring scientific knowledge further than defending old paradigms against all odds.*

These nagging questions show that there is more to uncertainty treatment than error propagation, Monte Carlo techniques, statistical uncertainty margins and probability figures. Of course we have to be aware that average emission factors have a spread, that there is meteorological variation or that critical load functions depend on the level of geographical detail. These technical analyses are awesome and necessary, especially when we try to define weak spots in our analysis that can be solved by better measurements or can advice us on the reliable spatial resolution of the model results in view of the available data and their variability. But they do not cover the whole picture.

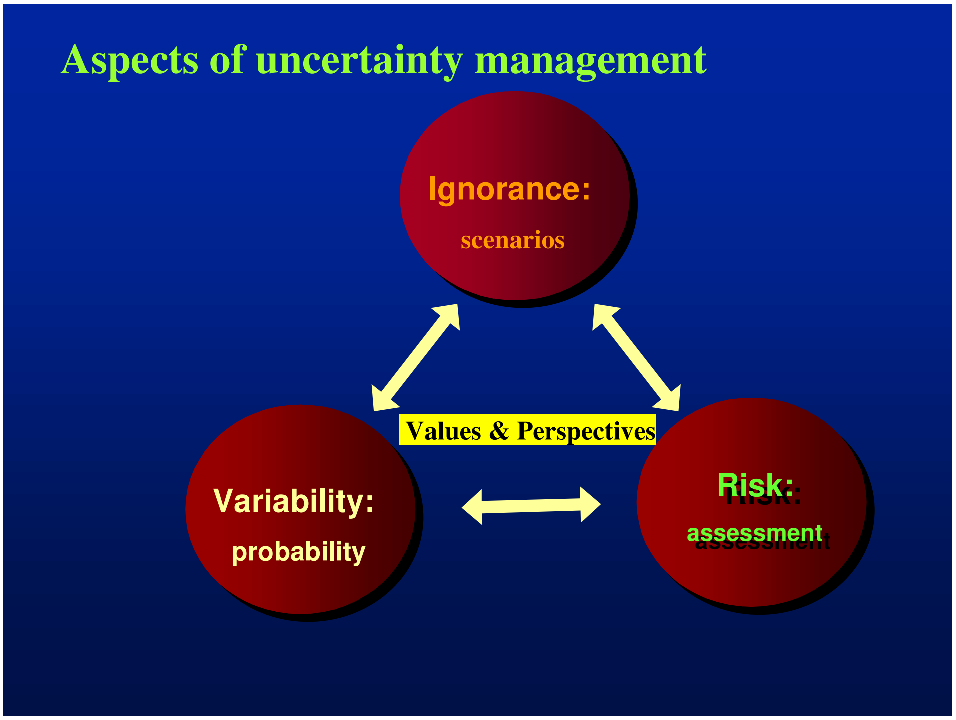
*Typos are uncertainties we tend to forget. Never underestimate the power of human stupidity: always be aware that simple typos, bugs and other artefacts might influence policy advise. Systematically scrutinise model results.*

There are several ways to distinguish the different forms of uncertainty. But the main boundary is between the quantitative uncertainties and the fundamental lack of knowledge (or ignorance). Of course this fundamental lack of knowledge should not only be tackled by philosophical remarks and obligatory disclaimers. We should develop ways to assess whether our policy advises are robust, show what the different theories mean for a policy decision, quantify them in scenarios (like we capture the inherent uncertainties in future developments) and present the right policy options for dealing with uncertainties.

## What can policy makers do?

Scientific uncertainty is a risk for the policy maker. A political risk, because if the policy maker makes the wrong choice she can be accused of not protecting the environment enough or throwing away public money. She then will of course blame the scientists. Good scientists would then show that they have warned for uncertainties and lack of knowledge, otherwise they might be liable or accessory.

How can we improve the quality of decisions when knowledge is lacking? What would a policy maker do when we present uncertainty margins or probabilities? There are several attitudes towards dealing with uncertainties in environmental policy. The two most extreme positions are ‘precaution’ and ‘no-regret’. But there are different forms in between. The policy makers that are in favour of the environmental precautionary principle would already act when there are reasonable grounds for concern. They would rather prevent problems, than take the risk of a respons that comes too late. ‘No-regret’-policy makers would only take those actions that are anyhow good and act when there is convincing proof that effects are likely and beyond reasonable doubt. They would like to wait until sufficient evidence is available and emphasise the costs of being wrong. They are in favour of economic precaution.




*Socio-political preferences are constructed during the assessment process. Assessment and decision taking belong together. Well designed procedures include stakeholder openness, disclosure of beliefs, willingness to understand the other (to go beyond the given perspective) and procedures to manage conflicts (both legally and scientifically).*

Can scientists be of any help? They can at least try to define their model output in terms of the potential risks, describe what would be needed when policy makers would be absolutely certain that health and environment are protected sufficient, even when economic growth is high, climate change policies would prove to be only hot air, and when we cannot identify the exact species of particulate matter that is causing the problem? We could also describe what would be needed with a more no-regret attitude: what would be needed anyhow if economic growth is low and additional emission reductions of air pollutants would be driven mainly by climate change policy? What abatement measures would be robust according to any theory on the health effects of particulate matter?

Does more research really help? In the long run the answer is probably yes, but in many cases reasonably certain results can hardly be expected by waiting a few years. Should policy makers wait for more research? That depends on what scientists can realistically achieve in the extra time and whether possible outcomes would really affect decisions and improve the quality of the decision process. Not waiting means more scientific uncertainty and more political risks. But perhaps these risks can be managed better when integrated assessors can more systematically present to policy makers what the range is in the probable answers in those situations where knowledge is lacking and what these answers would mean for the policy decision in view of the preferred attitude of a policy maker towards risks. What if scenarios that capture the possible structural uncertainties in integrated assessment models could be useful to test the robustness of policy strategies.

*Scientific consensus that leads to a denial of uncertainties could lead to common blindness and create more political risks than a pluralistic approach that acknowledges dissent*

For integrated assessors this would mean more open-mindedness towards conflicting or competing theories and models, as well as an active exchange of ideas with dissident experts, so that their ideas can be understood to the extend that an assessment can be made of whether their alternative views really matter for the robustness of a policy strategy. Do we hear enough dissident views within the scientific framework of the Convention on Long Range Transboundary Air Pollution or do scientists rather prefer to belong to the social group and accommodate to the views of the majority?

## How can we build trust?

Not many people understand what we are talking about, when we describe acidification and health effects and use jargon like critical loads, binding grid cells, gap-closure, ozone hills, AOTs or the statistical value of life. Laymen, politicians, businessmen and scientists who are not involved tend to be suspicious about scientific processes that are a black box to them. They complain about closed shops, lack of transparency and technocratic or even undemocratic decisions.

Many politicians and businessmen have no time or interest to study environmental problems. They hear about uncertainties and scientific dissent and take a position on the bases of  the view of those scientists they trust most, or of the scientists that can bring the message in a simple way or present a vision that does not compete with the stakes one has. Some would already get worried when some scientists express there suspicion that there might be a problem, and people who oppose regulations that could limit freedom and growth would stress the uncertainty and ask for more proof, sound science and peer reviews. Often they use the word uncertainty, while they mean that there is a lack of trust in the integrity of the scientists. Better communication is the only way out of this dilemma.

*Uncertainty is a part of any decision in public policy, in business or in private, but it often seems that environmental scientists have to play an uphill game and have to produce results with more certainty than in other policy areas.*

I my view integrated assessment modellers have already done a lot to improve their communication with the outside world: the model design was optimised to increase transparency, consistency and robustness; procedures were designed for creating consensus on input data and methodology; the participation to the scientific work was open to stakeholders, policy makers and national experts, and models, data and reports were put on the internet.

But nevertheless - due to complexity - the understanding of the model-results is still limited to those involved in the process. Can we make the problem less complex and more transparent? The debate on uncertainties will not make our communication with policy makers and stakeholders easier. That means that we at the same time have to think on how we can do better to communicate its meaning to policy makers and stakeholders.

## Literature

Further interesting reading that was used or misused in my analysis:

Paul Harremoës, David Gee, et al., *Late lessons from early warnings; the precautionary principle 1896-2000*, EEA-Environmental issue report 22, available at the EEA-website

Marjolein van Asselt, *Perspectives on Uncertainty and Risk*, Kluwer, Dordrecht, 2000

Jeroen van der Sluijs et al., *A guideline for uncertainty scanning and assessment*, draft, University Utrecht, November 2001