Dealing with Uncertainty in Policymaking

Netherlands Environmental Assessment Agency

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Dealing with Uncertainty in Policymaking

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FOREWORD

Uncertainties in policy-related knowledge: how do you determine them, how do you communicate them to policymakers, and how can you help policymakers deal with them? Adnan Rahman of Rand Europe and I met on several occasions when I was still Managing Director of the Netherlands Bureau for Economic Policy Analysis (CPB) and we discovered that these were questions that we both had on our mind. We were also convinced that a lot could be learnt from the answers that had been found in various policy areas in practice. This conviction gave us the idea to organise a conference in order to provide a forum for researchers and policymakers from different policy areas to share their experiences in this area. We were delighted to find that Arthur Petersen of the Netherlands Environmental Assessment Agency (current Dutch acronym: PBL; until May 2008: MNP – which is used in this report) was immediately prepared to get involved, so that the conference became a joint initiative of Rand Europe, the CPB and the Netherlands Environmental Assessment Agency. Representatives from the Dutch Ministry of Finance, the Ministry of Economic Affairs, the Ministry of Housing, Spatial Planning and the Environment, and the Ministry of Agriculture, Nature and Food Quality were also prepared to form a committee, together with the initiators, in order to decide on the programme of the conference and the list of delegates. Their efforts culminated in the conference entitled 'Dealing with Uncertainty in Policymaking', which was held at the Dutch National Academy for Finances and Economy in The Hague, in the Netherlands, on 16 and 17 May 2006.

The exchange of experiences and best practices was expected to provide some guidance for dealing with uncertainty in policymaking. It turned out that we were aiming too high, because of the complexity of the issues involved and the great diversity in policy environments, policy questions, types of uncertainty and experiences. However, the conference proved to be a welcome occasion for the delegates to discuss these questions and share experiences with one another. This conference report makes these insights and experiences accessible to a wider group of researchers and policymakers. Moreover, the final section seeks to bring together all the different strands of the various contributions and to draw some lessons from them.

The questions that we asked ourselves seem to be of interest to many people, but researchers and policymakers are often unaware of similar questions in other policy areas. The conference ensured that policymakers in the various ministries know that they are not on their own when they draw attention to the need to deal responsibly with uncertainty. The fact that there are usually no ready-made formulas for this may be regarded as a challenge to find a suitable policy answer in each specific case.

Thanks to the willing cooperation of the speakers, panel members, sponsors and the support team, organising this conference was not an onerous task. We are grateful to everyone for their enthusiastic input.

On behalf of the initiators,

Henk Don

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1 INTRODUCTION

1.1 Preamble

Policymakers and their advisers are expected to deal responsibly with uncertainty. The increasing complexity of the policy environment and the ever-rising cost of policy mistakes help to create uncertainties. Irresponsible handling may result in the wrong decisions. Policymakers are faced with a dilemma: on the one hand, they are expected to base their decisions on clear, measurable facts, while, on the other hand, they are confronted with developments that give rise to uncertainties as a result of variable and unpredictable processes.

The Netherlands Bureau for Economic Policy Analysis (CPB), the Netherlands Environmental Assessment Agency and Rand Europe organised the 'Dealing with Uncertainty in Policymaking' conference on the subject of this dilemma, with the cooperation of the Dutch Ministry of Economic Affairs, the Ministry of Finance, the Ministry of Housing, Spatial Planning and the Environment, and the Ministry of Agriculture, Nature and Food Quality. The conference targeted policy researchers as well as policymakers.

During the conference, the significance of clear and sound communication on how to deal with uncertainty was emphasised by means of an interactive experiment (annex A). The way in which an uncertainty is formulated appears to influence the way in which it is perceived. During the experiment the delegates were divided into two groups. Both groups were given the same uncertainty proposition, but the way it was formulated differed for each group. By way of illustration:

Group A
Suppose that the US is preparing for an outbreak of an unconventional type of Asian Influenza, which is expected to cost 600 human lives.
Two control programmes are available:
- programme A will result in 200 lives being saved.
- the result of programme B is more uncertain: there is a one-in-three chance that 600 lives will be saved, and a two-in-three chance that none will be saved.

Which programme would you choose, A or B?

Group B
Suppose that the US is preparing for an outbreak of an unconventional type of Asian Influenza, which is expected to cost 600 human lives. Two control programmes are available:
- programme C will result in 400 lives being lost.
- the result of programme D is more uncertain: there is a one-in-three chance that no lives will be lost, and a two-in-three chance that 600 will be lost.

Which programme would you choose, C or D?

This example is the well-known 'Asian disease experiment' by Kahneman and Tversky (1979). The experiment investigates how the way in which a problem is formulated (i.e. 'framing') influences the decision.

- In group A, 52% of the conference delegates opted for programme A. When the result was phrased in terms of 'gain', the *risk-avoiding* option was preferred.
- In group B, 72% of the conference delegates opted for programme D. When the result was phrased in terms of avoiding 'loss', the *risky* option was preferred.

This experiment clarified the significance of framing for the conference delegates.

Questions

The experiment set out above is only one example of risk communication. The conference focused on the following, more general questions:

- In decision-making, how can policymakers deal responsibly with uncertainties?
- What consequences does this have for communication on uncertainties in scientific policy advising?

To answer these two key questions, the conference objectives were defined as follows:

- To characterise dealing with uncertainty in the context of various types of policy problems.
- To investigate how people in the various policy arenas actually deal with uncertainty, the problems that arise and the successes achieved.
- To identify problems and important issues in communication on uncertainty between scientists and policymakers and the evaluation of 'best practices'.

The programme (annex B) shows that, in addition to a scientific consideration of dealing with uncertainty in policymaking, ample attention is devoted to the implications for policy in practice. The following policy areas were discussed in five case studies:

- Veterinary diseases and their potential transmission to human beings
- Macroeconomics and budgetary policy
- Security of energy supply
- Rural development
- Air quality.

The case studies were followed by a discussion session, introduced by a panel member involved in either policy science or policy practice. It was clear from the discussions that this topic was of great interest to both target groups.

1.2 Nothing is certain: that is the only certainty we have

Opening address by Pieter van Geel, Dutch State Secretary for Housing, Spatial Planning and the Environment

With this 'fact of life', Mr van Geel kicked off the conference. And yet we expect the State Secretary and other politicians to make decisions that are riddled with uncertainty, which sometimes has a far-reaching and adverse impact on major vested interests. As a result, politicians are constantly faced with dilemmas. If they pursue very strict policies, some things will be prohibited that they could easily have let pass. If, on the other hand, they pursue accommodating policies, they may allow things that they may very well come to regret at a later stage.

It therefore goes without saying that policy faces criticism from many quarters. Environmentalists do not mind if the government is very strict and prohibits things that are not all that serious. They argue that you cannot be too cautious where the protection of vital

ecological functions is concerned. Others feel that the government should not impose too many restrictions if the benefits in terms of conservation of ecological functions are not too certain. Faced with uncertainty, you can only do your best to make a good decision. But you make it with your fingers crossed, in the hope that your instinct is right.

There is also criticism on the way in which policy communicates uncertainties. Think of the 'de Kwaadsteniet affair' at the Dutch National Institute for Public Health and the Environment (RIVM), where the impression had been created that RIVM's publications were based on lies and deceit. These accusations stemmed from the fact that RIVM's environmental publications were not based solely on measurements, but also on computer models, and that they suggested a more certain outcome than was warranted. We have learnt a lot from this affair. The Netherlands Environmental Assessment Agency of the RIVM, now an independent planning bureau, has drawn up the *Guidance for Uncertainty Assessment and Communication*. The current reports of the Netherlands Environmental Assessment Agency use strictly defined terms such as 'virtually certain', 'very likely', 'likely' and 'fifty-fifty'.

On 25 April 2006 Mr van Geel submitted the Future Environment Agenda to the Dutch House of Representatives (*Tweede Kamer*). One of the basic principles of the Agenda is a sensible analysis of costs and benefits, which requires an understanding of these same costs and benefits. Of course, a picture can be drawn – even if everything cannot be calculated to the nth decimal place – but the problem is that policymakers and participants in the policy discussions should be plainly aware of the fact that they are relying on pictures that sometimes contain small and sometimes large uncertainties.
During the conference, Mr van Geel focused on two examples in his address:

- dealing sensibly with risks;
- climate change.

The key difference between these two issues is that dealing sensibly with risks may involve some certainty with regard to the probability distribution in terms of possible outcomes and their effects. With regard to climate change there is definitely no certainty.

Dealing sensibly with risks

Every year, 800 people die from the effects of radon exposure. This is almost as many as the 1,000 people killed in road accidents in the Netherlands every year. People are exposed to radon in the place where they feel safest: at home. Although the impact is high, it took years for preventive measures to be implemented. On the other hand, many measures have been taken in other areas where the risks are objectively lower, but where there is much more public protest, such as chlorine transport in the Netherlands, for instance. The Dutch government has spent millions towards relocating a plant in order to reduce chlorine transportations. Scientifically speaking, however, the actual risk was limited. This apparent discrepancy led to Mr van Geel launching the debate on 'dealing sensibly with risks'.

This is a complex subject area that involves various factors, ranging from hard data and scientific calculations right through to the way in which people perceive risks. The

government is faced with the challenge of performing a lucid analysis on the basis of all these different types of information. Centres of expertise can help the authorities make choices, not by calculating only the risks in terms of probability times the effect, but by looking one step ahead. What uncertainties do the calculations contain? How is the risk perceived? What are the advantages and disadvantages for society? What about the cost-effectiveness of risk-reducing measures?

The discussion on dealing with risks (complex or otherwise) has now been extended to other policy areas in other ministries in order to clarify what dilemmas they encounter and also to determine to what extent the process aspects of dealing sensibly with risks – such as transparent decision-making, making responsibilities more explicit and involving the general public – can serve as a common approach.

In this project, five dilemmas (see text box) have been identified that are important in the various stages of the decision-making process. These concern:
- unclear distribution of responsibilities ('the government is going too far' versus 'the government is not doing enough');
- basing policy on scientific certainty or uncertainty;
- standard policy versus tailor-made policy and
- the role of risk perception.

The subsequent assessment made varies per policy dossier and, as a result, may influence the choice of measures. In May 2006, Mr van Geel discussed the results of the analysis with his colleagues.

What this means is that, as far as exposure to radon is concerned, we know with a high degree of certainty how many people will die prematurely, but we do not exactly know who. The probability distribution and the effect have been determined to a reasonable

The cabinet's view on dealing sensibly with risks

Soon after the conference, the Dutch cabinet defined its view on the way in which risks should be dealt with (letter to the House of Representatives of 29 May 2006). The cabinet concluded that the Dutch government is incapable of preventing or controlling all of society's problems, but that society expects them to.
This discrepancy stems from five fundamental dilemmas that particularly come to the fore in the case of new and uncertain risks:
- a hands-off government versus political pragmatism;
- scientific rationality versus risk perception;
- scientific uncertainty versus scientific certainty;
- standard policy versus tailor-made policy;
- policy rationality versus political rationality.

The cabinet feels that there is no effective template that indicates how such new and uncertain issues should be handled politically and administratively. Furthermore, there is no uniform system of standards that applies to every risk in each policy area. Neither of these would be welcome in any case, a tailored approach is and will continue to be required with regard to new or uncertain politico-administrative issues. The cabinet has decided to seek support with regard to the following general and process-related aspects:
- opt for a transparent political decision-making process;
- make explicit the responsibilities of the government, the private sector and ordinary citizens;
- weigh up the dangers and risks against the societal costs and benefits insofar as possible;
- involve citizens earlier in policymaking than in the past;
- take into account the possible accumulation of risks in decision-making.

How these process-related agreements will work out in practice will, in the cabinet's opinion, differ depending on the issue in question, because a tailored approach is required.

degree of certainty. The emphasis is on controlling the risk against the background of many other factors.

Climate change

Climate change is a different matter altogether. The uncertainties are far greater and likewise is the magnitude of the interests. The extent to which the temperature will rise and the temperature increase that we may be able to prevent through policy are uncertain factors. The uncertainty range is large and we do not know the chances of ending up at the bottom or top of this range. We can visualise the possible effects of a temperature rise, but even then we are still faced with the uncertainty whether we have taken into account all the effects, which non-temperature-related effects are caused by the measures to be taken by us, and in what sort of world these effects will have an impact if they occur in 100 or 150 years' time. The only thing that is certain is that if the climate changes substantially, this will bring about drastic and painful changes in the way in which future generations live. This means that we are in completely different territory compared to the issue of dealing sensibly with risks. We do not know the probability distribution and, as far as the effects are concerned, we only know that they are potentially disastrous. This takes us into the realm of the precautionary principle, which the European Commission, in line with the Rio Declaration, defines as follows:

> *'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'*

In other words: not knowing is not a valid reason for not acting. And, believe it or not, that is actually sensible. It refers to the well-known English expression 'better safe than sorry'. Furthermore, the precautionary principle mentions 'cost-effective measures'. This is strange, of course, if there is so much uncertainty. The solution lies in the subsequent decision-making process.

- If the precautionary principle is invoked, it should first be agreed that the potential magnitude of the harmful effects is huge. This requires clear evidence.
- Secondly, research is needed to reduce the uncertainties. The measures should, of course, be revoked if it turns out that we are using a sledgehammer to crack a nut.

Furthermore, the measures should be proportional and non-discriminating. They should also be consistent, i.e. similar cases of uncertainty need to be translated into measures in a comparable way. The costs versus benefits should be considered in a broad sense. In this respect, the general principle in case law of the European Court of Justice should be taken into account: the protection of public health takes precedence over economic interests.

Conclusion

In his speech, Mr van Geel concluded that dealing sensibly with risks and decision-making relating to uncertainty is equivalent to making political decisions after weighing up unlike aspects. However, to ensure support for these decisions, the whole process must be meticulous and based on the available knowledge.

It goes without saying that not only politicians but also policymakers are confronted with uncertainties. The programme announcement stated that policymakers and their advisers are expected to deal responsibly with uncertainty: the increasing complexity of the policy environment and the ever-rising costs of policy mistakes may lead to uncertainty which results in the wrong decisions. The State Secretary therefore applauds the fact that the aim of this conference is to provide some guidance for policymakers in the area of dealing with uncertainty. For that matter, it is likely that politicians may also learn a great deal from this.

2 SCIENTIFIC CONSIDERATION OF UNCERTAINTY

There is ever-increasing interest in scientific research into dealing with uncertainty in policymaking at a policy science and policymaking level, which provides useful input for policy debate. During this conference, Arthur Petersen (Netherlands Environmental Assessment Agency) outlined different ways of characterising uncertainty. Rob Hoppe (University of Twente) then described the role of heuristics and boundary work arrangements in dealing with uncertainty in policy advising. Finally, Jeroen van der Sluijs (Copernicus Institute of Utrecht University) focused on the key role of uncertainty communication in bridging the gap between science and policy. A summary of their addresses is given below.

2.1 Dealing with uncertainty in policymaking

Arthur Petersen, Netherlands Environmental Assessment Agency

Uncertainties constantly attract our attention. During the preparations for this conference, the initiators became convinced of the importance of combining their efforts in the field of dealing with uncertainty in policymaking. The huge interest shown by policymakers and scientists to attend the conference confirmed the organisers in their view. The policy environment is characterised by uncertainties that can be defined in different ways. Many policymakers are faced with unfamiliarity with uncertainties, such as their significance and implications in preparing policy. Policy advisers are also constantly challenged by the question as to which uncertainties they need to take into account, and, in particular, how these should be presented. There are clearly plenty of reasons to consider the situation with regard to supply and demand of uncertainty information. This conference therefore aims to gain insight into what could be best practices, by looking at specific case studies.

Scientific advisers should adopt a reflective attitude when taking action. There are many methods to deal with uncertainty, but these are merely tools and not solutions as such.

In this respect, the *Guidance for Uncertainty Assessment and Communication* of the Netherlands Environmental Assessment Agency should be regarded as a tool rather than a protocol. [1)]

1) The *Guidance for Uncertainty Assessment and Communication* was developed from 2001 to 2003 by Utrecht University and the Netherlands Environmental Assessment Agency (at the time still part of the RIVM) with input provided by a multidisciplinary team of more than 25 experts on uncertainty from all over the world. More information about this document can be found on http://www.mnp.nl/guidance. See also van der Sluijs et al. (2008).

It is important for advisers to provide policymakers with adequate information about uncertainty. In this respect, they need to be aware of the fact that disclosure of uncertainties may result in fear of policy paralysis. Sound communication between policymakers and advisers therefore requires a great deal of attention.

The *Guidance for Uncertainty Assessment and Communication* produced by Utrecht University (UU) and the Netherlands Environmental Assessment Agency (at the time still part of the Dutch National Institute for Public Health and the Environment, or RIVM for short) makes use of a typology of uncertainties representing five dimensions [2] (see Figure 2.1) for communications between experts. This typology aims to determine which classes of uncertainty deserve special attention in a scientific study intended for policy.

- The first dimension is 'location': where do the uncertainties manifest themselves in the framing of the problem? The typology of uncertainties can be presented as a matrix in which the various possible locations are indicated vertically and the other four uncertainty dimensions each have their own column (see Figure 2.1).
- The second dimension is the 'level of uncertainty', which ranges on a scale from 'ignorance' to 'determinism'.
- The third dimension is the 'nature of uncertainty': uncertainty not only stems from incompleteness of knowledge and information, but also from the variable character of the system and/or problem under study.
- The fourth dimension is 'qualification of knowledge base'. This dimension refers to the degree of underpinning of the results and statements.
- The fifth dimension is the 'value-ladenness' of the choices made in a study: the perspectives, the knowledge and information that will be used, the presentation of results, etc. This serves as an evaluation of how scientists deal with the liberties they have.

The types of uncertainty that play a major role in a particular policy problem partly depend on two factors:

- the degree of consensus on the knowledge utilised in the policymaking process;
- the degree of consensus on values.

On the basis of these dimensions we are able to determine to what extent a problem is structured or unstructured. Where there is high consensus on knowledge and values, we can speak of a structured problem. This happens, for example, when road maintenance is on the agenda. If there is no consensus either on knowledge or values, we talk about a moderately structured problem. Examples include abortion and euthanasia, where there is definitely no consensus on values. Particulate matter is an example of a moderately structured problem with no consensus on, in particular, knowledge. There is general agreement that we are seeking to protect public health, but there are still many uncertainties at the scientific level regarding the causal explanation of the effects of particulate matter. An unstructured problem arises if no consensus can be reached on either knowledge or values. The topical theme of climate change falls into this category.

2) These five dimensions are explained in the RIVM/MNP document *Guidance for Uncertainty Assessment and Communication, Quickscan Hints & Actions List*, 2003, and in Petersen, 2006, among other publications.

UNCERTAINTY MATRIX			Level of uncertainty *(from determinism, through probability and possibility, to ignorance)*			Nature of uncertainty		Qualification of knowledge base (backing)			Value-ladenness of choices		
Location ↓			Statistical uncertainty (range+ chance)	Scenario uncertainty (range as 'what-if' option)	Recognized ignorance	Knowledge-related uncertainty	Variability-related uncertainty	Weak –	Fair 0	Strong +	Small –	Medium 0	Large +
Context		Ecological, technological, economic, social and political representation											
Expert judgement		Narratives; storylines; advices											
Model	**Model structure**	Relations											
	Technical model	Software & hardware implementation											
	Model parameters												
	Model inputs	Input data; driving forces; input scenarios											
Data (in general sense)		Measurements; monitoring data; survey data											
Outputs		Indicators; statements											

Figure 2.1 Uncertainty Matrix

The same two factors (degree of consensus on knowledge and on values) determine the types of uncertainty that merit most attention in scientific policy advising. In the case of consensus on knowledge and values it is usually sufficient to refer to statistical uncertainty. As far as little consensus on knowledge only is concerned, there is usually uncertainty in the evidence base, with increased reference to recognised ignorance. Where there is little consensus on values alone, uncertainty manifests itself in value-ladenness. In the case of little consensus on both knowledge and values, it is obvious that there is uncertainty due to lack of a systematic knowledge base and strong value-ladenness.

Conclusions

This typology of policy problems should not be interpreted statically. Different actors may have different views on the type of problem with which they are confronted and, consequently, also on how uncertainty should be dealt with. At a generic level, people may also have different views on the role of science in policymaking. The MNP and Utrecht University carried out an experiment with different actors to explore their attitude towards uncertainty and science. They presented the following four propositions:

1. Uncertainty is unwelcome and should be avoided. The challenge for science is to eliminate uncertainty by means of more and better independent research.
2. Uncertainty is unwelcome but unavoidable. The challenge for science is to quantify uncertainty and to separate facts and values as effectively as possible.
3. Uncertainty offers chances and opportunities. Uncertainty puts the role of science in perspective. Science is challenged to contribute to a less technocratic, more democratic public debate.
4. The division between science and politics is artificial and untenable. Science is challenged to be an influential player in the public arena.

The people who participated in this experiment had to choose the proposition that corresponded best with their perception.

During the conference, this experiment was repeated with the delegates, of whom approximately half were policymakers and the rest scientists. The outcome is set out in Figure 2.2.

This shows that there is a difference in attitude between the policymakers and the scientists who took part in the experiment as far as uncertainty and science are concerned. Most policymakers prefer quantified information about uncertainty and a clear distinction between facts and values. Most scientists regard uncertainty as a source of opportunities and would like to see society devote more attention to this topic. Although this experiment is not the same as scientific research, the results are equivalent to the results of scientific experiments carried out by the Netherlands Environmental Assessment Agency and Utrecht University. (See Wardekker et al., 2008).

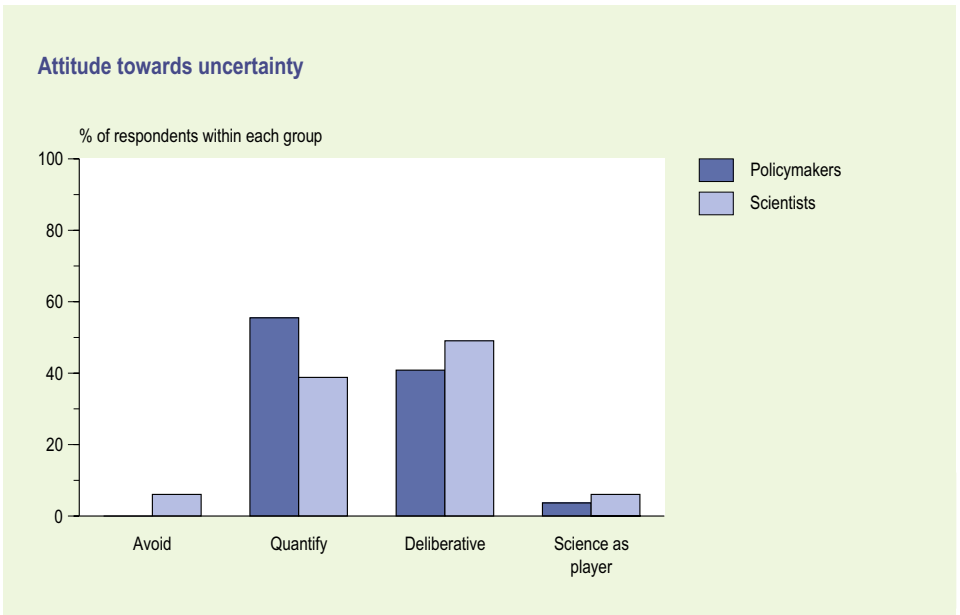


Figure 2.2 Results of experiment done at the conference

2.2 The role of heuristics in dealing with uncertainty in policy advising

Rob Hoppe, University of Twente

Introduction

Scientific policy advisers, including the Dutch planning bureaus, have noticed that analysis of and communication on uncertainty are politically sensitive issues, since the anticipated effects of policy measures have consequences for actors and sectors in society. Moreover, political sensitivity does not start as soon as the results are communicated, but back at the stage when an advisory report is commissioned, i.e. when the policy problem itself is framed (Jasanoff, 1990; van Asselt, 2000).

Fortunately, we have heuristics so that the wheel does not need to be reinvented time and again. Heuristics provide the direction for an extremely complex process of giving meaning to uncertainty (identifying, interpreting and analysing), developing knowledge about uncertainty, and making decisions on how uncertainty should be dealt with when making a model, or writing or presenting a report. Generally speaking, heuristics are more or less articulated methods for dealing with uncertainty.

They can adopt a wide range of forms, some of which can be identified clearly, while others require further analysis before they become manifest. Common forms of heuristics include scientifically detailed methods and techniques, social techniques, organisational cultures, protocols, guidelines, objects, rules of thumb and intuitive approaches. When considering the heuristics applied by leading scientific policy advising institutions, we observe that they have all undergone learning processes that resulted in completely different heuristics for dealing with uncertainty.

The Netherlands Bureau for Economic Policy Analysis (CPB) primarily applies modelling techniques (model refinements, margins of error and scenarios), while the National Health Council mainly uses social techniques (subtle committee work, carefully manoeuvring of secretarial staff, smooth handling, a new mixture of discretion and transparency). These social techniques are usually embedded in organisational cultures and practices. For the time being and insofar as visible for outsiders, the Netherlands Environmental Assessment Agency appears to be most advanced in codifying or standardising its heuristics by developing the *Guidance for Uncertainty Assessment and Communication*, with which it provides interesting input relating to new heuristics for the analysis of uncertainty. However, even with regard to this document, the ball remains firmly in the court of the scientific policy advisers. In dealing with uncertainty, the role of policy-making civil servants, administrators and politicians remains too obscure. This is a shame, because a dominant conclusion has emerged in literature relating to business administration and policy science with regard to the topic of usage of knowledge, namely that political knowledge and information determine what professional, policy-relevant information is significant enough to be included in the public debate. Political information (who thinks what, at what level of intensity, and with what consequences for

coalition-oriented policy and electoral chances?) is thus the framework and benchmark for policy information (is it true; does it work, is it effective, efficient and feasible?).

At least, this is the standard view shown by the outcome of empirical research into utilisation and transfer of knowledge. One good example is the recently published report of the Dutch Scientific Council for Government Policy about dealing with Islamism. Irrespective of people's views on the quality of this report in terms of policy information, it was evident that, for political reasons, this report needed to be excluded from public debate and public opinion-forming as soon as possible. The question is whether the standard view will last in models where policy/politics and scientific consulting tend to be considered more as dialogue-based, two-way traffic! For that matter, there is good reason to assume that political heuristics for dealing with uncertainty differ from more scientifically-influenced heuristics.

Boundary work arrangements

The practical solution to tackling the differences between political and scientific heuristics for dealing with uncertainty is provided by *dynamic dualism* or *boundary work*. People can handle polarities by alternating emphasis on unavoidable opposites: dynamic dualism, with, at the same time, refined methods of boundary work in the sense of division of labour between science and policy/politics, whereby a distinction is made and coordination takes place simultaneously. This brings us to the importance of insight into various types of boundary arrangements between science and policy/politics (Table 2.1).

All models live 'in the shade' of the politically-correct image: the primate of politics or decisionism. Earlier research (Hoppe and Huijs, 2003) showed that scientific advisers state their formal positions in terms of black-and-white contradictions, while they all claim to be seeking to move towards dialogue models.

Table 2.1 Types of boundary work arrangements (in academic research and the literature)

Operational code	Primacy in science	No primacy; dialogue	Primacy in politics
Divergent (at odds)	(1) Enlightenment model (provider of ideas)	(2) Advocates' model (provider of arguments).	(3) Bureaucratic model (provider of data)
Convergent (creating order)	(4) Technocratic model (science as a virtual power)	(5) Learning model (research community as a political role model)	(6) Engineers' model (social technology)

Source: R. Hoppe, Van flipperkast naar grensverkeer. Veranderende visies op de relatie tussen wetenschap en beleid, Advisory Council of Science and Technology Policy (AWT), Background study 25, February 2002.

Table 2.2 The complete data matrix relating to heuristics for dealing with uncertainty

	SP		MSP(t)		MSP(m)		UP	
	Analysis	Politics	Analysis	Politics	Analysis	Politics	Analysis	Politics
Problem framing								
Involvement of stakeholders								
Selection of indicators								
Appraisal of knowledge base and methods								
Assessment of relevant uncertainties								
Reporting and communicating on uncertainties								

Key: SP = structured problem; UP = unstructured problem; MSP(t) = moderately structured problem with target consensus; MSP(m) = moderately structured problem with means/knowledge consensus - all used in the sense explained in the preceding address by Arthur Petersen. The rows correspond to parts of assessments defined in MNP's Guidance for Uncertainty Assessment and Communication (MNP/UU, 2003).

If we consider the heuristics, these could relate to assignments for the case studies (cf. Table 2.2):

- Identify for each case the analytical methods and techniques or heuristics used by scientists or scientific advisers.
- Identify for each case heuristics based on political thinking and action used by policy advisers and administrators with political responsibilities, or by politicians themselves.
- Identify contradictions and controversies, or complementarity and like-mindedness.
- Why is something a good practice or a bad practice?

Conclusion: towards a systematic research agenda

Organisation of scientific work

- Key questions: what do I think that I actually know and don't know? How much will it affect the model/simulation and what does this mean for the policy-relevant statements that I seek to make on the basis of the results?
- Analytical methods for uncertainty are not solutions but tools for professional reflectiveness (see 'Niet bang voor onzekerheid', RMNO [3], 2003).
- Expert consensus is a political heuristic (acceptability heuristic) for utilising scientists' alleged authority in a politically legitimised way; it is not a solution (as suggested in 'Willens en wetens', RMNO, 2000)
- Experts can contribute at most to temporary but productive consensus on decisions at action level; incorporate the need for learning!

3) Raad voor ruimtelijk, milieu- en natuuronderzoek (Advisory council for research on spatial planning, nature and the environment) or RMNO for short.

- Transdisciplinarity has many pitfalls. 'Receptivity' to it is in contrast with cognitive functioning and professional identity (see 'Niet bang voor onzekerheid', RMNO, 2003).
- How much, in the sense of resources, do you need to earmark for research that can topple the prevailing policy paradigm? (This should roughly be in proportion to the societal damage caused if the prevailing policy paradigm proves to be entirely wrong).

Excessive uncertainty may result in people performing poorly from a cognitive point of view, in the same way as it may result in fear among animals, and, consequently, in a 'fight-or-flight' response. In politics and policy, excessive uncertainty and fear will prompt flight-into-fatalism behaviour and indifference ('I don't know anything about politics, and I don't care to know!') or fight-through-hierarchy behaviour (increasing call for energetic, bold leadership and straightforward policy: 'I say what I do, and do what I say!').

Organisation of politics and policy work

- Key question: if, from a political point of view, I intend to do this and I wish to take uncertainties into account, what should I do differently? What should I do and what perhaps shouldn't I do? Or do extra? (see 'Niet bang voor onzekerheid', RMNO, 2003)
- Horizontalisation (more coherence in policy through enhanced insight), fallibility (capable of making mistakes but evaluating them effectively and learning more from them quickly) and proceduralisation (fostering fair and cognitively responsible progress rather than concrete results).
- At odds with the image of political leadership as a 'man or woman without doubts'.
- Politicians would like to 'learn' but do not dare to 'try' for fear of being told they 'failed' at a later stage.

Organisation of boundary work

- At institutional level: research into the division of responsibilities regarding dealing with uncertainty (see Table 2.3) [4].
- At the level of practices and individuals: research into best practices, training and courses, etc.

4) Within the framework of MNP's research project 'Uncertainties, Transparency and Communication: Communication with policymakers and perspectives on uncertainty', A. de Vries, under supervision of Prof. R. Hoppe and Dr W. Halffman, all of them connected to the Science, Technology, Health and Policy Studies Capacity Group, conducted a study into the differences between the MNP and the CPB in how they deal with uncertainties in their practices of scientific policy advising.

Table 2.3 Outline of hypotheses relating to differences in models of boundary traffic between science and politics concerning uncertainty and confidence.

Dealing with	Enlightenment model	Technocratic model	Bureaucratic model	Engineers' model	Advocates' model	Learning model
Uncertainty	Political responsibility	Temporary problem; seldom practical objection	Rule-driven control from system perspective	Fallibilistic actor perspective	Negotiate; robustness	Designed and/or spontaneous learning processes
Confidence/ distrust	Institutional distrust	Institutional distrust	Ambivalent	Conditional confidence	Unsteady balance; a lot of confidence-oriented work needed	Institutional confidence

Source R. Hoppe, *Van flipperkast naar grensverkeer. Veranderende visies op de relatie tussen wetenschap en beleid*, Advisory Council of Science and Technology Policy (AWT), Background study 25, February 2002.

2.3 Uncertainty communication

Jeroen van der Sluijs, Utrecht University

Uncertainty communication plays a key role in bridging the gap between science and policy in the process of managing complex risks. Whether the emphasis is on accepting uncertainty, acting responsibly in an uncertain situation or understanding the nature of uncertainty, a balanced form of communication on this topic is essential. One of the Copernicus Institute's tasks is to carry out research into risks and uncertainties, including several projects that focus on uncertainty communication.

Research into uncertainty communication is based on workshops with international uncertainty experts, literature studies, communication experiments in the Policy Laboratory of Utrecht University and an on-line survey among a broad-based group of knowledge users. Participants in this survey included scientists, students, policymakers and policy advisers.

Complex, uncertain risks are characterised by the following typical traits (Funtowicz and Ravetz, 1990):

- Decisions are needed before there is unequivocal scientific evidence of the risks.
- The potential impact of these decisions (or lack of decisions) is immense and far-reaching.
- Social conflicts about values that are at issue.
- The knowledge base is characterised by major (partly uncontrollable and largely unquantifiable) uncertainties, multicausality, gaps in knowledge and insufficient understanding of the system.
- Risk analysis is dominated by models, scenarios, assumptions and extrapolations.
- Problem framing, assumptions made, indicators selected and performance indicators are subject to value-ladenness.

In the meantime, the scientific policy arena increasingly recognises the importance of dealing responsibly with uncertainty.

From the field of Sociology of Scientific Knowledge (SSK) we know that the phenomenon of an 'uncertainty trough' is common. When the degree of uncertainty in knowledge perceived by the various actors is considered in terms of social distance to the producers of knowledge; firstly, the actors that are directly involved in the production of knowledge, secondly the actors involved in institutional research programmes and that are users of the knowledge generated and, thirdly, the actors that are not involved either in the production of knowledge or in institutional research programmes. It is apparent that if the various groups of actors consider the same knowledge, the second category - those engaged but not directly involved in the production of knowledge - regard this knowledge as the least uncertain (MacKenzie, 1990).

Three fundamentally different paradigms of uncertainty in knowledge can be distinguished in the field.

1. The first is that uncertainty is considered to be a 'flaw'. In this respect, uncertainty is seen as a temporary problem. An attempt is made to reduce uncertainty, for example by producing increasingly complex models. The techniques applied include Monte Carlo, Bayesian belief networks and other quantification techniques. The pitfall of this paradigm is that a false certainty is created, because the numbers obtained from these models suggest more knowledge than there actually is.
2. The second paradigm considers uncertainty to be a problematic lack of unequivocalness. The solution proposed is a comparative evaluation of individual research results, focused on building scientific consensus. Multidisciplinary expert panels such as the Intergovernmental Panel on Climate Change (IPCC) are established for this purpose. This approach focuses on generating robust conclusions. The pitfall of this paradigm is that matters on which no consensus can be reached continue to receive too little attention, while, in fact, this dissension is often extremely policy-relevant.
3. The third paradigm is that of uncertainty as a fact of life. It acknowledges that complex issues are dominated by unquantifiable uncertainties that partly result from the production of knowledge (e.g. the use of models). This correlates with a more qualitative and reflective approach to uncertainty. The aspects to which more attention is devoted include ignorance, assumptions, value-ladenness, underdetermination (the same data allow for several interpretations and conclusions), etc. Techniques that are applied to deal with this are Knowledge Quality Assessment and risk management (including production of knowledge) as a deliberative (participative) social process. The pitfall of this paradigm is that uncertainty is highlighted to such an extent that we forget how much we actually do know about the risk concerned and on which aspects there is, in fact, consensus.

Interesting insights into uncertainty have been acquired. Whereas research usually aims to reduce uncertainty or control it more effectively, the fact is that it often results in increased uncertainty. This is due to unforeseen complexities and irreducible uncertainties. Moreover, complex risks are often dominated by non-quantifiable uncertainties. At the same time, the failure of uncertainty management implies that confidence in science

and institutions may be shaken. Information about uncertainties therefore provides useful input for the policy debate. Instead of focusing on reducing uncertainty, it is important to deal with it in an explicit, systematic and open way.

Four uncertainty dimensions to promote uncertainty communication can be identified:
1. Technical uncertainty, where accuracy and inaccuracy are the two limits.
2. Methodological uncertainty, where reliability and unreliability are the two limits.
3. Epistemological uncertainty, where understanding and ignorance are the two limits.
4. Social uncertainty, where social robustness and social non-robustness (widely perceived untrustworthiness of knowledge claims) are the two limits.

A good example of these four dimensions is the massive changes in reported ammonia emission in the year 1995 in successive annual editions of the Environmental Balance, which range from 150 to 200 million kilograms. The technical uncertainty mainly relates to the margin of uncertainty in the conversion factors of the manure and ammonia model, whereby nitrogen in animal feed is converted into nitrogen in manure, and nitrogen in manure is converted into ammonia emissions for different animal species, types of sheds, grazing practices, fertilisation practices, etc.

As a result of new measurements and progressive insight, both the averages and the standard deviation for these conversion factors (constants in the model) change, at which point emissions in previous years are recalculated using the agricultural censuses for that period, but using newly determined conversion factors. The impacts of these recalculations (reflecting methodological uncertainty) on the calculated 1995 emission falls outside the 95% confidence interval that accounts for the technical uncertainty only. The epistemological uncertainty prevails, because the actual extent of the systematic error in the monitoring method is and will remain unknown. This is due to the fact that ammonia emissions from manure are a highly diffuse source. There are no measuring instruments that can validate the annual emissions of ammonia in the boundary layer between the ground level in the Netherlands and the atmosphere.

The apparently major impact of recalculations of emission figures and the fact that the figures are adjusted with retroactive effect every year are confusing for society and raise questions among knowledge users about the reliability of the figures and the competence of the producers of knowledge. As far as social uncertainty is concerned, the apparently significant impact of recalculations on the emission figures plays a key role.

Pedigree analysis

Pedigree analysis is an analysis that evaluates the ‘strength’ or scientific status of a figure. Pedigree literally means ‘genealogy’, ‘origin’ or ‘background’: how did the figure originate and does it have a good background? Two aspects are considered here: how does a figure (in a conclusion) come about and what is its scientific status, and how is it substantiated?

Criteria that may be used in the pedigree analysis for evaluating a model include ‘proxy’ (degree of directness of the indicator applied), ‘quality and quantity of the empirical

basis', 'theoretical basis', 'representation of the system's underlying causal mechanisms', 'plausibility' and 'degree of consensus'. A score ranging from zero to four is allocated to each criterion in the pedigree analysis, depending on how the figure originated. The total score gives an idea of the knowledge level per factor analysed. For example, the knowledge level of the NH_3 emissions factor may obtain a high or low score for use in models, in terms of empirical basis and theoretical understanding.

Environmental Balance for 2005

The Netherlands Environmental Assessment Agency commissioned the Copernicus Institute to carry out an evaluation of uncertainty communication in the 2005 Environmental Balance (2005 EB), see Wardekker et al. (2008). This involved other policymakers and stakeholders, amongst others. The results showed that nobody had read annex 3, in which the uncertainty terminology used was defined and explained. As a result, readers had interpreted these terms other than intended. It was also found, however, that readers considered uncertainty information to be useful input for public and scientific debate. The aspects that are definitely policy-relevant should be determined better and communicated clearly and in understandable language.

Use of Pedigree analysis

Pedigree analysis is useful because it enables you, for example, to prioritise agenda items and model improvements, determine the robustness of measures and assess risks. It also supports negotiations and assessment of the desirability of actions. At the same time, however, we notice that at political level interest in uncertainty information does not increase until something has really gone wrong.

Research has shown that policymakers consider the extent to which a target is exceeded just as important as the probability of exceeding it. In other words, respondents weigh the impact of an occurrence just as heavily as the risk of it happening. The conclusions of the surveys and the literature study also indicate that the choice of wording relating to certainty expressions such as 'virtually certain' and 'very unlikely' are context-sensitive. This mainly seems to depend on how severe the effect is and the need for policy intervention. In this respect, it has also been found that probability terms are interpreted differently per actor. Policymakers interpret the expression 'fifty-fifty' much more broadly.

Another aspect is the fact that, with regard to the 2005 EB, it was decided to handle estimation uncertainty and monitoring uncertainty differently for relative and for absolute policy targets. Estimation uncertainty refers to uncertainty in predicting trends in emissions between now and the target year. Monitoring uncertainty expresses the degree of accuracy with which emissions can be measured. In the case of the climate, there is a relative policy target (reduction in emissions compared to 1990). The choice made in the 2005 EB is based on the fact that with a set monitoring method, the monitoring uncertainty in the target year and in the reference year may cancel each other out and that only the estimation uncertainty is relevant. As far as NO_x is concerned, there is an absolute emission ceiling that should not be exceeded. In this respect, both the estimation uncertainty and the monitoring uncertainty in the target year are important with regard

to the question as to whether the target will be achieved. The respondents disagreed that monitoring uncertainty should be omitted for relative targets and felt that both should always be specified, because, at sectoral level, absolute ceilings are applied and relative targets are often translated into absolute ceilings over the course of time.

The resulting criteria for effective uncertainty communication are:
- Meet the criteria for good scientific practice by ensuring a scientifically and methodologically sound basis.
- Give access to underlying uncertainty information.
- Put essential uncertainty information in the most widely read parts of a report (i.e. not in an annex, preferably in the summary, for example).
- Be clear and unequivocal to avoid possible misinterpretation and bias.
- Do not make the information needlessly complicated, and write clearly and in understandable language.
- Ensure that the message is tailored to the information needs.
- Actively build confidence and credibility.

The following quotation is very relevant to the question of how to deal effectively with information, particularly relating to complex topics (Pereira and Corral, 2002):

> *'"Progressive Disclosure of Information" entails implementation of several layers of information to be progressively disclosed from non-technical information through more specialized information, according to the needs of the user.'*

Conclusions

On the basis of the study, the initiative was taken to compile a list of factors that determine the policy relevance of uncertainty. Further research may supplement this list.

The policy relevance of uncertainty is higher if:
- it has a significant impact on policy advice.
- the outcome of an indicator is close to the policy target or a threshold value.
- there is a possibility of major effects or catastrophic consequences.
- an underestimation of risks has completely different policy implications compared to an overestimation ('being wrong in one direction is very different from being wrong in the other').
- there is social controversy relating to the risk concerned.
- choices made in the production of knowledge are value-laden and conflict with the interests of stakeholders.
- the public observes a high risk and distrusts the results that indicate a low risk (e.g. UMTS masts).

3 UNCERTAINTY IN POLICY PRACTICE

In line with the objective of the conference, namely to determine how different policy arenas deal with uncertainties and the problems and successes emerging from them, in this chapter the following case studies of policy in practice are presented, including the results from discussions on:

- veterinary diseases and their potential transmission to human beings;
- macroeconomics and budgetary policy;
- security of energy supply;
- rural development;
- air quality.

Finally, this chapter will give an account of the panel discussion and the ensuing reactions from the audience.

3.1 Case I: veterinary diseases and their potential transmission to human beings

Reneé Bergkamp, director-general of the Ministry of Agriculture, Nature and Food Quality

The policy problem

This presentation focuses on the ability of the Ministry of Agriculture, Nature and Food Quality to learn from policy in practice during a veterinary disease crisis. In the first part of the presentation Mrs Bergkamp briefly discusses European and Dutch policies governing veterinary disease. Following this, in the second part the BSE crisis is discussed, the third component is the story of how the Ministry deals with veterinary diseases and their potential transmission to human beings with the case of 'Avian Influenza'. The final part will consider what the Ministry has learnt from both cases with a view to possible veterinary disease crises in the future.

Control of veterinary disease always entails drastic decisions. This applies even more to veterinary diseases that may be transmitted to human beings (zoonoses). In times of crisis it is therefore necessary to act without delay even if the situation is still uncertain. Risk assessment and risk management are subject to high political pressure and time pressure. In such situations we cannot afford to initiate long-term research paths and wait for the results. They require immediate action. As a veterinary disease crisis involves uncertainties that concern every individual, this topic may lead to considerable disruption and unrest for many people.

European and Dutch policy in a nutshell

At the European level, legislation governing prevention and control of veterinary disease has been harmonised. In other words, all European countries pursue an identical policy governing the control of veterinary disease. The current EU policy governing veterinary disease aims at a disease-free status for major contagious diseases such as BSE, Avian Influenza and FMD, the so-called A list. The key focus areas for achieving the policy target include non-inoculation of animals, increased protection of animals by means of higher hygienic standards and reduction of the risk of contamination from outside. The latter can be achieved with restrictive import criteria and inspections. Although the EU has a harmonised policy, the precautionary principle offers national governments some leeway in the *application* of European policy.

A trend can be observed whereby the European Commission (EC) is gradually abandoning the strict interpretation of harmonisation. The EC is looking for a differentiated approach. This quest is also prompted by the fact that the European member states are increasingly beginning to realise that the current path is not always the right one for every situation and gives rise to high costs as well as causing social resistance. The EC is looking for the right balance. At all events, inoculation is now permitted, in principle, as a control measure and so is preventive inoculation as a pilot project for Avian Influenza.

In the Netherlands the scope offered for applying the precautionary principle has led to the development of a unique system known as the 'standstill principle'. This principle is applied at the moment of an outbreak of veterinary disease, whereby no animals or products are transported to and from cattle farms for a period of 72 hours. Furthermore, the recommendations of an independent expert group and ongoing monitoring provide insight into the problem so that choices can be made in order to reduce risks (e.g. inoculation or non-inoculation). In this respect, crisis scenarios are of vital importance for the implementation and maintenance of the policy decided upon.

The BSE crisis

Background and risks

During the mid-nineteen eighties BSE became well-known as a bovine animal disease. At the time, we only knew that the disease could be transmitted from carcass meal to other cattle. People were not aware of the fact that BSE could also be transmitted to human beings. During the early nineteen nineties there was ever-growing evidence that people could contract Creutzfeldt-Jakob disease (CJD) after eating contaminated beef, which prompted new discussions on the basic insight into infectious diseases.

The impact of BSE as a risk to public health was significant due to a combination of factors. This was a completely new and threatening phenomenon. It was feared that many people were already potentially infected at a moment that those responsible for public health came to realise how serious the situation was. The long incubation time (six years and longer) and the prognosis of the eventual number of victims intensified this uncertainty. Furthermore, it became clear that people at that moment could not imagine how drastic the required prevention measures would be.

During the BSE crisis, the European policy principle governing food production stipulated that member states could not take preventive measures until there was hard evidence of a risk to public health. In the build-up to the BSE crisis, the conflicting scientific recommendations regarding BSE risks was therefore one of the causes of high tension between European and national policymakers. Several member states took unilateral measures. The EU eventually gained control of the situation by taking draconian measures which – in retrospect – it could only afford to do once. Financial and social considerations would exclude a repetition of this approach.

In summary, the problems relating to BSE comprised: a new disease of unknown magnitude, contradicting scientific recommendations, no control by the EU, a panic situation, reflective review at the time of the problem, and no early warning system.

In comparison with other member states, the BSE crisis went smoothly in the Netherlands. Major reasons for this include decisive and unilateral action, prompt implementation of measures, and transparent, adequate communication to the consumer. The former Minister, van Aartsen, had a cohort of calves (63,000) that had been imported from the United Kingdom slaughtered as a precautionary measure. The affected parties received financial compensation. The scientific view was that this was a disproportional approach, but people in political circles responded differently: Mr van Aartsen had shown vigour!

The Netherlands is often one of the forerunners in controlling a crisis. This is probably due to the fact that we are an exporting country and need to act transparently. In this respect, maintaining consumer confidence is at the forefront. The advantage of this 'forerunner' approach, is that there was no mass embargo on people buying beef in the Netherlands. This is also the result of transparent communication to the general public. Things were very different in our neighbouring countries. The British government applied the tried-and-tested strategy of covering things up and denying. Even when there was overwhelming evidence of the magnitude and risks of BSE, the British government still acted as though it was of no concern. This ostrich attitude led to ministers in the United Kingdom, and also in Germany, being forced to step down and senior officials being dismissed.

The role of scientific knowledge and experts
Scientific knowledge is of vital importance for making an unknown problem known and recognised. At the time of the BSE crisis, however, decision-making was purely a political process both at the time that the member states took unilateral action and when the EC gradually regained control. The main reason for this was the lack of consensus in the scientific recommendations. Since then, veterinary experts – represented in the Standing Veterinary Committee – have been given a mandate to transpose the current policy into specific measures. Furthermore, following the many veterinary disease crises that had occurred, in 2002 the European Food Safety Authority (EFSA) was founded. This scientific authority is in charge of scientific risk analysis and assessment of food and food safety, which includes animal health, animal welfare and crop protection. Theoretically speaking, the EFSA's recommendations are guidelines but in practice

they are almost always binding. It therefore hardly ever happens that the EU ignores its recommendations.

What did we learn from the BSE crisis?
Transparent and adequate communication, also about uncertainty, is of overriding importance for consumer confidence.

Political decision-making and scientific consulting need to be separated. As mentioned earlier, veterinary experts are represented in the Standing Veterinary Committee. Also, the EFSA was founded and, in the meantime, has developed into a leading authority on scientific advice in the field of food and food security.
Monitoring and reflection by science has a legitimising and cushioning function. During and after the BSE crisis in the Netherlands there was an increased need for knowledge so that we would not be taken by surprise again and would be better able to anticipate the attendant risks and uncertainties of such a crisis in the future.

In times of crisis, the EU can regain control by applying the precautionary principle and looking for a balance between harmonised European policy on the one hand and differentiated, more tailor-made measures on the other. The initiative for establishing European BSE policy was taken during the BSE crisis at a time when the priority was to provide an effective answer to an uncertain and potentially major risk to public health. The present measures have been extensively harmonised, mainly because member states had taken unilateral measures and the EU felt that it had lost control. A general lesson that the EU has learn from the BSE crisis is that it could only afford the 'luxury' of taking draconian measures one time. Society would not accept such drastic measures again, simply because the economic and social costs incurred are too high. In future, we will need to deal differently with veterinary disease crises that may pose a risk to humans.

The first signs of awareness can be observed in the TSE roadmap. With this document, the European Committee initiated a broad-based discussion about the possible reform and relaxation of the measures taken within the framework of the BSE issue. Monitoring data has shown that the BSE epidemic is definitely on its way out. Furthermore, large-scale monitoring of TSE/BSE scrapie among sheep and goats has been carried out and, in the summer of 2007, the EFSA will express its scientific judgement on a new test that distinguishes between scrapie (which does not pose a risk to human health) and BSE. Both diseases have similar symptoms but no distinction can actually be made, so that drastic measures are also in force with regard to sheep. The new test may solve this problem.

Avian Influenza in 2003 and the possible introduction of H5N1 in 2005 – 2006

Background and risks of Avian Influenza in 2003
In 2003, the Netherlands was confronted with the high pathogenic Avian Influenza virus (AI), commonly known as bird flu virus, which had not occurred for several decades. The way in which the Ministry of Agriculture, Nature and Food Quality handled the

possible introduction of Avian Influenza (AI) in 2005 – 2006 was directly related to the 2003 trauma. Furthermore, the death of the veterinary surgeon who was one of the first to carry out research and analysis at a contaminated farm also upset the Ministry deeply. This, however, did not lead to a panic situation in the Netherlands, because the issue was dealt with in a down-to-earth way.

A major problem was that AI-related knowledge was surrounded by many uncertainties. At the same time, the situation needed to be controlled immediately. In the first place there was uncertainty about the number of cases of contamination that the bird flu might cause. This uncertainty arose because it was not clear how the virus spread and because of its widely-scattered occurrence. There was also uncertainty about the variation in mortality rates of bird flue (the possibility that one, but also that a thousand people might die). Another problem that occurred was the lack of consensus in the scientific advice on the veterinary risks. Experts were contradicting each other, which made it difficult to conduct legitimised risk management. It was therefore difficult for policymakers to intervene in this veterinary disease crisis.

What did we learn from the AI crisis in 2003?
The absence of a unequivocal scientific view on risk assessment relating to the AI in 2003 was the immediate reason for *establishing an independent scientific group of experts* (including virologists and epidemiologists, among others) that provides support to the Ministry on request or voluntarily in the event of veterinary risks and the need for risk measures. This expert group is considered a leading authority inside the Ministry and beyond, and also plays an important role in setting up an *early warning system* and in *monitoring*.

Close *cooperation with the Ministry of Health, Welfare and Sport* is needed with regard to research, the implementation of measures, and communication to the general public.

The AI crisis in 2003 accentuated the need to practise the application of up-to-date *scenarios*. By practising crisis exercises, the organisation has become more alert and processes run very smoothly. The lessons learnt have been re-invested in the organisation. In addition, *pilot light agreements* have been entered into with suppliers, for obtaining large quantities of vaccine for preventive inoculation in emergency situations, for example.

During the crisis, the Ministry of Agriculture, Nature and Food Quality had pet poultry destroyed on a limited scale in order to avoid the possible further spreading of AI. The EU has adopted this measure. Evaluation of the AI crisis has shown that *communication with the pet-poultry keepers could have been better-geared to this new target group*. The destruction of animals among pet-poultry keepers in particular causes quite a stir in society. At the time, the means of communication used did not always address the emotional climate among the pet-poultry keepers. This aspect is now taken into account more explicitly in policy implementation.

Threat of the introduction of H5N1 in 2005 – 2006

There are many forms of AI and many ways in which it can spread. The H5N1 bird flu variety differs from the AI strain in 2003 and is linked to bird migration. For years little was known about the connection between bird flu and bird migration and it was even denied. As a result of large-scale monitoring, this connection is now being recognised. In addition, there was uncertainty about the origin of the bird flu virus, its magnitude and the speed at which it spreads. Questions that still remain unanswered, include: 'What type of birds are affected?' and 'Can a healthy bird carry the flu virus?'

Risk approach

In order to learn more about this bird flu variety a large-scale monitoring exercise has been initiated focused on amassing knowledge at the source in Asia. Monitoring is carried out by the Erasmus University Rotterdam and the Central Institute for Animal Disease Control Lelystad (CIDC-Lelystad). With the outbreak of AI in 2003 still fresh in everyone's minds, the control scenarios have been updated. In this respect, aspects such as public health and pet poultry were taken into account, but also the risks relating to wild birds. The Ministry of Agriculture, Nature and Food Quality also applies a 72-hour standstill period, during which an independent group of experts will be asked for advice, in particular about whether inoculation should be initiated. The expert group's complete and unabridged advice is submitted to the Dutch House of Representatives. This will contribute towards the perceptibility and transparency of the process and thereby boost confidence. The Minister may only deviate from the advice of the independent expert group for well-founded reasons. This indicates that the expert group has a strong position and status. Besides veterinary aspects – which are of a directional nature - the Governing Council also takes into account social, economic and political aspects to arrive at a tailor-made package of control measures. Consequently, there is a division between risk assessment and risk management.

On the basis of the risk analysis it was decided to introduce the 'under cover requirement and preventive inoculation for poultry', which initially met with incomprehension within the EU. In this respect, the Netherlands was a forerunner, which may have given the EU the idea that it was temporarily losing control again. After the H5N1 virus had hit our neighbouring countries, the Dutch method of confining pet poultry proved justified. In a nutshell, it can be said that risk assessment is of vital importance in establishing the AI strategy.

Conclusion: what did the Ministry of Agriculture, Nature and Food Quality learn from dealing with crises relating to veterinary disease?

When a crisis arises it initially appears easier to revert to the precautionary principle as this is regarded as a sign of political vigour (in this respect, consider the example above about former Minister van Aartsen who had a cohort of calves destroyed during the BSE crisis). Once this step has been taken, you cannot simply turn your back on this principle. An example is Germany where, at the time of this conference (May 2006), pet poultry still had to be kept under cover. If you keep poultry confined until after the summer, there is no reason to let them out ever again. After all, there is always the risk of bird flu when

birds start migrating again in September/October. We therefore advocate focusing on an effective risk strategy that is implemented consistently in every respect.

Another lesson learnt is that knowledge should be organised, even in peacetime. For example, every week Brussels records the situation regarding the development of potential veterinary diseases, so that up-to-date knowledge is available, tailor-made for potential action.

Another objective of this approach is that, when the political arena calls for pointless, major measures, it can be convinced by well-founded scientific analysis. In this respect, science has a cushioning effect. However, it is still a learning process, because in some cases there is no uniformity among scientists. For example, during the AI crisis there was contradictory knowledge concerning AI in relation to pigeons: are pigeons susceptible to the flu or not? Should they be confined or not? If there is no uniformity, the European door is open for a political lobby by pigeon breeders.

In short, the following has been learnt from the BSE and the AI cases:
- Separation of political decision-making and scientific consulting.
- Organisation of knowledge (in peacetime) and giving it an independent status.
- Communication and information (also about uncertainties) are crucial.
- Long-established policy can be changed by lobbying (e.g., non-inoculation policy), even in the EU.
- If a risk strategy is chosen, implement it logically and consistently, and get it '200%' right.
- Learn from a crisis. This is only possible in a culture that *allows for* mistakes.

Discussion

Roel Coutinho, Director of the RIVM Centre for Infectious Disease Control

Measures

What measures should be taken in the event of a new veterinary disease crisis (emerging risks)? Existing scenarios form the basis of dealing with a new crisis. Furthermore, expert advice can be sought, such as the EFSA. If necessary, the 72-hour standstill period can be imposed, during which independent experts are asked to carry out an analysis of the indicative risk and the package of risk measures.

A disadvantage of scenarios is that uncertainty is translated into 'paper', as a result of which uncertainty appears to be reduced. Is it not common sense that usually lets us down in times of crisis? During the nineteen nineties there was no authoritative European institution for transmittable diseases, but satellite groups were used in the various member states, based on 'best judgements' by experts. Politics apparently managed to assess scientific advice much better by bringing the various disciplines and member states together. In this respect it is important to allocate a discernible place for advice. Fortunately, the era of Brussels preparing the policy before seeking any advice is increasingly becoming a thing of the past.

Humane approach
The European Commission is exerting increasing influence aimed at the humane coordination and tackling of veterinary disease crises, which is evident from the establishment of the European Centre for Disease Prevention and Control. The SARS crisis also saw a more humane approach as a result of scientific laboratories and physicians all over the world combining forces, and maintaining daily video-conference communications on how to tackle the problem.

Scientific advice
At the start of the H7N7 crisis Mr Veerman stated that this bird flu strain was not dangerous for man. Later, however, scientific evidence showed that this virus could definitely be transmitted to human beings. It is understandable that politicians seek to reduce uncertainty and reassure the general public with their statements but, in fact, this is a matter of a false statement. False statements increase politicians' vulnerability when something turns out not to be true. Politicians should therefore first seek scientific advice before issuing statements about risks.

In politics, recommendations on uncertainties are usually adopted unabridged, while there is constant uncertainty at scientific level. This offers the political arena little scope for dealing with uncertainties. We should not pretend to be in control of something that we cannot control. Any scientific knowledge focused on dealing sensibly with uncertainties is therefore welcome.

3.2 Case II: Security of energy supply

Pieter Boot, deputy director-general of the Ministry of Economic Affairs

The policy problem
The policy problem of the security of energy supply at an international level involves political as well as economic aspects. Political aspects in particular are playing an increasingly important role. Besides the consuming countries, the actors involved in this issue are the oil-producing countries and the oil companies. The most important oil-producing countries are situated in the Middle East, North Africa, Russia, the Caspian Sea area, Nigeria and Venezuela. The major oil companies are partly the large players in the market such as Shell, BP and ExxonMobil, and partly the national state-controlled organisations. These oil-producing countries and oil companies are responsible for creating conditions *for* and investment *in* exploration and production. We are currently observing a trend of increasing state influence. While 20% of the production stock belongs to the largest players, 80% of it is owned by state-controlled organisations. In other words, it is a highly politicised situation. Moreover, serious political problems are developing in Iran, Iraq, Nigeria and Venezuela. These developments to a large extent influence the uncertainties that we are currently faced with. Five years ago we wondered whether the OPEC would be willing to supply enough oil. Now we mainly wonder who is going to invest in order to be able to meet the demand. Is enough actually being invested in exploration, exploitation, transport and refining?

The World Energy Outlook of the International Energy Agency (IEA) is an instrument for defining this problem by means of scenarios. Various forms of investment behaviour and the corresponding implications form the core of these scenarios. Two scenarios have been used as a basis.

- In the rose-coloured scenario the oil-producing countries jointly make investments to meet the explosive demand in energy. It is mainly countries such as China and India that contribute to this explosive demand. This means that, from today until 2030, twice as much will be invested in oil production compared with the past decade.
- The other scenario is the 'deferred scenario', which anticipates that oil prices will rise considerably in the future. The reduced investment results in reduced production and diminished export. According to this scenario, this would result in the price per barrel increasing to over 80 dollars in 2030. Furthermore, the West will then still be highly dependent on the oil-producing countries.

Europe

In 2004, the IEA expressed its concern about the increasing oil prices. The importance of high oil production had already become a topical issue and investment was essential to be able to influence the price positively. In the meantime, even more oil is needed in order to influence the price. This is due to the decreased elasticity of oil prices, which is probably a result of the ever-increasing transport component.

The European gas market also has its problem areas. Russia produces a lot of gas but also uses increasingly more because the domestic price is low. As a result, consumption increases. Investment, however, is insufficient to meet the demand. Within a few years the availability of gas from Russia will have passed its peak, so that the price will probably increase again. In the meantime Europe still needs gas.

Anticipation by institutions

Energy is no longer a purely economic demand, but has increasingly become a political demand. Economy and politics are difficult to combine in one model. The Netherlands Institute of International Relations 'Clingendael' and the Energy Research Centre of the Netherlands (ECN) responded flexibly to this. In the near future they will jointly conduct a study into indicators of secure supply.

In short, policy has become a byword for dealing with uncertainty. There is nothing wrong with uncertainty, but it is important to identify the relevant factors and continue to make a distinction between the long, medium and short term. You should avoid coming up with short-term solutions for a long-term problem, or vice-versa.

Conclusions

The Ministry of Economic Affairs has not progressed as far as the Ministry of Agriculture, Nature and Food Quality, which has developed a guideline for coping with uncertainty, but progress is being made thanks to the input of the IEA. It is therefore also important that science enters into dialogue with the political arena. In this respect it is essential to focus on an effective model of dialogue between both parties (as presented by Rob Hoppe, see section 2.2). Furthermore, it is important that the political arena

examines uncertainties at an early stage. In this way, policymakers taking ad hoc action in times of uncertainty, due to lack of dialogue with science, can be avoided.

Discussion

Remko Ybema, ECN Policy Studies

Aspect of time

The most important perception mentioned is the aspect of time. However, if too much emphasis is placed on the distinction between the short term (which is how people are currently trying to improve relations in the Middle East), the medium term and the long term, there is a risk that solutions will be developed that are too specific. It is not effective to focus on the short, medium and long term and then to come up with tailor-made solutions that are only interesting for the term concerned. Transitional management plays a major role in the approach for a particular term. It enables us to address short-term problems without losing sight of the long term. This means that, if a short-term problem is addressed, the medium term and long term are kept in mind while developing solutions for this problem. It is a framework that serves to transfer solutions in a structured way from a particular term to a subsequent term. This increases the sustainability of solutions.

In relation to the presentation by Arthur Petersen (see section 2.1), the problem of the security of energy supply can be classified as a moderately structured problem, with time dynamics as the uncertain factor. The political arena should ask itself who controls this issue and how it should be dealt with from a risk-aversive point of view. In this respect, measures such as cost-benefit analyses and the Clingendael/ECN model can serve as methodologies to address the problem in a structured way. It is a shame that we did not get involved with the politicising influence on oil production five years ago. As a result, the current strategies of ministers mainly focus on the short term. The uncertainties that we are now faced with are also different from those of five years ago. It is very likely that oil prices will remain high, but now we are also confronted with considerable fluctuations.

Information uncertainty (OPEC)

Another uncertainty stems from the OPEC itself. The reserves as stated by the OPEC were significantly lower than in reality. As a result, oil prices have risen to excessive levels. It is clear that, although OPEC information is available, this information is not always very reliable. The Joint Oil Data Initiative (JODI) of the IEA and the OPEC is trying to do something about this.

Europe

Another source of concern is the fact that Russia would rather build gas pipes to China than to Western European countries. Apparently this is due to the slow processes within Europe, such as the prolonged fight about a communal energy policy. For years, energy policy in Europe was mainly determined from an environmental viewpoint and not on the basis of the demand for energy as such. This is a sign of unbalanced policy. As long as Europe continues to focus on discussing aspects that have nothing whatsoever to do

with energy supply it is very unlikely that we will be in time to anticipate the explosive demand for energy. Far more attention should be devoted to the uncertainties with regard to supply.

Science
The problem with scientific hypotheses is that they have not yet been proven in practice. As a result, they cannot simply be put to use immediately. A good example is the 'Clash of Civilizations' by Huntington, who explains that future conflicts will probably occur more at the level of cultural differences rather than between countries and states. This is clearly a growing trend if we look at the oil-producing countries. It would be a good thing if policymakers devote more attention to these hypotheses in order to broaden the body of thought within the policy arena. Generally speaking, there is currently a willingness to improve the dialogue between science and politics.

3.3 Case III: macroeconomics and budgetary policy

Henk Don, former director of the Netherlands Bureau for Economic Policy Analysis (CPB)

The policy problem
The *policy problem* can be summarised in the question: 'How will public finance evolve in connection with certain policy proposals during a new cabinet term?' or, more specifically, 'How can particular targets with regard to public expenditure, taxes and social security, and the EMU balance be achieved?' This is a crucial issue with regard to the way in which budgetary policy is developed and implemented for a cabinet period.

The issue under discussion therefore focuses on the medium term. The choice of targets is partly prompted by long-term analyses of topics such as the ageing population, etc. However, long term issues are not addressed in this presentation. Short term issues will be touched upon in relation to the implementation of budgetary policy.

Actors and their role
In discussing the actors and their role three phases can be identified:
- preparation;
- elections and cabinet formation;
- implementation.

Each phase is characterised by role analysis, advice and political choice.

Phase 1: preparation
The Netherlands Bureau for Economic Policy Analysis (CPB) explores the structural economic growth and the corresponding estimated uncertainty. On this basis, it outlines two growth scenarios (cautious and favourable) with an estimated evolution of expenditure, taxation and balance. The Study Group on the Budget Margin (*Studiegroep Begrotingsruimte*) and, to date, the Social and Economic Council of the Netherlands (SER)

have given advice on the safety margin, the target values for the key variables and on budgetary rules (how to handle windfalls and setbacks). To date, political parties have used the cautious scenario as a conservative starting point for budgetary policy proposals and have made their own choices where target values (and possibly the rules) are concerned.

Phase 2: elections and cabinet formation
The CPB reports on the expected outcome of various election programmes in the context of the cautious scenario. The Central Economic Committee (CEC) and the SER give advice about the economic policy and the budgetary rules during the new cabinet term. The coalition parties record the agreed policy plans and budgetary rules in a coalition agreement.

Phase 3: implementation
The CPB reports on the expected results of the coalition agreement in the context of the cautious scenario. Furthermore, every quarter it makes new short-term economic forecasts for the current and the following year. The CEC advises on economic policy and adaptations to the policy in the short term. The cabinet decides on adaptations to its policy plans on the basis of new facts and estimates. Henk Don is convinced that the separation of analysis and advice enhances the credibility of both. This goes one step beyond what we have heard up to now.

Why a cautious scenario?
A cautious growth estimate means that there is a better chance of windfalls than of setbacks. The rationale behind this is that, in practice, policy cannot respond flexibly (due to a delay in information becoming available and adaptation of policy) and that it is more difficult to deal with setbacks than with windfalls from a politico-administrative point of view. Since 1994, budgetary policy proposals have therefore been based on a cautious scenario.

In accordance with the recommendations made by the Social and Economic Council of the Netherlands (SER) and the Study Group on the Budget Margin, in 2001 the safety margin was reduced from over 0.5% in annual GDP growth (for 1994 – 1998 and 1998 – 2002) to 0.25% in annual GDP growth (for 2002 – 2006 and 2003 – 2007). Roughly speaking, the likelihood of disappointing growth therefore increased from 1 in 9 to 1 in 4.

The reasons for reducing the margin were that the balance appeared to have arrived in safe waters and the windfalls turned out very high from 1998 to 2000 (which, in turn, proved to be awkward from a politico-administrative point of view).

In a recent report the IMF praised the Dutch budgetary policy system, while – remarkably – it had critical comments about using a safety margin. The IMF report advocates using the best estimate, i.e. a further increase in the likelihood of setbacks to 1 in 2. It gave two arguments for this: cautious starting points give out a negative signal and undermine policy credibility.

Henk Don disagrees. Next to the cautious scenario, the CPB develops a favourable scenario to avoid a negative signal, among other things. Furthermore, the safety margin is formulated explicitly and is not secretly hidden in the estimates, as happened in Canada recently. All too often, central estimates actually serve as an excuse for ignoring uncertainty. It is also striking that Germany recently announced its intention to deliberately start using conservative estimates.

A deliberate and explicit use of margins requires a reliable estimate as a starting point. This was recently emphasised by the IMF and the EC, which advocate an independent institution for reliable estimates. The cautious scenario worked well in taking uncertainty about mid-term economic growth into account in budgetary policy.

The idea of basing policy relating to the environment, infrastructure etc. on the favourable scenario for the same reason (a better chance of windfalls rather than setbacks), however, failed to find acceptance. This was dismissed as inconsistent and/or unfair by left-wing as well as right-wing parties. The environmental policy plans are not robust against growth windfalls, but, to a certain extent, can respond more flexibly than budgetary policy: the targets usually have a longer time horizon, so that there is more time for adjusting policy.

Budgetary policy also involves more uncertainties in the medium term than contained in the two scenarios. The 'cautious' and 'favourable' scenarios focus on uncertainty about structural GNP growth. The cyclical component is deliberately handled differently, because the phase of the cycle in the final year of the cabinet term does not allow for a forecast five years ahead: by assumption the final year in the scenarios is cyclically neutral, the budgetary rules are (partly) geared to buffering the cyclical component in expenditure and taxation in the overall balance.

Uncertainties that are not connected to GDP growth are ignored (in advance). And yet, sometimes these have a considerable impact on the budget; these could include the oil price, house prices, interest rates, stock market quotations, expenditure relating to disability benefits and health care, inherent fluctuation in tax revenue, and budgetary policy pursued by municipalities and provinces. These uncertainties are partly cushioned by budgetary rules (gas revenues, expenditure, municipal and provincial balances). Uncertainties relating to gas revenues, recurrent expenses and tax revenues have been known and recognised for a long time. The rest came more or less as a surprise and resulted in major setbacks from 2001 to 2004. This left something for government to tackle. A practical problem relating to short-term policy is the difference between cyclical and structural windfalls and/or setbacks. The expenditure framework offers some stability, but on the income side it is more difficult.

Evaluation: how should we assess current practice?
Scientifically speaking, the current situation is still far from ideal because many uncertainties are ignored in advance and because of the one-sided focus on budgetary targets. However, from a historical and international perspective, it is also quite an achievement

(for example, the difference in treatment between economic cycle and structure, explicitly incorporated caution, rules for windfalls and setbacks).

Analysis of uncertainty in GDP growth has improved over the years (from historically determined margins to a bottom-up analysis of growth determinants) and is communicated effectively by means of cautious/favourable scenarios. During the early nineteen eighties, politics was not yet responsive to two scenarios, which were called 'high' and 'low' in those days. At the time of the cabinet formation, a political working group recommended maintaining a middle course. Analysis of other uncertainties is still underdeveloped. There are no guidelines for reporting on uncertainty in this field. International practice varies and the Netherlands is a positive exception as far as impact on policy is concerned.

Some lessons learnt from experiences in this field:
- Wording is important (not 'high' and 'low', but 'favourable' and 'cautious').
- A consistent role division (Study Group, SER, CPB, CEC) enhances acceptance.
- Independent estimates are not systematically distorted, while politically directed estimates usually are (more important for credibility than the use of safety margins).
- Scenarios are more compelling in confronting uncertainties than variations or margins.
- Scenarios help to deal with uncertainty, but may be obstructive when used in several areas simultaneously.
- Rules for windfalls or setbacks are important (beware of detecting structural windfalls too quickly and losing them).
- Large margins soon become counterproductive.
- Our knowledge relating to uncertainty is limited (all statistical indicators are based on the premise that, one way or another, the future originates from the same process as the past). This is sometimes difficult to maintain in practice; consider, for example, the oil price.

However, the following device also applies here:

'experiences from the past are no guarantee for future results…'

Discussion

Laura van Geest, treasurer general of the Ministry of Finance

Laura van Geest approved of Henk Don's presentation and added a more general note to CPB's role in preparing policy. The CPB's high credibility, based on independence and high quality, is essential for nearly all the positive lessons Don has drawn. By means of estimates and analyses, the CPB contributes significantly to consistency and discipline in economic and budgetary policy. The IMF has therefore put forward the CPB as a good example for other countries. However, Ms van Geest expressed the hope that the following device applies to the CPB's activities: 'experiences from the past are a guarantee for future results…'

Mainly by way of supplementing Mr Don's presentation, Ms van Geest put forward five points of comment from a *policymaker*'s point of view.

- Different classes of uncertainty: what is CPB's secure role?
- Refining the CPB models: cutting with Ockham's policy razor?
- The short term: how susceptible are we to sensitivity analysis?
- Medium term: being more cautious rather than just having a cautious scenario?
- Long term: ageing population: better safe than sorry?

Different classes of uncertainty: what is CPB's secure role?

The CPB cannot reduce uncertainty but it can offer insight into uncertainty. As a result, in principle, policymakers are better capable of dealing responsibly with uncertainties. Policymakers, however, are faced with many more uncertainties than those related to economic estimates and policy extrapolations. A total of five classes of policy uncertainties can be distinguished:

- Uncertainty about realisation (the GDP of previous years is frequently adjusted, apparently the device 'to measure is to know' does not always apply.)
- Uncertainty about economic forecasts.
- Uncertainty about policy effects.
- Uncertainty about policy amendments (during political and public discussions, decisions are made to change policy. It is a good thing to take this into account at an earlier phase of analysis and assessment).
- Uncertainty about policy implementation (are stimuli for implementation actually as sharp as we assumed?).

Refining CPB's models: cutting with Ockham's policy razor?

A model – or, as Tinbergen put it, 'a set of stylized facts' – is a hypothetical reality. Communication about the limitations and uncertainties of forecasting and policy models is essential. Models can be improved, which is an ongoing process. In this respect, however, there is a risk that false certainty is enhanced. Policymakers cannot really discern the limitations of the model, with the ultimate risk that the model no longer conforms to reality, but reality conforms to the model. Moreover, one refinement or extension may not be as important as another. A type of 'Ockham's razor' could do the job: expansion of models is only desirable if it increases forecasting power and reduces uncertainty. From a policy point of view this means that priority is given to important variables that are significant to policymaking, and that yield the highest benefits. For example, because of its contribution to the GDP and VAT revenues, consumption is more important to public finance than is the level of investment.

Short term: how sensitive are we to sensitivity analysis?

The CPB does not provide a quantitative indication of uncertainties in forecasts and estimated policy effects. Technically, an entirely Bayesian approach (based on continuous updating of insight) is unfeasible, but – what is more important – if we could know the quantitative aspect of these uncertainties, would we, as policymakers, actually do something with this information? As a practical and effective alternative, the CPB is presenting, on request or voluntarily, sensitivity analyses that give an impression of the risks. These also play a role in policy discussions, such as those relating to purchasing

power. Whether the risks relating to purchasing power are largely upward or downward is relevant in determining any extra compensation measures. It is therefore important to know the distribution of uncertainty in the estimates. Another example is that, for the time being, forecasts are merely 'pencilled in' until more sources are pointing in the same direction. At the same time, we should not deny that political practice often also has a different rationale: recognising uncertainties and communicating them is complicated.

Medium term: being more cautious rather than just having a cautious scenario?
The notion of caution is even clearer when it involves the mid-term scenarios Don mainly discussed. By opting for a cautious scenario as the baseline, there is a better chance of windfalls rather than setbacks. Theoretically, this tallies with the fact that people are risk averse: we consider a more secure but lower level of prosperity more valuable than an uncertain but higher level of prosperity (of equal expected value). And, from a politico-administrative point of view windfalls are actually easier to manage than setbacks. Furthermore, medium-term expenditure and taxation frameworks contribute towards a steady policy line in the budgeting process, whereby cyclical fluctuations are absorbed into the public balance. In order to be resilient to such fluctuations, the balance needs to be structurally sound. These agreements have also been laid down at European level. A substantial buffer is also needed if we want to allow for the possibility that the cautious scenario could also turn out to be the most realistic one. This is what is happening during the current term of government, which we actually started with very low growth. This form of *contingency planning* through the budgetary deficit cushions the existing uncertainty for other economic actors.

Long term: ageing population: better safe than sorry?
The budgetary implications of ageing are uncertain and demand a policy response. Sitting back and doing nothing would mean that the government creates uncertainty rather than reducing it. Precautionary measures are required. Not least, because we know that the burden of adaptation will increase if we postpone taking measures and by making a selection now we will choose from a larger range of policy options (adapting ageing-related institutions, increasing labour force participation and increasing efficiency in government expenditure). In June 2006 the Study Group on the Budget Margin published a report on budgetary policy during the next term of government entitled 'Ageing and Sustainability'.

3.4 Case IV: rural development

Chris Kalden, secretary general of the Ministry of Agriculture, Nature and Food Quality

The policy problem
In her presentation, Renée Bergkamp, director general of the Ministry of Agriculture, Nature and Food Quality, already discussed the aspect of dealing with uncertainty in policy at a moment of veterinary disease crises and potential transmission of veterinary disease to human beings. In situations like these, risk assessment and risk management often take place under high time pressure. Her presentation focused on the learning potential of policy practice during situations of crisis.

The dynamics and content of this case are of a different nature. The establishment of the *Veenweidepact Krimpenerwaard* treaty as well as the Climate and Nature policy are long-term rural development projects in which diversity of uncertainties plays a major role. To identify and unravel these uncertainties, scientific insight into dealing with uncertainties is relevant in the quest for robust solutions.

For example, consider the problems relating to the Krimpenerwaard, an area of peat land in the western part of the Netherlands. Up to forty years ago, ditch water levels were much higher than today. Arguments for this were that the subsidence of peat soils would be minimal with high water levels, so that no drought damage would occur and damage to foundations and roads would be avoided. But this led to income-related problems for farmers because, if the topsoil is too wet, the carrying capacity is very limited so that the cows cannot be put in the fields to graze and the machines to mow. It was therefore decided to reduce the water level much further, which resulted in more subsidence of peat soils.

Over the past decades a lot of research has been done into this phenomenon. The outcome was that the soil is dropping by an average of one meter per century, which is five times as fast as 40 years ago. Consequently, in the future, wet natural areas and built-up areas (with pile foundations) will be towering high above the cultivated landscape. This will not only result in a curious landscape, but also in a drastic increase in the cost of use and management of water and land. For example, from 1992 to 2002 the cost of water management more than doubled in parts of the western peat meadow area.

From 'water level follows function' to 'function follows water level' [1)]
Initially, finding a solution to this problem was attempted through the 'water level follows function' policy. Even though scientific research has shown that this solution would not lead to a sustainable result, in the local area itself abandoning the 'water level follows function' principle was hardly open to discussion. The Krimpenerwaard was a

1) Up to now, the water level was often adapted to land use ('level follows function'). This will increasingly change to 'function follows level'; water management will determine more and more where functions such as agriculture, nature, recreation and activities may fit in.

highly polarised issue. In terms of administrative law and policy science, here a situation of a moderately structured problem (medium consensus) becomes visible. With regard to such an issue, discussions focus on the efficiency of certain measures and the distribution of gains and losses among the parties involved. In dealing with uncertainty a fallibilistic attitude is adopted, which advocates a phased approach in order to address action uncertainty and yield uncertainty through trial and error. Action uncertainty refers to uncertainty in the body of alternative policy options, while yield uncertainty refers to uncertainty about the costs and yields of the solution to the policy problem. However, the policymaker's everyday reality can rarely be translated directly into scientific theories. Because the Krimpenerwaard issue was highly polarised, suffered from a lack of openness, and even the smallest details within the compromises were heavily negotiated, this ideal-typical problem-solving strategy of articulation of interests and negotiating failed to yield a robust solution. More was needed than just a phased approach.

In the knowledge that, as a result of the 'water level follows function' principle, the number of gauging sections will increase from 25 to 80 (i.e. highly fragmented) and undesired differences in level will arise in the longer term, there were unarticulated doubts about this solution. The authorities, LTO Nederland (the Dutch Federation of Agriculture and Horticulture, an entrepreneurial and employers' organisation) and nature organisations were dissatisfied but also hesitant about addressing this issue more decisively. The year 2003 saw a breakthrough when the 'Nota Ruimte' (National Policy Document on Spatial Planning) was published, which focused on the system-reforming 'function follows water level' policy. As a powerful restructuring principle, 'function follows water level' is characterised by shifts from functions to areas that are stable and sustainable as regards water systems and subsoil. In practice, this results in nature flourishing at places where agriculture has disappeared and vice versa, among other things. Robustness of the 'function follows water level' principle is also essential for the number of gauging sections; i.e. not from 25 to 80 but to 3 or 6 at the most. After many years, there is finally a prospect of bringing up for discussion a number of conflicting matters in the Krimpenerwaard. This breakthrough can mainly be attributed to a changing body of actors that urge each other on in a positive sense and continue to put pressure on this paradigm shift. Of course, this involves people like Leen van der Sar, Hans Oosters, Jaap Slingerland and Rob van Brouwershaven.

From an administrative point of view there is consensus between the government, provinces and water boards, although some water boards have fundamental questions with regard to the impact on their role and position. The municipalities are adopting a neutral, anticipatory attitude. Certain agricultural groups, however, are expressing their concern about the future of livestock breeding in the area. They have their reservations about 'function follows water level' because of its possible impact on agriculture and nature. That does not alter the fact that expectations have been set high with regard to the 'function follows water level' paradigm shift. All the more, because at the end of 2005 the *Veenweidepact Krimpenerwaard* treaty was signed, which is currently being implemented in municipal land use plans.

Multi-track approach

While the decision-making process continues, the *praktijkcentrum Zegveld*, an applied research centre for dairy livestock, is currently working on two ambitious research programmes for the development of a sustainable cattle farming system for dairy farmers in the peat meadow area.

In this situation it could easily happen that one party is waiting for another, e.g. policy is waiting for research, implementation is waiting for policy, etc. A multi-track approach for policy, knowledge and practice is therefore employed. This means making use of the existing knowledge base and current trends in policy development. The agenda will initially be filled with experiences gained in practice and best professional judgement. This will be expressed in quick scans on the basis of research, a limited number of policy-oriented anchor points and topics that are considered to have priority, and a select number of hot spots determined via GIS systems for typical problem areas. [sentence O.K.?] Based on this information, analyses and model calculations will be carried out that will be tested by specialised experts and those responsible for policy. This practical method will also be used to develop a systematic analysis and evidence base, with regard to both the topics and the measures. With regard to policy development, there will be interactive contact with both central government and regional parties. In this way, an integrated method is pursued in which policy, knowledge, practice and implementation are intertwined to form an effective and efficient approach.

With this case, Chris Kalden wanted to demonstrate the fact that – and the degree to which – scientific disciplines, theories and insights matter to the government in dealing with uncertainty. However, this case also shows that the reality for policymakers often differs from what is stated in scientific theories. In this respect, the following question emerges: what are the limitations and shortcomings, and where does science see opportunities for further development?

It is considered necessary for the government to deal differently with uncertainty. Mr Kalden feels that politicians, policymakers and policy implementers as well as society should adopt a different attitude, i.e. from focusing unilaterally on controlling uncertainty towards accepting a certain degree of uncertainty. We are already doing this, but much too implicitly. The question is how can we jointly shift from a tendency of total control – which results in a false certainty – to creating active space for uncertainty? This involves dealing with areas for which you are not 100% sure what might happen, but where you no longer need or want to revert to the iron, hierarchical will to control. In order to illustrate even better the revolution in the government's way of thinking and acting, Mr Kalden would like to discuss the case of Climate and Nature.

Nature consists of very complex systems that are often dynamic and difficult to predict. It is exactly this complexity – 'biodiversity' – that we appreciate about nature and wish to protect, but the extent of this complexity is still unknown or not understood.

Over the past decades these dynamics have increased considerably as a result of human interference. As a result, unpredictability has also increased because the complexity we

have known to date is changing and partly exceeds our knowledge base. Examples of unpredictability include:

- The effects of climate change on our flora and fauna are definitely important, but it is still difficult to predict what these effects will entail, although a lot of research is being done at Wageningen University in the Netherlands and elsewhere in the world.
- The unwanted introduction of species into ecosystems where they were not found previously, due to increased mobility and transport throughout the world. These may also have a great impact on the original natural environment. Here the consequences are also very unpredictable and our knowledge is inadequate.

In other words, in the complex, unstructured issue of climate in relation to nature we are dealing with variability plus lack of knowledge, ranging from inaccuracy, practical immeasurability, ignorance, and a lack of clear definition.

It is clear, however, that the dynamics in the world's ecosystem that has been increased by mankind is threatening the earth's biodiversity and many ecosystems - for example because habitats are destroyed or ecosystems cannot adapt to new conditions quickly enough.

From time immemorial, habitat and wildlife protection and policy have been focused on preservation. This is understandable and necessary but, at the same time, there should be scope for adaptation and the introduction of new developments. After all, further shifts – also in the light of climate change – will be inevitable. Preservation and the restoration of things to how they used to be will result in increasingly higher costs ('like flogging a dead horse'). Nature with a high biodiversity may then become more feasible by creating sound preconditions and leaving it to its own devices instead of trying to control nature and failing. However, sound preconditions will definitely need to be created; otherwise biodiversity will continue to deteriorate. How do we deal with this in the Netherlands? The National Ecological Network (NEN) is the main concept in Dutch nature policy. The NEN (terrestrial part) covers about 730,000 hectares of nature reserves that are interconnected by so-called 'robust nature links'. These links were initially intended to interconnect areas and their natural populations to link up larger and therefore less vulnerable units.

Now that climate change is increasingly becoming an issue, scientists also consider robust nature links to be the right answer to this problem: if climate zones are shifting, flora and fauna populations will need to be able to 'shift' also and reach other nature reserves within the network. In isolated nature reserves, however beautiful and large, they will be trapped if the circumstances gradually become unsuitable.

Climate change is an outstanding example of an issue whereby dealing with uncertainties and risks plays a major role. At the moment it is certain that the climate is changing, but how and to what extent is still very uncertain. What measures does the government adopt in this respect to reduce uncertainty? Uncertainty can partially be made manageable by means of emission scenarios and impact assessments, but currently only on a large scale (Europe). Uncertainty is infinitely greater on a regional and local scale, where the risks

are the greatest. A further reduction of uncertainty can be achieved by mobilising as many scientists as possible, such as in the Intergovernmental Panel for Climate Change.

The learning government

Despite these uncertainties, there is a great sense of urgency both at national and international level, which renders a government response necessary. Partly inspired by the precautionary principle, which is embedded in the Global Climate Treaty, mitigation and adaptation are required. With regard to nature, this involves increasing its resilience, steadiness and robustness, so that changes can be absorbed. In this respect it should be made clear that not every uncertainty can be eliminated and there will always remain certain risks. In this complex problem the government applies the learning strategy, known as 'intelligent trial and error' in the world of policy science. With a view to uncertainty the government does not postpone decisions but it decides on the basis of a learning strategy of 'intelligent trial and error', with central elements such as early debate, flexible structuring, early precautionary measures, and accelerated feedback. The purpose of this way of dealing with uncertainties is to make risk management more robust in the complex process of decision-making.

This applies to nature, but also to safety. For example, future discussions will increasingly focus on which safety levels for flooding will apply to which locations. In this respect it is important to take into account the social environment in which this happens. Not everything can be prevented at any cost. A good example of adaptation of climate change is the National Programme for Spatial Adaptation to Climate Change (ARK) that was drawn up to climate proof the spatial planning in the Netherlands. It relates to house-building, spatial infrastructure, nature and agriculture and the changes that will be noticeable in the next 30 to 50 years. A major question in this respect is whether it is sensible to build houses in the lowest parts of the Netherlands, while we already know that the sea level will rise by 50 cm.

For a government to deal differently with uncertainties also requires a completely different communication strategy, both towards the general public and the House of Representatives. The Dutch House of Representatives, but also many community-based organisations, still demand that risks be reduced to virtually zero. For that purpose, they work with set accountability targets for the government (from policy budgets to policy accountability etc.), among other things. If, however, the government adopts the new uncertainty approach it will also need to create scope for targets that are less accountable due to a high degree of uncertainty. In this respect it is essential for the government to be transparent vis-à-vis the general public and the political arena about the degree of uncertainty that would arise and the practical and legal consequences that abandonment of the pursuit for zero tolerance would have for our dealing with risks.

Conclusions

In summary, Chris Kalden argued for the government and society to acknowledge the existence of uncertainties more liberally and to give it a place in policy. In addition, he advocates creating active space for uncertainty, among other things. Space within which the government is not 100% certain about what might happen and thus the tendency

towards full control can be abandoned. There is much talk of risk-based policy, but people often do not observe it or act accordingly.

Finally, Mr Kalden asked the delegates what further options for action were available - besides the ones that he had presented - that would allow the government to follow this path and, also, how could the science itself contribute towards the desired paradigm shift.

Discussion

Wim van Leussen, University of Twente

Stumbling forwards sensibly

The expression 'stumbling forwards sensibly' defines the essence of Mr Kalden's message and indicates acknowledgment of the fact that eliminating uncertainty should allow space for correct action amidst uncertainty. It can be argued that we are constantly trying to find our way amidst uncertainty.

Implementation of scientific concepts

It is clear that, in the pursuit of dealing more effectively with uncertainty, the ultimate implementation is the most difficult part. This applies to national governments and local parties alike. Praiseworthy efforts have resulted in several scientific concepts for facing uncertainties. These concepts contain definitions, uncertainty typologies, methods and techniques which result in uncertainty being given a place in the process of decision-making. However, there are no solutions for the actual implementation of these concepts. This still appears to be the most significant obstacle to be overcome. Scientists use the metaphor of a boy scout for dealing with these types of complex and adaptive systems: how do you become a good boy scout? By being prepared for any situations that may occur on your journeys and choosing the best possible options in such situations. Translated into the world of policymakers this means recognition of and dealing optimally with changes in scientific concepts and being ready to choose the right interventions.

This is a very complicated issue: we expect policymakers to be leaders, while leadership is based on certainty. In other words, there is not enough space for uncertainty. As already mentioned, politics means 'making decisions that are riddled with uncertainty', but when decisions are made nobody wants to know about the risk of a negative impact. People prefer unequivocal decisions that have been made very confidently. In fact, we are making contradicting demands of policymakers. The question 'What does science offer?' should perhaps be put not only to scientists but also to policymakers. Their input is important for overcoming the greatest obstacle - namely the implementation of scientific concepts.

With this input, science will be able to conduct research into political obstructions. And this, we hope, will bring us to the major question of 'How do we organise creatively the encounter between science and policy?' Our aim should be to transfer general scientific knowledge about uncertainty from the conceptual phase to the implementation phase.

A new paradigm

For science this also means a new paradigm. It now needs to focus more on dealing with uncertainty in the same way in which it used to focus mainly on reducing uncertainty. In order to achieve this, science should take a strong and prominent stance in this regard. Of course, the next step is that the policy arena recognises and accepts the need to deal with uncertainty. The efforts of the scientific world should be warmly received by demonstrating understanding for a new attitude towards uncertainty. Generally speaking, we can draw the conclusion that a much needed shift is taking place: while it was important to reduce uncertainty, now the focus is increasingly on allowing more space for uncertainty and on dealing with it sensibly. This shift now only needs to become manifest in practice.

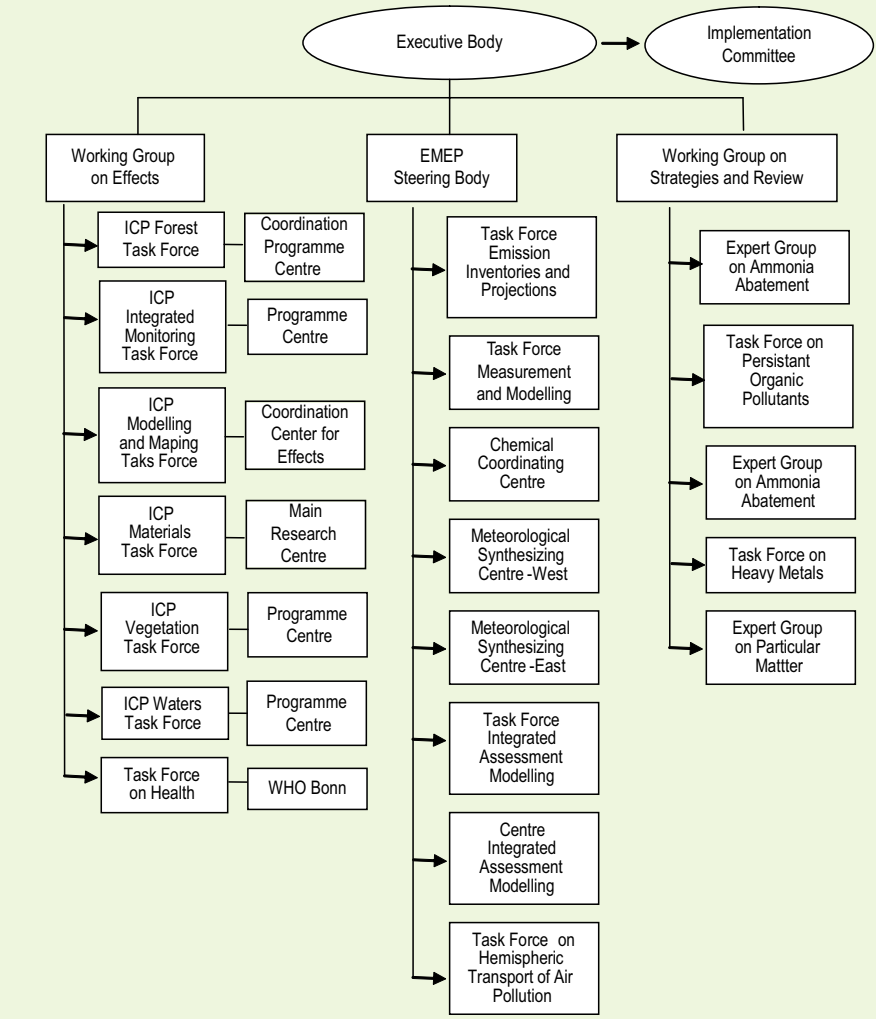
3.5 Case V: air quality

Leen Hordijk, director of the International Institute for Applied Systems Analysis, Austria

The policy problem

A characteristic aspect of acidification – which was mainly an issue during the nineteen eighties and nineties – is that it is a transboundary problem. The causal relationships in the domain of acidification do not conform national, international and intercontinental boundaries. The problem was initially discovered in Scandinavia, but later also in the Netherlands and the Federal Republic of Germany, because the quality of the forests deteriorated. Good East-West relations play an important role in tackling this problem, which became obvious from the stagnant positions adopted by the United Kingdom and the former Eastern bloc. The European Commission and the Organisation for Economic Cooperation and Development (OECD) also failed to come up with effective solutions.

A consultative structure was therefore developed to tackle the problem of air pollution over long distances (Convention on Long-Range Transboundary Air Pollution, or CLRTAP for short). The organisation comes under the United Nations Economic Commission for Europe (UNECE) which, in turn, comes under the United Nations Economic and Social Council (ECOSOC). The UNECE strives to foster sustainable economic growth among its 56 member states by providing a forum for communication between member states; supporting international legal instruments and conducting statistic and economic analyses. The consultative structure (CLRTAP) that addresses long-range transboundary air pollution has many bodies, including working groups, task forces and expert groups (see figure 3.1). The Task Force on Integrated Assessment Modelling (TFIAM) mainly focuses on generating scenarios using information gathered from the other working groups and through computer models. These are needed to support the development of legislative instruments.



Figuur 3.1: Consultative structure of CLRTAP

Examples of results include a series of protocols that lead to the member states dealing sensibly with activities that influence the air quality. These protocols include:

- 1999 Protocol to Abate Acidification, Eutrophication and ground-level Ozone;
- 1998 Protocol on Persistent Organic Pollutants (POPs);
- 1998 Protocol on Heavy Metals;
- 1994 Protocol on Further Reduction of Sulphur Emissions;
- 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes;

- 1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes;
- 1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent;
- 1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

The most important uncertainties that played a role in the studies conducted within the CLRTAP include:
- economic growth and structure in the future:
- emission sources, which also includes national sources;
- the costs and benefits of a reduction in emissions;
- the impact of atmospheric variability on cross-border pollution;
- the effects of air pollution;
- policy pursued by other countries.

There was also uncertainty about the strength of the sources: the reports from the partners to the treaty did not apply uniform rules. This point was raised, for example, when it became evident that the Polish central statistical office failed to include small companies in its calculations.

How the TFIAM dealt with uncertainties
The TFIAM has developed scenarios to be able to deal with these uncertainties. They were not used to make forecasts, but to present possible images of the future. There were also occasions when the generation of scenarios was stopped because an abundance of scenarios led to a delay in decision-making. Uncertainty relating to the costs and benefits of emission reduction was circumvented by not conducting cost/benefit analyses but determining the cost effectiveness of packages of measures instead. In addition, the preparation of detailed impact calculations was also avoided. Instead, threshold values for anti-pollution tax were determined.

In the scientific methods applied much emphasis was placed on scenario analysis. In this respect, three integrated models were initially used and, at a later stage, only the RAINS (Regional Air Pollution Information and Simulation) model of the International Institute for Applied Systems Analysis (IIASA), a non-governmental research organisation located in Austria. With the RAINS model, scenario analyses were made and also optimisations of environmental objectives were determined. Given the quality objectives relating to the environment, calculations were made with the RAINS model as to which package of measures for each country would yield the cheapest solution for Europe as a whole. The model yielded quantitative data for each country regarding the total costs incurred in the measures proposed, the emissions, atmospheric dispersion and the environmental effects. The TFIAM has carried out many model comparisons and quality checks but devoted relatively little attention to the quantification of uncertainty.

Other CLRTAP working groups and task forces have made summaries of the current status of science in all relevant fields (technology, emissions, costs, atmospheric transport, the effects of pollution).

Conclusions

The following lessons were learnt from CLRTAP's experiences:

- A large international network of working groups and task forces has performed well.
- Co-production between science and policy was possible by enabling policymakers and scientists to work together in working groups and tasks forces.
- The quality of scientific input should be incontrovertibly established.
- For this to be possible there must be mutual trust between science and policy.
- In such policy problems, more emphasis should be placed on quality improvement rather than on quantitative uncertainty analyses.

Model developers can also draw lessons from this project. It cannot be repeated often enough that models do not make forecasts or provide a recipe for solving a policy problem. Decision-makers do not want a single solution but a series of alternatives from which they can choose. When building the model, it is important when selecting model components to take into account the policy-related requirements and the circumstances of the specific policy problem. It is therefore of paramount importance that considerable time is invested in generating an appreciation of policy issues among researchers. Furthermore, negotiations at an international level are of a different nature from those at a national level. The model developers' attitude needs to be brought into line as far as possible with the arena in which they provide their services.

Finally, the following are a few quotations from Donald Rumsfeld, former US Secretary of Defence (2003):

*'Reports that say that something hasn't happened are always interesting to me, because as we know, there are **known knowns**; there are things we know we know. We also know there are **known unknowns**; that is to say we know there are some things we do not know. But there are also **unknown unknowns** - the ones we don't know we don't know.'*

and

'I would not say that the future is necessarily less predictable than the past. I think the past was not predictable when it started.'

Discussion

Hans van der Vlist, director general of the Ministry of Housing, Spatial Planning and the Environment

Policy and measures

It is important not only to be interested in the effects of policy, but also in the effects of measures. We should always make a clear distinction between these two items. This also applies to debates. In debates it is important to be clear and precise. We now live in a time and age in which policy relating to air quality is largely determined by standards. However, do we adequately consider the question as to what effects policy and measures

may have on the economy and international competition? We could well wonder whether there is, in fact, any ambition at all to deal with uncertainty.

Interaction between science, policy and the general public
In the TFIAM consultative structure, interaction between science and policy is fed by the tree structure of task forces. The question is, however, to what extent the officials who also take part in the task forces actually determine how scientific input is employed.

A good example of direct communication between science and the general public is parents' reactions to the assumed dangers of UMTS masts. Parents with children at schools situated close to a UMTS mast opt for transferring their children to other schools. In other words, the contribution of science to policy involves not only the communication line between science and policy, but also the communication line between science and the general public.

Obstacles in correct policy
A newspaper headline once claimed that the problems relating to acid rain were blown out of all proportion. This was based on the fact that no major problems had actually materialised, while they had been predicted. When acid rain initially became manifest, it proved to be an alarming situation. Where the newspaper's reasoning fell short, however, was the fact that, in the meantime, the actual emission of acidifying compounds had been reduced substantially. As a result, the impact was less negative than expected. This shows that uncertainty may create obstacles even where correct policy is applied. If you are not certain about the actual effects of particular trends, correct policy may also come under attack. Complications with uncertainty therefore involves far more than merely 'acting wrongly'.

Contribution by science
Contributions made by scientists may also result in improved dealing with uncertainty in policymaking. Scientists can devote themselves better to the question as to how they can influence the policy agenda. If they only consider the best way to carry out analyses and calculations, the gap between science and policy will be retained. This links up to the success of TFIAM's co-production structure, whereby scientists and policymakers work together in task forces. In this way, scientists gain more insight into the problems that policymakers need to contend with.

3.6 Panel discussion

Chair: Arthur Petersen
Panel members: Henk Don, Rob Hoppe, Leen Hordijk, Jeroen van der Sluijs, Marjolein van Asselt

Prior to the discussion, Arthur Petersen asked the panel members for their main findings regarding the conference:

Rob Hoppe: 'An avalanche of ideas has been provided. This confirmed my opinion that we are moving towards a systematic approach to dealing with uncertainty. The problem is currently being redefined. Uncertainty is no longer the only problem, but so are the relations and obstructions between actors.'

Leen Hordijk: 'I was struck by the openness with which this topic is dealt with these days. Unlike during the nineteen seventies, the CPB is increasingly entering into dialogue with commissioning bodies. It is important to involve more people from the world of science, who could learn from this exchange of knowledge and the tension between science and policymakers, without immediately becoming part of it. I would personally like universities to contribute more knowledge in this area because they are not part of the policy process.'

Henk Don: 'The metaphor of the boy scout in the discussion led by Wim van Leussen was an illustrative example. A boy scout needs to be prepared for certain situations, but cannot solve everything. This also applies to policymakers and politicians. In addition, there are various phases and ways to deal with uncertainty. In practice, this proves not always very simple. A good example is the House of Representatives which still has trouble dealing with uncertainty issues. It is important to accept uncertainty and to deal with it by adopting a learning attitude. The term 'stumbling forwards sensibly' describes this perfectly.'

Jeroen van der Sluijs: 'Ides Boone, a Flemish delegate, just told me that the Netherlands is far more advanced than Belgium as far as dealing with uncertainty in policymaking is concerned. With regard to this topic, however, there is little insight in the situation in other countries. The European Environmental Agency shows considerable interest in what is happing in the Netherlands. During the conference I did not hear much about practical solutions. Ideas that come to mind include safety factors, the anticipatory design, incorporating a flexible policy, mandatory learning (case-by-case approach), robust solutions, the risk approach (also without quantification), precautionary policy, backstop options, and adaptive management (anticipating new information and circumstances).'

Marjolein van Asselt: 'Tackling uncertainty in policymaking is an area in which many things are not made into an issue. The role of science should therefore be to provide more practical support in the future.'

Reactions from the audience

Knowing the unknown unknowns
How do we communicate unknown unknowns? In the air quality case, this characterisation by Donald Rumsfeld, former US Secretary of Defence (2003), is described as follows:

> *'Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know.'*

In this respect we should think in terms of policy targets and measures and act on the basis of our standards. Dealing with 'unknown unknowns' requires us to switch from an ontological to a more deontological way of thinking. This form of uncertainty means acknowledging the limit of our knowledge base, because it involves unidentified areas and backgrounds ('unknown unknowns'). Herein, the paradox lies hidden of getting a grip on a situation, while getting a grip is not always an option. 'Late lessons from early warnings', a publication by the European Environmental Agency was referred to as an example. Although here it is more a question of 'known unknowns', this publication shows that it takes long for policy to respond adequately to environmental problems. This calls for 'early listening' as soon as 'unknown unknowns' start developing into 'known unknowns'.

Psychological side of uncertainty
One of the remarks made relates to the absence of the psychological side of uncertainty (courage and caution, for example) during the conference. The role of intuition in the process of decision-making should not be forgotten. What can we do with psychology and intuition as non-quantifiable aspects of insight? Sometimes intuition actually works (in the police force or fire brigade, for example). How should we consider this in the discussion on dealing with uncertainty? There appears to be a natural incompatibility between analysis and intuition, but one element does not need to rule out the other. For example, on the basis of intuition, science could respond to matters that policymakers consider important. Publications and conferences on the topic of uncertainty try to respond to the psychology of fear. They should contribute towards thinking differently, as a result of which psychology and intuition can be properly appreciated: 'creativity is the act of a prepared mind'. There is a positive hope that the conference has initiated this trend because of the large turnout of both policymakers and policy scientists.

Cost/benefit analyses
Why do we need to deal cautiously with cost/benefit analyses? [2)] There is considerable uncertainty about cost/benefit analyses, or rather, a false certainty is being created. This

2) Prior to the panel discussion, Marjolein van Asselt put her findings with regard to the conference in a thematic summary, which led to a number of main conclusions and recommendations. The core features from this presentation have been incorporated into the next chapter. The discussions on cost/benefit analyses and, subsequently, on the guideline refer to this thematic summary.

results in increased controversy in the discussion on uncertainty. In the world of policy-making there is no getting away from analysing problems using a cost/benefit approach. A distinction should therefore be made between the quantitative way of analysis of costs and benefits, and gaining insight into them. The first option mainly offers scope for a quantitative explanation, while the second one also offers scope for a qualitative explanation.

Too early for a guideline?

To what extent can a guideline serve a strategy to pull apart or unite science and policy? A guideline does not offer a solution to everything. With a guideline, however, pitfalls and dealing irresponsibly with uncertainty can be avoided. In this respect it is important to start from a case-by-case assessment as is done in legal practice, and to learn from each individual case. The 'de Kwaadsteniet affair' was the reason for the MNP to draw up the *Guidance for Uncertainty Assessment and Communication* focused on a more alert approach to dealing with uncertainty. This conference should lead to best practices that may result in a guideline that could be applied much more broadly than that of the MNP. On the basis of the outcome of this conference it might be better to speak of a phased plan rather than a guideline. However, the transitional process of policymakers dealing more effectively and more responsibly with uncertainty is clearly visible.

4 CONCLUSIONS AND RECOMMENDATIONS

Arthur Petersen and Marjolein van Asselt

As the organisers of the conference have already stated, uncertainty is becoming an increasingly important factor for policy as a result of both the growing complexity of the policy environment and the ever-rising economic, social and political costs of policy mistakes. At the same time, it is proving difficult for policymakers to take proper account of relevant uncertainty in their policymaking.

This problem is now recognised cabinet-wide. For example, soon after the conference, the Dutch cabinet defined its view on the way in which risks should be dealt with (Ministry of Housing, Spatial Planning and the Environment, 2006). Furthermore, the cabinet concluded that the government is incapable of preventing or controlling all of society's problems, but that society expects them to. The cabinet feels that there is no effective template that indicates how such new and uncertain issues should be handled politically and administratively. A tailored approach is required with regard to new or uncertain politico-administrative issues. In the cabinet's letter the topic of nanotechnology is given as an example of a new and uncertain issue on which the government seeks to deal more sensibly with uncertainty.

What can be learnt from the conference in terms of the implementation and further development of policy relating to dealing with uncertain risks? The issue mentioned above requires a different way of thinking about uncertainty, and new methods are needed with a more systematic approach to relevant uncertainty. In practice we come across numerous forms of defining, communicating and handling uncertainty. These range from simple uncertainty margins and sensitivity analyses to elaborate scenarios and policy recommendations. During the conference the topics discussed included which approaches are used, how they affect policy in practice, and how they are used to address uncertain policy issues. In setting up this conference the organisers focused on the following questions:

1. How can dealing with uncertainty be defined in the context of the various types of policy problems?
2. How do the various policy arenas actually deal with uncertainty, what problems arise from this and what successes are achieved?
3. What problems and major issues can be identified with regard to communication on uncertainty between scientists and policymakers and what are 'good examples' of dealing with uncertainty?

All these questions have been discussed to varying degrees in the previous chapters. This final chapter will outline a number of themes that run through the conference as a whole. The first two questions are discussed in section 4.1. In this section those classes of uncertainty will be evaluated that played a role in the various cases (veterinary diseases and their potential transmission to human beings, security of energy supply, macroeconomics

and budgetary policy, rural development, and air quality) and how they were dealt with. Section 4.2 gives a summary of what can be distilled from the conference in terms of dealing 'responsibly' or 'irresponsibly' with uncertainty. The third question regarding uncertainty communication and 'good examples' of dealing with uncertainty is discussed in section 4.3. The institutions that may lead to dealing 'effectively' with uncertainty are discussed in section 4.4. Finally, section 4.5 will provide some recommendations on the basis of these conclusions.

4.1 The typology of uncertainty applied to the various cases

Various types of uncertainty are identified in chapter 2, each of which is important to varying degrees, depending on whether we are dealing with a structured, moderately structured or unstructured policy problem. On the basis of the cases described in this document, examples will be given of variability-related uncertainty, statistical uncertainty, scenario uncertainty, recognised ignorance, methodological unreliability and value-ladenness (see van Asselt, 2000; MNP/UU, 2003; Petersen, 2006 for an explanation of these types). Where possible, it is indicated how these specific uncertainties were dealt with in policy.

Variability

- Crises will always occur with new, partly unidentified veterinary diseases. This is due to the variability and changeability of pathogens. It is clear that scenarios will therefore never be complete (this is a form of recognised ignorance). However, a variety of assumptions can be assessed (scenario uncertainty). (Case relating to veterinary disease crises).
- In addition to having a structural component, the oil price is subject to substantial short-term fluctuation. (Case relating to the security of energy supply).
- The flexible, cyclical component is not incorporated into long-term economic estimates. The budgetary rules (partly) focus on buffering the cyclical component in expenditure and taxation in the overall balance. (Case relating to macroeconomics and budgetary policy).
- Nature consists of very complex systems that are often dynamic and difficult to predict. It is exactly this complexity – 'biodiversity' – that we appreciate about nature and wish to protect, but little is at yet known or understood about this complexity. Owing to human intervention, dynamics - and, as a result, variability - has increased considerably and so has unpredictability. (Case relating to rural development).

Statistical uncertainty (a range of probabilistic statements)

- The uncertainty margin applied to macroeconomic long-term growth estimates nowadays is fixed at 0.25% (was 0.5% up to 2001). This margin can be interpreted statistically: despite cyclical fluctuations, there is a 1 in 4 chance that economic growth will be below the cautious growth estimate. Statistically speaking, fewer windfalls are now expected over a term of government compared to the situation before 2001. However, the uncertainty margin thus presented is not entirely a Bayesian approach, in which insights are reviewed constantly and quantitative statements on probability

distribution can be made that may provide more profound quantitative insight into uncertainty. (Case relating to macroeconomics and budgetary policy).

Scenario uncertainty (a range without probabilistic statements)

- With the outbreak of Avian Influenza in 2003, the estimated mortality rates varied by a factor of 1000. There was too much uncertainty to link probabilistic statements to this. It was only possible to place various assumptions (scenarios) next to each other. (Case relating to veterinary disease crises).
- The World Energy Outlook uses future scenarios on the basis of which uncertainty relating to future secure energy supplies can be identified. In the rose-coloured scenario the oil-producing countries invest jointly to meet the explosive demand in energy. The second, much less favourable scenario involves reduced investment with a strong increase in oil prices. (Case relating to the security of energy supply).
- A good alternative for providing insight into the probability distribution of economic estimates is CPB's presentation of sensitivity analyses or 'uncertainty variants' that give an impression of the influence of major assumptions. (Case relating to macroeconomics and budgetary policy).
- How, and to what extent, the climate is changing is very uncertain. This uncertainty can partly be made manageable by means of emission scenarios with corresponding assessments of the impact of climate change. (Case relating to rural development).
- Scenarios were also developed within the framework of international negotiations on transboundary air pollution (UNECE, CLRTAP) in order to deal with uncertainty in this area. Assumptions vary with regard to the following uncertainties, on the basis of which these scenarios were developed: economic growth and structure in the future, emission sources, costs and benefits of a reduction in emissions, impact of atmospheric variability on air pollution, effects of air pollution, and policy pursued by different countries. (Case relating to air quality).

Recognised ignorance

- During the early nineteen nineties the first evidence of a possible connection between BSE and Creutzfeldt-Jakob disease (CJD) prompted new discussions on the basic insight into infectious diseases. (Case relating to veterinary disease crises).
- For years the connection between bird flu and bird migration was very uncertain and even denied. This resulted in new research to better understand this connection. Questions that still remain unanswered, include: 'What type of birds are affected?' and 'Can a healthy bird carry the flu?'. (Case relating to veterinary disease crises).
- Political processes appear to be becoming dominant in the problem relating to the security of energy supply. People are increasingly beginning to realise that there is hardly any knowledge about these processes available in a form that could be used by policymakers. (Case relating to the security of energy supply).
- It is possible - but we do not know this for certain - that it will increasingly become a matter of a clash of civilisations, with conflicts focusing more on cultural differences. In this 'clash' the oil-producing countries could become opponents of the Western world. (Case relating to the security of energy supply).
- In long-term government budget estimates, all uncertainty that is not connected to GNP growth is ignored (in advance). Consequently, policymakers are not aware of the

budgetary risks of uncertain factors such as the oil price, house prices, interest rates, stock market quotations, expenditure relating to invalidity benefit and health care, inherent fluctuation in tax revenue, and budgetary policy pursued by municipalities and provinces. This uncertainty is partly intercepted by budgetary rules in the form of cushioning factors (see chapter 3.3) and these non-included factors may cause unexpected surprises. (Case relating to macroeconomics and budgetary policy).
- The climate problem will always hold a fundamental uncertainty that cannot be reduced completely. In this complex problem the government applies the learning strategy known as 'intelligent trial and error' in the world of policy science. (Case relating to rural development).

The previous three categories (statistical uncertainty, scenario uncertainty and recognised ignorance) involve 'degrees of uncertainty'. Two other dimensions that can be used alongside uncertainty levels to characterise uncertainty are: 'methodology unreliability' (strength/weakness of underpinning) and 'value-ladenness'. 'Weak underpinning' involves qualitative assessment of the underpinning (empirical, model-oriented, theoretical, consensus) of knowledge.

Methodological unreliability
- In the early days of the BSE crisis, many conflicting scientific recommendations were given. Generally, the world of science considered the policy response excessive and felt that the knowledge base applied in this respect had been insufficiently underpinned (which was not possible given the conflicting recommendations. It was a matter of a drastic implementation of the precautionary principle). (Case relating to veterinary disease crises).
- With regard to the BSE case, people tried to cope with uncertainty by establishing an independent expert group and the European Food Safety Authority (EFSA). The idea behind this was that scientists should jointly try to give their views on the underpinning of various claims and arrive at a well-considered scientific recommendation. (Case relating to veterinary disease crises).
- Measuring the economy is riddled with uncertainty. Economic indicators from previous years are therefore frequently reviewed. These changing statistics also partly form the basis of future estimates. (Case relating to macroeconomics and budgetary policy).
- A wide range of uncertainties play a major role in the development of area-oriented policy in the peat meadow area. A pragmatic research approach was chosen, making use of the existing knowledge base and current trends in policy development. The agenda will initially be filled with experiences gained in practice. (Case relating to rural development).

Value-ladenness
- The policy problem of the security of energy supply at international level involves political as well as economic aspects. Political aspects in particular are playing an increasingly important role. The definition of a 'secure supply of energy' is also a political choice. (Case relating to the security of energy supply).

- The knowledge base available to determine oil stocks is not free of general or political values. The reserves stated by the OPEC prove to be considerably lower than the actual reserves. The International Energy Agency has taken the initiative to do something about this political bias. (Case relating to the security of energy supply).
- Institutions that produce estimates such as planning bureaus make assumptions on the basis of policy adjustments. There are various alternatives for these assumptions. The assumptions of planning bureaus are usually conservative and calculations are based on established policy; proposed policy is considered too uncertain for making estimates. Policymakers do not always agree. (Case relating to macroeconomics and budgetary policy).
- There are different ways of defining the problem of the water level and soil subsidence in the Krimpenerwaard area of peat meadows. Originally the 'water level follows function' policy principle applied. This has shifted to 'function follows water level', which resulted in differences in the scientific information that is considered relevant for the case. 'Water level follows function' relates to the efficiency of certain measures and the distribution of gains and losses among the parties involved, 'function follows water level' is characterised by shifts of functions to areas that are stable and sustainable as regards water system and subsoil. The perspective from which the issue is considered thus determines what information is considered relevant. Because various perspectives are involved, these can be regarded as a dimension of uncertainty. (Case relating to rural development).

This list of examples of the various types of uncertainty that occur in the cases shows that different uncertainties play a role in each case: no specific type of uncertainty is dominant. However, the economic case (macroeconomic and budgetary policy) is perceived as a relatively structured policy problem. In policy practice the CPB therefore confines itself to designating statistical uncertainty. The cases of veterinary disease and of air quality are characterised by moderately structured problems with little consensus on the knowledge base, whereby, from a policy perspective, the underpinning of scientific recommendations in particular is made into an issue (methodological unreliability). In policy practice the cases of the security of energy supply and of rural development are handled as unstructured problems because there is little consensus on social values as well as on scientific knowledge. In addition to the other types of uncertainty, the emphatic value-ladenness of scientific recommendations for unstructured problems is a key area of focus (which does not mean that value-ladenness relating to other problem types is not important).

Besides making a distinction between types of policy problems on the basis of their degree of structure, we can also make a distinction between cases in which high time pressure plays a role versus cases that encompass long-term processes. The veterinary disease crises are excellent examples of pursuing policy with many uncertainties and high time pressure. Time pressure is far less important for the other four cases (there is some time pressure and yet slightly more time).

As stated during this conference, there is no lack of uncertainty typologies. Uncertainty typologies are therefore a means and not an objective. They can be used to get a better

understanding of where the shoe pinches and what class of uncertainty should be kept in mind during policy discussions. The crucial point is how we can also utilise this insight on various classes of uncertainty in policy practice when dealing with new, uncertain policy challenges.

4.2 Dealing responsibly and irresponsibly with uncertainty in policymaking

On the basis of different statements made during the conference, a picture can be drawn of what the delegates considered dealing 'responsibly' and dealing 'irresponsibly' with uncertainty. It is considered *irresponsible* if *policymakers*:

- close their eyes to uncertainty, deny or ignore it;
- focus unilaterally on a single scenario;
- focus unilaterally on controlling and reducing uncertainty;
- do not take into account any irreversible, disastrous consequences;
- pursue too strict a policy by way of precaution, when the current state of science does not legitimise this;
- pursue accommodating policy (taking too large a risk) that they will regret at a later stage;
- surrender to panic measures;
- fail to adopt an open attitude (i.e. embrace axioms, dogmas and dominant solutions; exclude dissidents, practise groupthink);
- wait for a crisis;
- are confronted with too great a windfall;
- offer undue reassurance and pseudo-security to the political arena;
- shop around within scientific opinion;
- wait for each other (paralysis);
- harm mutual trust between science and policy;

Scientists and advisers can also contribute effectively towards dealing irresponsibly with uncertainty. From the conference it became clear that people consider it *irresponsible* if *scientists*:

- offer pseudo-security;
- make bold claims;
- offer undue reassurance;
- wrongly cause unrest;
- quantify non-quantifiable uncertainty and risks;
- provide point estimates instead of scenarios;
- suffer from disciplinary deafness and stubbornness
- believe in their own models and analyses;
- apply old knowledge to new phenomena without further consideration;
- fail to give alternative hypotheses and world views a chance;
- are not 'early listeners' (cf. RMNO, 2004).

People consider it a matter of dealing *irresponsibly* with uncertainty if *actors in society*:
- demand a zero-risk society;
- idolise political leadership; a man or woman without any doubts - require security as their mainstay.

If policymakers, who are prompted by scientists and advisers and supported by actors in society, are guilty of dealing with uncertainty as set out above, this will lead to what Ulrich Beck summarises very aptly in the term 'organised irresponsibility'. Organised irresponsibility – a contradiction in terms at first sight – refers to situations in which society, despite all the institutions and procedures, projected security and the idea of control, is unprepared for unavoidable surprises, adverse effects and/or long-term consequences.

But, then again, people feel that scientists, policymakers and others deal *responsibly* with uncertainty if they:
- are uncertainty-tolerant and 'susceptible' (cf. RMNO, 2003);
- stay alert:
- decide sensibly;
- act intelligently;
- are reflective (keep thinking);
- are honest;
- show courage without boasting;
- provide openness:
- communicate clearly;
- are cautious with cost/benefit analyses;
- work with the knowledge base available and are aware of its limitations;
- learn and dare to learn from 'mistakes';
- take doubts seriously;
- operate with caution and by way of precaution;
- choose robust and flexible strategies;
- act proportionally;
- work contextually and offer a tailored approach;
- utilise 'peacetime' (when there is no crisis);
- create active space for uncertainty;
- pose strategic questions;
- acknowledge their concern even before a solution is found;
- learn to live with uncertainty.

In this way, dealing responsibly with uncertainty is given a more concrete form and hopefully offers more support to policy actors to deal differently with uncertainty.

4.3 Dealing with and communicating uncertainty: best practice heuristics

During the conference, the delegates were unanimous about the proposition that uncertainty is no reason for not taking action. Various heuristics for dealing with uncertainty were reviewed. These heuristics ranged from developing scenarios (and 'rules' for how to deal with 'what ifs') to models for cooperation between scientists and policymakers. One example of a heuristic was highlighted, namely the MNP's *Guidance for Uncertainty Assessment and Communication* (MNP/UU, 2003; http://www.mnp.nl/guidance), an instrument that helps scientific policy advisers to deal reflectively with uncertainty.

In fact, what it all comes down to is that dealing 'effectively' with uncertainty, to a large extent, is linked with 'sound' communication about uncertainty and about the limitations and boundaries of knowledge. This relates to communication between the actors: between science and policy, policy and the general public, science and the general public, science and science, and between policy and politics. The importance was stressed of the choice of words and the need for investing in mutual understanding (which is a difficult and time-consuming process!). People should actively build on mutual trust, which is very important in situations of uncertainty: if there is no security, then mutual trust and faith in each other's opinion will be necessary to prevent paralysis.

The following criteria were stated for effective uncertainty communication between scientists and policymakers, or other actors:

- Meet de demands for 'good scientific practice' by ensuring a scientifically and methodologically responsible basis (in situations of uncertainty, however, this is easier said than done: there is then more confusion about the criteria for 'good scientific practice' and uncertainty information often perishes as a result.).
- Give access to underlying uncertainty information.
- Put essential uncertainty information in the most widely read parts of a report, i.e. not in an annex, preferably in the summary, for example.
- Be clear and unequivocal to avoid the most obvious misinterpretation and bias.
- Apply the 'progressive disclosure of information' principle: offer information about uncertainty in different layers that range progressively from non-technical information to more specialised information, geared to the user's needs.

4.4 Institutional possibilities for dealing responsibly with uncertainty

What institutional options can be identified in dealing with uncertainty, focused on facilitating the following developments?

- horizontalisation of policy (more coherence in policy through enhanced insight);
- fallibility (capable of making mistakes but evaluating them effectively and learning more from them quickly);
- proceduralisation (fostering fair and cognitively responsible progress rather than concrete results).

These desired developments, however, are at odds with the image of political leadership as a 'man or woman without doubts'. Politicians would like to 'learn' but do not dare to 'try' for fear of being told they 'failed' at a later stage. It is therefore also important to enter into discussion with society about 'leadership', in order to create scope for dealing responsibly with uncertainty.

The cases emphasised institutional cooperation between policy and science as a way of dealing with uncertainty and, in particular, the creation of 'expert institutions' (case relating to veterinary disease crises: the EFSA and a national expert group; case relating to macroeconomics and budgetary policy: the CPB) and 'consultative structures' (cases relating to rural development and to air quality). This contains an inherent danger. Preference appears to be given to international 'super expert institutions' (such as the EFSA; the IPCC is another example from the climate domain) that bridge uncertainty by means of authoritative consensus. It is often considered a goal that policymakers, in principle, do not deviate from the recommendations given by super expert institutions. Some conference delegates, however, made a distinction (three-way division) between scientific analysis, advice and policy. This means that expert institutions would not give policy advice and the responsibility for making choices would rest more clearly with the politicians. It is recommended that the institutions are 'permanent' (fixed, consistent division of roles) and that they consult with policymakers when giving explanations and coordinating the programme of activities. However, over the course of time shifts may occur between institutions or new ones could be created depending on shifts in the issue that is being addressed and changes in the type of policy problem. In the event of a crisis (e.g. a new veterinary disease), the Netherlands now applies a standard 72-hour standstill period, offering experts time to provide recommendations on the basis of which measures can be determined. The recommendations should be public and disseminated 'uncut' to government and politicians and the general public (which does not mean that they will actually be read or be understandable).

The problem arises when such consensus and recommendations by super expert institutions are treated as a certainty, because this, in fact, may lead to increased organised irresponsibility. It is therefore of vital importance that expert institutions, as users of the recommendations that emanate from these bodies, are trained in dealing responsibly with uncertainty. Current university education emphasises 'fact-finding', as a result of which the aspect of dealing responsibly with uncertainty is hardly seriously addressed. There is a serious risk that such expert institutions provide pseudo-security instead of uncertainty information. The questions or demands of politics and society may evoke or enhance uncertainty *in*tolerance among the experts. Especially where there is a tradition of not deviating from recommendations and where experts have adopted a permanent position, it will become increasingly difficult for experts to deal responsibly with uncertainty. They will then be sorely tempted to make bold claims. The role of expert institutions should therefore be to assess matters critically. After all, it is a matter of cutting through political knots and taking responsibility for considered decisions where science simply cannot do so.

A second example of institutional cooperation between policy and science is establishing *consultative structures* (co-production between science and policy), as was considered successful in the case relating to air quality. This involves long-term cooperation in a network, whereby scientists and policymakers meet each other frequently. The skill is to arrange meeting each other in the right way. This is done step by step, learning as you go, like boy scouts. Only then will all participants come to realise that it involves 'working with people' and that more than one path should be followed. Trust is both the basis and the outcome of this form of cooperation. Scientists set a limit for 'accumulation of research': i.e. conducting never-ending research as a means of postponing political decisions, while relevant uncertainties can only minimally be reduced through more research, if at all. The risk of this approach is that science and policy may become too closely linked, as a result of which scientists will withdraw and it will no longer be possible to obtain an appropriate scientific view of the situation.

We trust that it is now clear that a cultural change or even a paradigm shift is necessary for dealing responsibly with uncertainty, which applies to both policymakers and experts, but also to society. Heuristics and institutional options alone will offer no solutions. Even then there will always be the lurking danger of a quest for certainty and the illusion of solid ground. In the meantime, there are plenty of publications (also comprehensible for policymakers) on dealing with uncertainty and plenty of scientists who are actively addressing the following question: dealing with uncertainty, how is it done?

Policymakers can make use of these publications and these scientists in their attempts within the world of policy at least to raise for discussion the culture and the prevailing paradigm. This conference and this publication hope to contribute towards this end and to be a source of inspiration and support for policymakers who are concerned about how uncertainty is being handled.

4.5 Recommendations

One of the most important results of the conference is that nearly all delegates appreciate the significance of uncertainty in policy-supporting analyses. At the same time, it is clear that uncertainty takes on different dimensions and forms. Finally, from the presentations and discussions it has also become clear that there is no unequivocal solution for dealing with uncertainty and that such a 'success recipe' may not even be desirable. In his presentation, the State Secretary for Housing, Spatial Planning and the Environment referred to the conference organisers' initial aim of arriving at a guideline for policymakers for dealing with uncertainty. The conference delegates reached the conclusion, however, that it is still too early for such a guideline (in the sense of a 'timetable'). Nevertheless, the following ten recommendations can be linked to the conference conclusions in order to improve dealing with uncertainty in policy.

1. The 'deficit model' (experts know everything and policymakers nothing) should be abandoned (by experts, policymakers and society).
2. Scientists, policy advisers and policymakers should adopt an uncertainty-tolerant attitude.

3. Uncertainty information should also be regarded as knowledge.
4. Make a distinction between science, advice and policy, but do not separate them rigidly. Acknowledge the significance of coordinated work between science and policy and the presence of checks and balances.
5. Determine a policy 'expiry date' in uncertain policy dossiers, after which the scientific status is reviewed and policy can be adapted on the basis of this ('planned adaptation').
6. Introduce forms of 'extended peer review', involving experts from other disciplines and other actors when reviewing scientific reports.
7. Retain space for 'dissidents'.
8. Withstand the pressure to quantify non-quantifiable uncertainty, offering false certainty, and unproductive accumulation of research.
9. Ministries should create awareness of uncertainty and ways of tackling it among their workforce. A number of simple ways of achieving this include:
   - organising a course focused on uncertainty for the entire workforce.
   - adding a section on uncertainty to all analyses that are carried out within or at the request of the ministry.
   - selecting important projects that have been implemented by the ministry over the past twelve months and assessing how uncertainty was dealt with.
   - developing the function of an uncertainty expert within each ministry. This person will act as a guard dog and whistleblower and needs to reflect critically on how uncertainty is being dealt with in policy-supporting analyses within the ministry concerned.
10. Organise a second edition of the 'Dealing with Uncertainty in Policymaking' conference in four years.

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ANNEX A: INTERACTIVE EXPERIMENT

Perception and communication of risks and uncertainty

Directed by: Paul Besseling, Netherlands Bureau for Economic Policy Analysis

Design: Peter Janssen (Netherlands Environmental Assessment Agency), Arjan Wardekker (Copernicus Institute of Utrecht University), Paul Besseling (Netherlands Bureau for Economic Policy Analysis) and Judith Mathijssen (RAND Europe)

Author of the annex: Arjan Wardekker

The first conference day included a 'Playful Element' as an intermezzo. During this conference component, the delegates were presented with several experiments relating to perception of and communication about risks and uncertainty. The experiments consisted of multiple-choice questions, whereby the delegates could indicate their choice by means of a voting machine. During the introductory presentation by Arthur Petersen (MNP) this same system was used to assess the delegates' attitude towards uncertainty (see Attitude Assessment) and to familiarise them with the system. The experiments are outlined below. The question posed to the delegates, the answer options, the results and background are set out for each experiment.

Attitude assessment

Question

The delegates are asked to choose from four propositions relating to uncertainty. A distinction is made between scientists and policymakers in this respect:

1. Uncertainty is unwelcome and should be avoided. The challenge for science is to eliminate uncertainty by means of more and better independent research.
2. Uncertainty is unwelcome but unavoidable. The challenge for science is to quantify uncertainty and to separate facts and values as effectively as possible.
3. Uncertainty offers chances and opportunities. Uncertainty puts the role of science in perspective. Science is challenged to contribute to a less technocratic, more democratic public debate.
4. The division between science and politics is artificial and untenable. Science is challenged to be an influential player in the public arena.

Answer options

Policymakers:

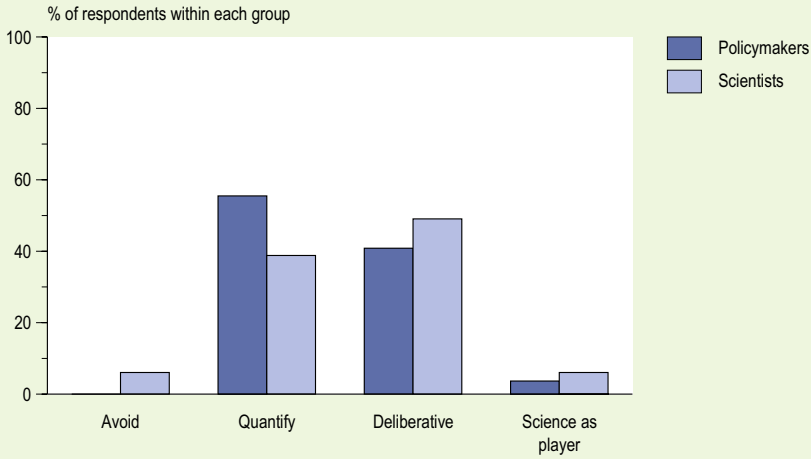
1. Avoid uncertainty.
2. Quantify uncertainty.
3. Uncertainty offers chances.
4. Science as a player.

Researchers:

5. Avoid uncertainty.
6. Quantify uncertainty.
7. Uncertainty offers chances.
8. Science as a player.

Results

Attitude towards uncertainty



Background

Recent studies into the science-policy interface focused on the views of policymakers and scientists with regard to uncertainty and the challenge for science therein. Views were measured on a four-point scale ranging from 'positivism' (science is objective and can provide 'the' answer) to 'constructivism' (science is part of society and therefore not objective, 'the' answer cannot be provided). The majority of the participants in the studies gave preference to 'quantification', a minority to 'science as a player'. The conference delegates appear to be more or less equally distributed over both middle answers. This is probably no surprise given the topic of the conference. The policymakers opted for 'quantification' slightly more often and for 'uncertainty offers chances' less often than the researchers.

Literature:

Van der Sluijs, J.P. (2005) Uncertainty as a monster in the science-policy interface: four coping strategies. Water Science & Technology, 52, pp. 87 – 92.

Wardekker, J.A., Van der Sluijs, J.P. (2006) *Evaluatie van Onzekerheidscommunicatie in de Milieubalans 2005*. Copernicus Institute for Sustainable Development and Innovation, Utrecht University.

Wardekker et al. (2008), see p.71.

Experiment 1: Opinion of one's own driving skills

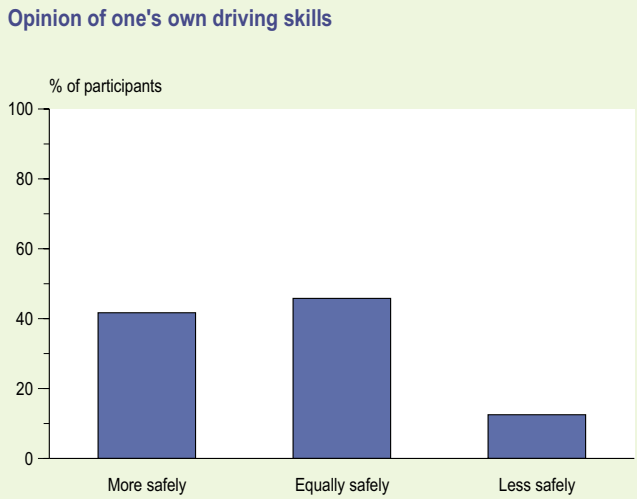
Question

How safely do you drive compared to the average car user?

Answer options

1. More safely.
2. Equally safely.
3. More unsafely.

Results



Background

During the early nineteen eighties, studies were conducted in Sweden and the USA into how car users assessed their own driving skills. The results showed a clear tendency by people to consider themselves better than average (USA: 78% safer, Sweden: 60% safer). In this case, the conference participants scored lower. The original data from Sweden and the USA may imply overconfidence, assuming that the group studied is characteristic of all car users. Gigerenzer (2002) stated, however, that the answers given need not necessarily indicate an irrational form of overconfidence. After all, it could also involve a asymetric distribution in the number of accidents, whereby a small group is responsible for the majority of accidents. In that case, more than 50% of the people can claim to drive more safely than 'average'.

Literature:

Gigerenzer, G. (2002) Calculated Risks: How to know when numbers deceive you. New York: Simon & Schuster.
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Experiment 2: The effect of framing

Question

For this question the audience was divided into 'left' and 'right' and each group was given a different question in an envelope.

Left group:
Suppose that the US is preparing for an outbreak of an unconventional type of Asian Influenza, which is expected to cost 600 human lives. Two control programmes are available, whereby:
- programme A will result in 200 lives being saved.
- the result of programme B is more uncertain: there is a one-in-three chance that 600 lives will be saved, and a two-in-three chance that none will be saved.

Which programme would you choose, A or B?

Right group:
Suppose that the US is preparing for an outbreak of an unconventional type of Asian Influenza, which is expected to cost 600 human lives. Two control programmes are available, whereby:
- programme C will result in 400 lives being lost.
- the result of programme D is more uncertain: there is a one-in-three chance that no lives will be lost, and a two-in-three chance that 600 will be lost.

Which programme would you choose, C or D?

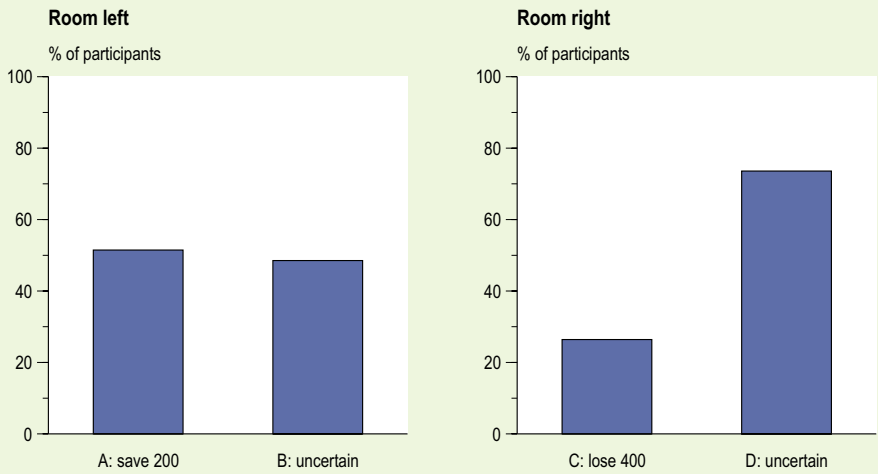
Answer options

Left group:
Programme A: save 200 lives.
Programme B: an uncertain result.

Right group:
Programme C: lose 400 lives.
Programme D: an uncertain result.

Results

Framing effect



Background

The above experiment is the well-known 'Asian disease experiment' by Kahneman and Tversky (1979). In the first case (left group), 72% of the tested people opted for programme A. In the second case (right group) 78% opted for programme D. This while programmes A and C are the same and so are programmes B and D. The only difference is the wording. A and B (left) involve 'saving', while C and D (right) involve 'losing'. During the conference a majority also opted for A rather than B, and for D rather than C. Apparently the difference between messages that are 'framed' positively or negatively matters. This situation often occurs in the practice of medicine. A positively framed message (chance of surviving) is more effective than a negatively framed one (chance of dying) when convincing someone to undergo a risky operation. In this respect framing in terms of gain (staying healthy) or loss (of health, years of one's life, relatives) is similar. Loss framing is more effective when convincing people to undergo a certain screening test. Hammond et al. (1999) gives several tips to avoid/reduce a distorted effect as a result of framing.

Literature:

Hammond, J.S., Keeney R.L., Raiffa, H. (1999) Smart Choices: a Practical Guide to Making Better Life Decisions. Cambridge, Mass.: Harvard Business School Press.
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Experiment 3: The effect of 'impact' on the communication of probabilities

Question

This experiment was subdivided into part 'A' (sender's perspective, great impact) and part 'B' (receiver's perspective, little impact).

Experiment 3A:
Suppose, you are a weather forecaster with a regional television channel. The meteorological institute informed you that there is a chance of heavy rain. This will have all kinds of consequences such as raised water levels in ditches and rivers, sewers that can no longer process the water and, possibly, flooding of low-lying areas (e.g. polders).

- You are a regional weather forecaster in a *low-lying polder area.*

The meteorological institute forecasts a 20% probability of heavy rain and you consider this a good estimate. Which of the following terms would you use to describe the probability of heavy rain to the viewers?

Experiment 3B:
Suppose, you are watching the regional news on the television. The weather forecaster forecasts heavy rain. This will have all kinds of consequences such as raised water levels in ditches and rivers, sewers that can no longer process the water and, possibly, flooding of low-lying areas (e.g. polders).

- You are a farmer in a *higher agricultural area.*

The regional weather forecaster, whom you trust, says that it is unlikely that there will be heavy rain. Based on this forecast, how likely do you think it is that there will be heavy rain?

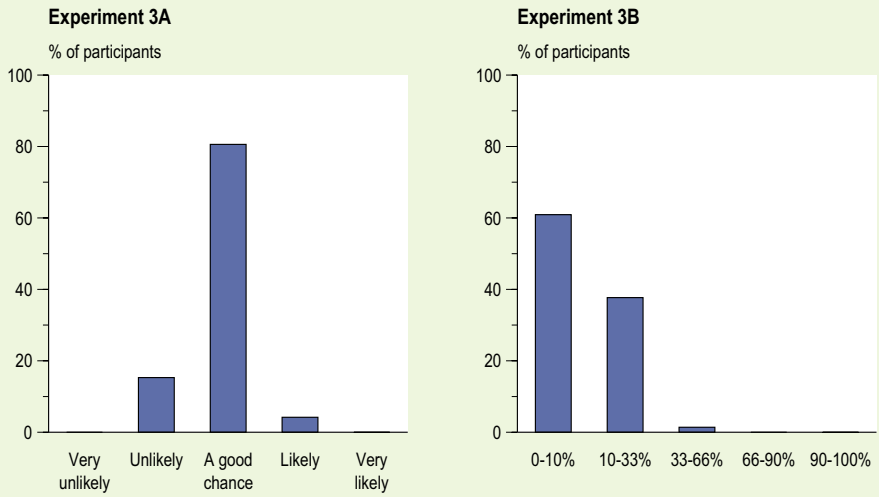
Answer options

Experiment 3A:
1. Very likely.
2. Likely.
3. A good chance.
4. Unlikely.
5. Very unlikely.

Experiment 3B:
1. 0% – 10%
2. 10% – 33%
3. 33% – 66%
4. 66% – 90%
5. 90% – 100%

Results

Impact effect for verbal and numerical communication on probabilities



Background

Literature (Patt and Schrag, 2003) shows that, when choosing an uncertainty term, people intuitively keep the impact in mind. Matters that have a great impact are communicated in more certain terms than those that have little impact. When interpreting, the receiver of such a message intuitively takes into account the sender's inclination. In matters that have a great impact, the normally 'too certain' term is translated into in a reduced likelihood. In matters that have little impact, the normally 'too uncertain' term is translated into an increased likelihood. This may present problems when standardised terminology is used (e.g. IPCC terminology). In choosing a term, the sender no longer takes the impact into account, but the receiver still does. The conference experiment presented a situation with 20% probability and a corresponding standardized probability term 'unlikely'. Experiment 3A focuses on 'sender, great impact', 3B on 'receiver, little impact'. Questions relating to 'sender, little impact' and 'receiver, great impact' were left out and experiments 3A and 3B were carried out in a series (not independently of each other), because of the time involved. Nonetheless, a difference appears to be noticeable: with regard to a great impact (3A) the centre term is chosen, while the lower ranges of probability are chosen with regard to little impact (3B). The outcome of 3B appears in conflict with Patt and Schrag; here the normally 'too uncertain' term is translated into a reduced instead of an increased likelihood. Without the questions that were left out, however, it is difficult to say whether the outcome of this experiment can be explained by the difference in impact or, for example, the difference in interpretation of the terms and ranges of probability.

Literature:

Patt, A.G., Schrag, D.P. (2003) Using specific language to describe risk and probability. Climatic Change, 61, pp. 17 – 30.

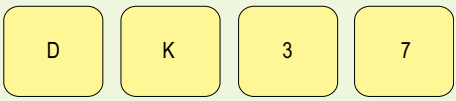
Experiment 4: Confirmation bias (tendency to look for affirmative information)

Question

This experiment consists of two equivalent problems of choice in different situations.

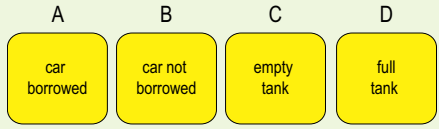
Experiment 4A:
Someone has a pack of cards and says that the following rule applies to these cards: *'A card with a letter D on one side also has a figure 3 on the other'.*

Next, four cards are put in front of you, whereby you may turn two of them to check whether this rule has been complied with.



Which two cards do you choose to turn?

Experiment 4B:
The children of the Janssen family are allowed to borrow their parents' car in the weekend provided that they return it with a full tank.
You are interested in finding out whether they keep to this agreement. Each card represents one of the four children, whereby one side shows whether the child borrowed the car on a particular day and the other side whether the tank had been filled on returning the car.



Which two cards do you choose to turn?

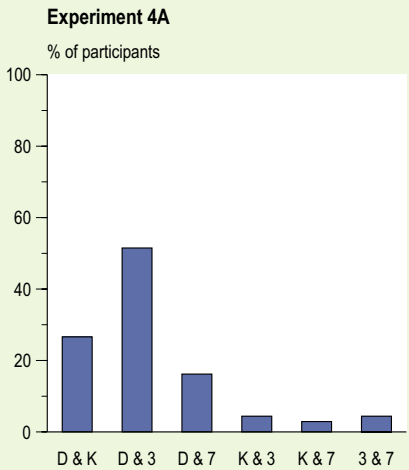
Answer options

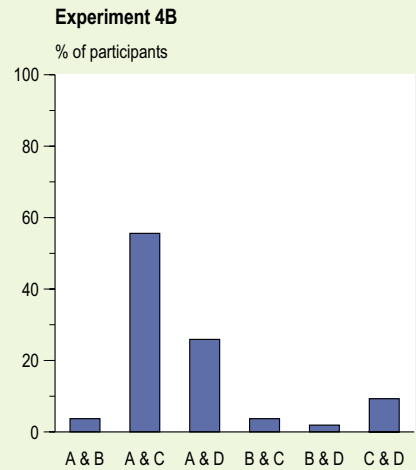
Experiment 4A:
D and K
D and 3
D and 7
K and 3
K and 7
3 and 7

Experiment 4B:
A and B
A and C
A and D
B and C
B and D
C and D

Results

Confirmation bias





Background

With the abstract problem in experiment 4A, people tend to turn cards D and 3, in search for an affirmative answer. Strong first impressions structure the way in which the next information is interpreted. The conference delegates also picked D and 3. Logically speaking, D and 7 would have been the right choice: D to verify, and 7 to falsify. In the concrete situation of experiment 4B, people's own experience appears to be leading: people are not purely looking for confirmation that these are good children. They usually choose correctly 'car borrowed (A)' and 'empty tank (C)'. The conference delegates did exactly the same. The confirmation bias (resulting in selecting A and D) appears to be playing a less important role here.

Literature:
Slovic, P., Fischhoff, B., Lichtenstein, S. (1984) Behavioral Decision Theory Perspectives on Risk and Safety. Acta psychologica, 56, pp. 183 –203.

Experiment 5: Anchoring (relying too much on initial thoughts/impressions/ information)

Question

For this question the audience was divided into 'left' and 'right' and each group was given a different question in an envelope. The delegates were asked first to answer questions A and B for themselves. Next they were asked to make their choice using the voting system.

Left group:
(a). Is Turkey's population higher than 35 million?
Answer: [Yes/No].
(b). How many people do you think live in Turkey?
Answer: ... million.

Right group:
(a). Is Turkey's population higher than 100 million?
Answer: [Yes/No].
(b). How many people do you think live in Turkey?
Answer: ... million.

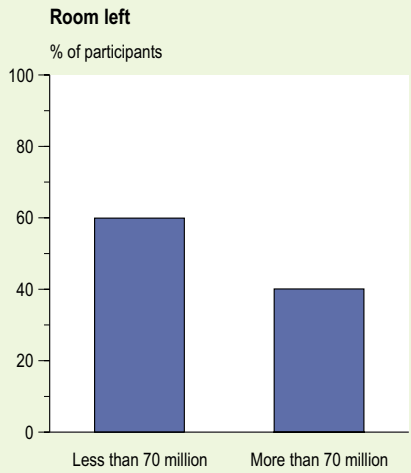
Answer options

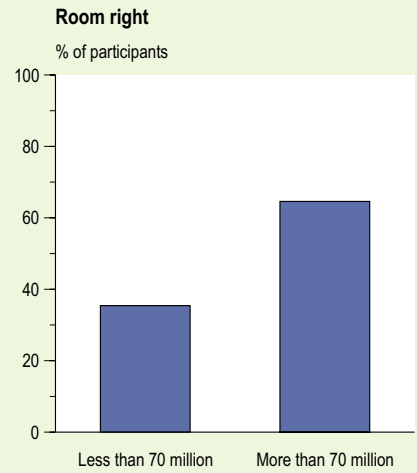
Left group:
Turkey's population < 70 million
Turkey's population > 70 million

Right group:
Turkey's population < 70 million
Turkey's population > 70 million

Results

Anchoring





Background

When answering questions, people tend to base their answers on previous thoughts, impressions or information (anchoring). In this case, first the number of 35 million (left) or 100 million (right) was mentioned. People's own, subsequent estimate can be 'anchored' to this number. Conference delegates who were initially told 35 million, later opted more often for 'less than 70 million' than those who were initially told 100 million. According to the CIA World Factbook Turkey actually has a population of approx.70 million.

Literature:

CIA (2006). The World Factbook. On the internet: https://www.cia.gov/cia/publications/factbook/
Hammond, J.S., Keeney R.L., Raiffa, H. (1999) Smart Choices: a Practical Guide to Making Better Life Decisions. Cambridge, Mass.: Harvard Business School Press.

Experiment 6: Prospect theory: valuation of profit and loss

Question

For this question the audience was divided into 'left' and 'right' and each group was given a different question in an envelope.

Left group:
Suppose you are given 300 euros. You now have the option of receiving another 100 euros or tossing a coin. If you win the toss, you will receive another 200 euros; if not, the amount stays at 300 euros.

What option do you choose (1 or 2)?

Right group:
Suppose you are given 500 euros. You now have the option of handing in 100 euros or tossing a coin. If you lose the toss, you need to pay back 200 euros; if you win you do not pay back anything.

What option do you choose (3 or 4)?

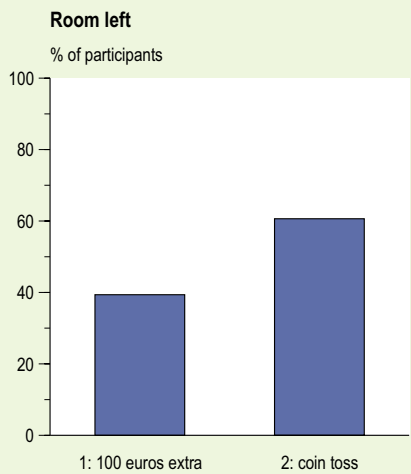
Answer options

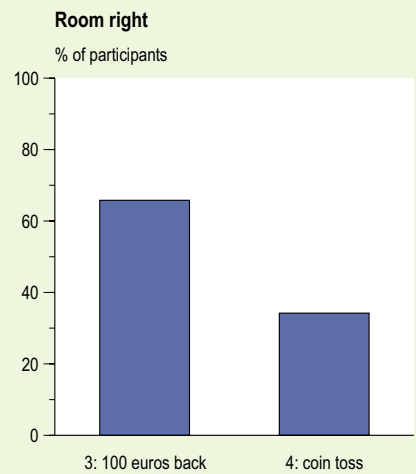
Left group:
Receive another 100 euros.
Toss a coin.

Right group:
Hand back 100 euros.
Toss a coin.

Results

Valuation of profit and loss





Background

The Prospect Theory asserts that risks relating to profit and loss are valued differently. In the case of profit (left group) people appear to prefer certainty (risk-avoiding behaviour). A 50% chance of getting another 200 euros is 'weighted lighter' and considered more unattractive than the certainty of winning 100 euros. With regard to loss (right group), people prefer to gamble (risk-seeking behaviour). The majority of the conference delegates, however, appear to have other preferences.

Literature:
Kahneman, Daniel, Tversky, Amos (1979) Prospect Theory: An Analysis of Decision under Risk, Econometrica, XVLII, pp. 263 – 291.

Experiment 7: Communicating about probabilities

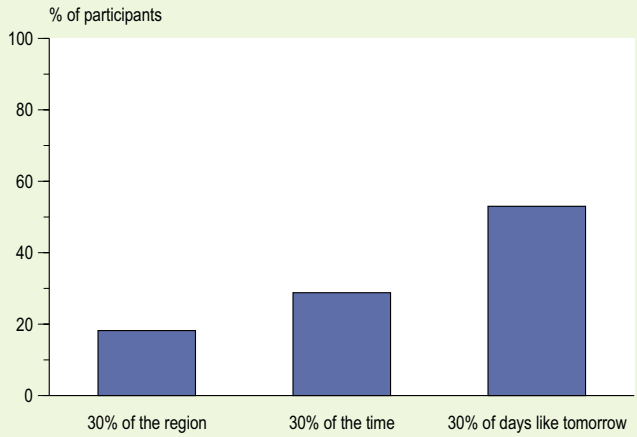
Question

In a news bulletin you read: A 30% chance of rain tomorrow.
What do you think this statement means?

Answer options

Tomorrow it will rain in 30% of the area.
Tomorrow it will rain for 30% of the time.
It will rain on 30% of days that are like tomorrow.

Results



Background

A recent study among pedestrians in four large cities in Europe and the USA, showed that the majority opts for '30% of the time'. The interpretation as used by weather forecasters 'on 30% of days like tomorrow' is chosen by the fewest pedestrians. The majority of the conference delegates choose the right answer. The lesson learnt from this is that, in order to avoid misunderstandings in communication, experts should explicitly refer to the right context/meaning/class of reference that they are applying. The above example could have been better communicated in terms of frequency rather than in terms of probability.

In another example, experienced forensic experts were presented with a report on the risk of a patient committing another violent crime after a treatment. When it was stated that 'an estimated 10 in every 100 patients like Mr Jones will commit a violent crime after a six-month treatment', the patient was considered more dangerous than when it was stated that 'there is a 10% chance that patients like Mr Jones will commit a violent crime after a six-month treatment'.

Literature:

Gigerenzer, G., Hertwig, R., Van den Broek, E., Fasolo, B., Katsikopoulos, K.V. (2005) 'A 30% chance of rain tomorrow': How does the public understand probabilistic weather forecasts? Risk Analysis, 25, pp. 623 – 629.
Slovic, P., Monahan, J., MacGregor, D.M. (2000) Violence risk assessment and risk communication: The effects of using actual cases, providing instructions, and employing probability vs. frequency formats. Law and Human Behavior, 24 (3), pp. 271 – 296.

ANNEX B: CONFERENCE PROGRAMME

Conference programme 16 May 2006
Session Chair: Dr. Adnan Rahman

13:00 – 13:30	Registration
13:30 – 13:45	Opening *Pieter van Geel, M.Sc., State Secretary for Housing, Spatial Planning and the Environment*
13:45 – 14:30	Understanding uncertainty and the importance to consider uncertainty in policy making and policy analysis *Dr. Arthur Petersen, Director of the Methodology and Modelling Programme, Netherlands Environmental Assessment Agency* The role of uncertainty in policy processes *Prof. Dr. Rob Hoppe, Professor of Policy Sciences, University of Twente*
14:30 – 15:10	Case study Veterinary diseases and their potential transmission to human beings *Renée Bergkamp, LL.M., Director General of the Ministry of Agriculture, Nature and Food Quality* Discussant: *Prof. Dr. Roel Coutinho, Director of the RIVM Centre for Infectious Disease Control*
15:10 – 15:40	Break
15:40 – 16:20	Case study Security of energy supply *Dr. Pieter Boot, Deputy Director General of the Ministry of Economic Affairs* Discussant: *Remko Ybema, M.Sc., Unit Manager ECN Policy Studies*
16:20 – 16:50	Interactive experiment Under the guidance of *Paul Besseling, M.Sc., Programme leader Mobility and Infrastructuur, Netherlands Bureau for Economic Policy Analysis (CPB)*
16:50 – 17:30	Case study Macro-economie en budgettair beleid *Dr. Henk Don, Former Director of the Netherlands Bureau for Economic Policy Analysis (CPB)* Discussant: *Laura van Geest, M.Sc., Treasurer General, Ministry of Finance*
17:30 – 18:30	Reception
18:30 – 21:00	Dinner

Conference programme 17 May 2006
Session Chairs: Dr. Henk Don and Dr. Arthur Petersen

8:45 – 9:00	Registration
9:00 – 9:10	Opening *Dr. Henk Don, Former Director of the Netherlands Bureau for Economic Policy Analysis (CPB)*
9:10 – 9:50	Case study Rural development *Chris Kalden, M.Sc., Secretary General of the Ministry of Agriculture, Nature and Food Quality* Discussant: *Prof. Dr. Wim van Leussen, Professor of River Basin Management, University of Twente*
9:50 – 10:30	Case study Air quality *Prof. Dr. Leen Hordijk, Director of the International Institute for Applied Systems Analysis, Austria* Discussant*: Hans van der Vlist, M.Sc., Director General of the Ministry of Housing, Spatial Planning and the Environment*
10:30 – 11:00	Break
11:00 – 11:30	Transparency of uncertainty information and ways of monitoring, communicating and reporting uncertainty *Dr. Jeroen van der Sluijs, Senior Researcher, Utrecht University*
11:30 – 12:15	Thematic summary of the conference *Prof. Dr. Marjolein van Asselt, Senior Researcher, Maastricht University* Concluding discussion with panel of speakers
12:15 – 12:30	Closure *Dr. Arthur Petersen, Director of the Methodology and Modelling Programme, Netherlands Environmental Assessment Agency*

ANNEX C: CONFERENCE DELEGATES

Surname	Forename	Organisation
Aalbers	Theo	Netherlands Environmental Assessment Agency
Aans	Wiebe	Wageningen University and Research Centre
Aazami	Omid	RAND Europe
Asselt, van	Marjolein	Maastricht University
Augusdinata	Datu Buyung	Delft University of Technology
Bakker	Jacques	Ministry of Agriculture, Nature and Food Quality
Beek, van	Frans	Directorate General for Public Works and Water Management – Transport Research Centre
Berg, van den	Peter	Ministry of Finance
Berg, van den	Reinier	Netherlands Environmental Assessment Agency
Bergkamp	Renée	Ministry of Agriculture, Nature and Food Quality
Berkhout	Frans	Institute for Environmental Studies
Besseling	Paul	Netherlands Bureau for Economic Policy Analysis *+
Bloemen	Pieter	Ministry of Housing, Spatial Planning and the Environment
Boone	Ides	Centre for Research in Animal Medicine and Agricultural Chemistry
Boot	Pieter	Ministry of Economic Affairs
Braat	Leon	Netherlands Environmental Assessment Agency
Bree, van	Leendert	Netherlands Environmental Assessment Agency
Brinkman	Rob	Ministry of Housing, Spatial Planning and the Environment
Broekhans	Bertien	Ministry of Transport, Public Works and Water Management
Cath	Albert	DynaVision
Coutinho	Roel	National Institute for Public Health and the Environment (RIVM)
Demkes	Roger	Directorate General for Public Works and Water Management
Dijstelbloem	Huub	Scientific Council for Government Policy
Don	Henk	*+
Donk, van de	Wim	Scientific Council for Government Policy
Doorne, van	Ellen J.A.	Ministry of General Affairs
Dorland	Kees	Program Council Climate changes Spatial Planning
Duijnhouwer	Frans	Ministry of Housing, Spatial Planning and the Environment *
Egmond, van	Stans	Erasmus MC
Eijgenraam	Carel	Netherlands Bureau for Economic Policy Analysis
Endt, van der	Jolinda	Ministry of Agriculture, Nature and Food Quality
Engelen, van	Joop	National Aerospace Laboratory
Faber	Thomas	Ministry of Finance
Fieret	Danielle	RAND Europe
geel, van	Pieter	Ministry of Housing, Spatial Planning and the Environment
geest, van	Laura	Ministry of Finance
geurts	Ben	Ministry of Housing, Spatial Planning and the Environment
giessen, van der	Anton	Netherlands Environmental Assessment Agency

Surname	Forename	Organisation
gorter	Joeri	Ministry of Social Affairs and Employment
Haanstra	Hayo	Ministry of Agriculture, Nature and Food Quality
Hage	Maria	Radboud University Nijmegen
Halffman	Willem	University of Twente
Hanekamp	Jaap	Heidelberg Appeal Nederland
Hanemaaijer	Aldert	Netherlands Environmental Assessment Agency
Hazeu	Cock	Scientific Council for Government Policy
Hecker	Edwin	Ministry of Agriculture, Nature and Food Quality *
Heeres	Hendrik Jan	Ministry of Finance
Heiligenberg, van den	Harm	Netherlands Environmental Assessment Agency
Hisschemöller	Matthijs	Institute for Environmental Studies
Hoed, den	Paul	Scientific Council for Government Policy
Hoefnagel	Frans	Scientific Council for Government Policy
Hoogervorst	Nico	Ministry of Housing, Spatial Planning and the Environment
Hoppe	Rob	University of Twente
Hordijk	Leendert	International Institute for Applied Systems Analysis
Huijs	Simône	Ministry of Agriculture, Nature and Food Quality *
Husmann	Chiel	Ministry of Housing, Spatial Planning and the Environment
Janssen	Peter	Netherlands Environmental Assessment Agency
Jenniskens	Marie Josée	Ministry of Agriculture, Nature and Food Quality
Jong, de	André	Ministry of Finance
Jung	Dick	Ministry of Housing, Spatial Planning and the Environment
Kabat	Pavel	Wageningen University and rResearch Centre
Kabel	Dick	Ministry of Finance
Kalden	Chris	Ministry of Agriculture, Nature and Food Quality
Kirschenmann	Peter	VU University Amsterdam
Kloprogge	Penny	Rathenau Institute
Klostermann	Judith	Wageningen University and Research Centre – Alterra
Klumpers	Teun	Ministry of Agriculture, Nature and Food Quality
Koesveld, van	Ernst	Ministry of Finance *
Kooiman	Peter	Netherlands Bureau for Economic Policy Analysis *
Kroes	Eric	RAND Europe
Kruitwagen	Sonja	Netherlands Environmental Assessment Agency
Lammers	Wim	Netherlands Environmental Assessment Agency
Lankhorst	gertjan	Ministry of Economic Affairs
Lanser	Debby	Netherlands Bureau for Economic Policy Analysis
Leeuwe, van	Paul	Scientific Council for Government Policy
Leussen, van	Wim	University of Twente
Lever	Kees	Ministry of Housing, Spatial Planning and the Environment

Surname	Forename	Organisation
Manders	Ton	Netherlands Environmental Assessment Agency
Mathijssen	Judith	RAND Europe *+
Meijer	Ineke	Utrecht University/Delft University of Technology
Melse	Johan	Netherlands Environmental Assessment Agency
Molemaker	Roelof Jan	Ecorys
Molen, van der	Remco	Ministry of Finance
Mulder	Rob	Scientific Council for Government Policy
Nijboer	Irene	Ministry of Social Affairs and Employment
Okker	Ruud	Netherlands Bureau for Economic Policy Analysis
Opstal, van	Rocus	Netherlands Bureau for Economic Policy Analysis
Pas, van der	Jan-Willem	Delft University of Technology
Petersen	Arthur	Netherlands Environmental Assessment Agency *+
Pieters	Jan	Ministry of Housing, Spatial Planning and the Environment
Plug	Kees	Ministry of Housing, Spatial Planning and the Environment
Pool	Erik	Ministry of Transport, Public Works and Water Management
Rahman	Adnan	RAND Europe *+
Riet, van de	Odette	Delft University of Technology
Roukens	Bert	Ministry of Economic Affairs
Scheenjes	Xanthe	Ministry of Finance
Seebregts	Ad	Energy Research Centre of the Netherlands
Sevenster	Jan	Ministry of Agriculture, Nature and Food Quality
Slob	Marjan	Rathenau Institute
Sluijs, van der	Jeroen	Utrecht University
Stroop	Andre	Ministry of Economic Affairs
Svärd	Mari	RAND Europe
Sweers	Michiel	Ministry of Social Affairs and Employment
’t Hoen	Arjen	Ministry of Transport, Public Works and Water Management
Teulings	Coen	Netherlands Bureau for Economic Policy Analysis
Toren, van den	Jan Peter	Ministry of General Affairs
Vaessen	Annemarie	Delft University of Technology
Verbruggen	Johan	Netherlands Bureau for Economic Policy Analysis
Visser	Hans	Netherlands Environmental Assessment Agency
Vliet, van	Lodewijk	Ministry of the Interior and Kingdom Relations
Vlist, van der	Hans	Ministry of Housing, Spatial Planning and the Environment
Vos	Reinout	Ministry of Foreign Affairs
Vries, de	Annick	University of Twente
Wardekker	Arjan	Utrecht University
Wezel, van	Annemarie	Netherlands Environmental Assessment Agency
Wijst, van der	Ton	Social and Economic Council of the Netherlands
Woittiez	Reinout	National Institute for Public Health and the Environment (RIVM)
Ybema	Remko	Energy Research Centre of the Netherlands

* member programme commission + member organisation committee

Information about uncertainty is important for policymaking

Uncertainty is becoming an ever more important factor for public policymaking, both because of the growing complexity of policy arenas and because of the high economic, societal and political costs of policy mistakes. At the same time, it appears to be difficult for policymakers to properly take relevant uncertainties into account in the policies they develop.

This publication reports on a conference "Dealing with uncertainty in policymaking" which brought together researchers and policymakers for an exchange of experiences in different policy areas. It became apparent that the importance of the theme was widely recognised. The report concludes with ten recommendations for a better way of dealing with uncertainty.

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and Rand Europe