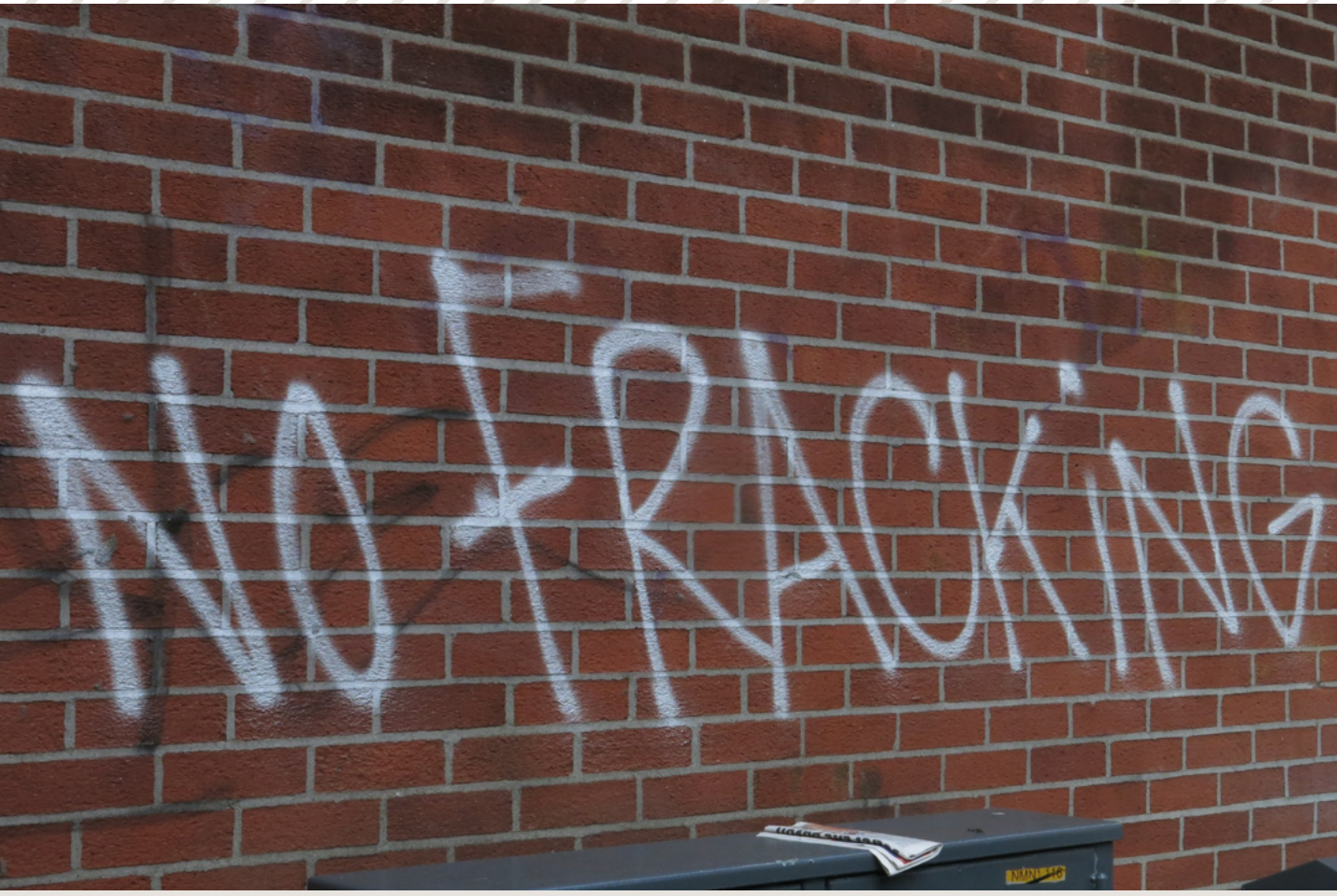
Contested science

Public controversies about science and policy



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Foreword

‘Research shows…’ is an all-too-common turn of phrase in policy reports and political debate. These two small words instil great confidence: they imply that policy-making rests on solid grounds, that it is based on objective facts.

But opinions may be divided about the facts. The Netherlands has witnessed repeated controversies in recent years concerning the way in which policymakers use science. The controversies have concerned such divisive issues as the underground storage of carbon dioxide, exploratory drilling for shale gas, and vaccinations against cervical cancer.

In this study, we look at six recent controversies and attempt to answer the following questions: In what way do policymakers call in scientific expertise? How do other parties (local residents, local authorities, civil society organisations) respond? Is there a lack of trust in science in such cases? And what lessons can we learn from the way that policymakers and scientists have dealt with public controversies?

This is a subject that touches upon the core mission of the Rathenau Instituut: the study of science and technology in public contexts. Life in a ‘technotope’ - an environment dominated by technology - forces us, as citizens, to tackle difficult questions. Should I have my daughter vaccinated against cervical cancer, and what side-effects will that vaccination have? Will shale gas drilling destroy the landscape in my environment? What health risks will a mobile phone mast pose if it is installed in my neighbourhood?

Scientific evidence is needed to answer these questions, but this study shows that such evidence is not enough to address public unrest. Science does not serve as an independent arbiter in such cases; it is itself drawn into the controversy. Each of the parties involved invokes its own truth and digs its heels in deeper as the controversy continues. The cases described in this report show that while new modes of consultation can be created, this usually happens too late in the process, when public resistance has already gathered too much force and viewpoints have become intransigent.

These cases offer policymakers and the scientists involved in policymaking valuable lessons that show them how to deal with public opposition in new ways. One of the most important lessons is that it is impossible to remove all scientific uncertainties. We will have to make do with a kind of science that is ‘good enough’ and ensure that the policymaking process also acknowledges the broader public concerns and interests involved. The Rathenau Instituut would like to help policymakers use scientific evidence in new ways that will allow them to generate greater public support for their policies.

Jan Staman
Director, Rathenau Instituut
The Hague, May 2014

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Part I Introduction

Evidence-based policy

Policymakers are increasingly turning to science to substantiate their policy measures. There is much to be said for evidence-based policy of this kind (Slob & Staman 2012). Many of the political and social issues that we face in our high-tech society are so complex that scientific evidence is indispensable to the policymaking process. That is certainly true of developments in medicine, food safety and the long-term sustainability of our energy supply, but it can also be said about our ability to manage the financial crisis or the risks and opportunities associated with the information society, to give just a few examples. Policymakers and politicians assume that their policy decisions will be more persuasive if they can give scientific arguments to support those decisions.

But the practice of invoking science is not always trouble-free. In the Netherlands, a series of recent public controversies has raised questions about evidence-based policy. They include public unrest about the inclusion of a vaccine against cervical cancer in the Dutch State Vaccination Programme, protests against licences granted to conduct exploratory drilling for shale gas, and the political fuss kicked up about errors in the climate assessment reports issued by the Intergovernmental Panel on Climate Change (IPCC).

These controversies are often associated with declining public trust in science (KNAW 2013, Dijstelbloem & Hagendijk 2011). However, a recent public survey by the Scientific Council for Government Policy and the Rathenau Instituut denies that trust in science is generally declining or that distrust in science is growing. In fact, the survey shows that the public still holds ‘science’ in high regard (Tiemeijer & De Jonge 2013). What it also reveals, however, is that public trust falls off sharply as soon as scientific research is used for commercial and policymaking purposes. The controversies mentioned above - the HPV vaccine, the exploratory drilling for shale gas, and the IPCC reports - appear to point in the same direction.

These findings indicate a paradoxical situation. Specifically, the survey shows that the public’s appreciation of science depends largely on the contribution that scientific research makes to such societal objectives as good healthcare, safe food, prosperity and the quality of life. But it is precisely with regard to public wellbeing that scientists are forced to collaborate with government, businesses and other parties. In all the uproar caused by the HPV vaccine or IPCC report controversies, not a single party argued that policymakers should cease drawing science into their discussions. For now, fact-free politics has very few fans. The question that does arise is: when is the public’s trust in science at risk, and what is needed to retain that trust?

Prerequisites for trust

In this study, we review six recent public controversies in the Netherlands about evidence-based policy in order to consider the prerequisites for trustworthy science. In doing so, we aim to gain a better understanding of why, in these particular cases, the use of scientific evidence in

policymaking led to public disquiet. We also explore what is needed to win public support for evidence-based policy.

The key questions we pose are the following:
- When and how do policymakers call on scientific expertise?
- How do other parties respond (local residents, civil society organisations, local authorities, and experts who have reached differing conclusions)?
- What role does scientific evidence play in allaying controversy?
- To what extent does public trust in science or distrust of science play a role?
- And finally, what lessons can we learn from the way that scientists and policymakers have dealt with public controversies?

This study is intended mainly to help policymakers understand what they need to do to generate public support for evidence-based policy, and to give scientists and policymakers guidelines for dealing more effectively with public opposition. Scientists and policymakers are thus the main target groups of this study.

Six public controversies

We have selected six examples of evidence-based policy that led to public controversies in the Netherlands. In each case, scientific arguments were used to substantiate policy proposals or policy measures; in each case, again, the policy proposals and measures came under fire in part because the public disputed the scientific evidence. Most of the case studies were written by external authors.

The six cases are:
1. Electromagnetic radiation by mobile telephone masts (authors: Marijke Hermans, Marjolein van Asselt and Wim Passchier);
2. Inclusion of HPV vaccine in the Dutch National Vaccination Programme (authors: Albert Meijer, Paulus Lips and Huub Dijstelbloem);
3. Underground storage of carbon dioxide (authors: Suzanne Brunsting, Eefje Cuppen and Ynke Feenstra);
4. Exploratory drilling for shale gas (author: Tamara Metze);
5. IPCC climate assessment reports (author: Monique Riphagen);
6. Food safety: the EHEC bacterium (author: Franck Meijboom).

Part II consists of six summarized case studies that focus on the factual sequence of events. The detailed case studies can be found at http://www.rathenau.nl/publicaties/publicatie/wetenschap-als-strijdtoneel.html. In Part III, we use the questions listed above to analyse the cases, based in part on the analysis (or proposed analysis) of the authors of the case studies.

By comparing the six cases, we have noted certain patterns that would not have emerged if we had simply studied a single case. In anticipation of the case analysis in Part III, we will briefly mention a few of these patterns below. This will also give readers something to go by when they read the (abbreviated) case studies in Part II.

Public unrest

In each of the cases, the policy proposals or policy measures provoked public unrest at a certain point. Often, the unrest had several causes: a concern about environmental or health risks, distrust in the National Government's intentions, or protests against visual pollution. The groups involved were also often diverse and included local residents, civil society organisations, local authorities and critical experts.

Invoking the evidence

In each of the cases, scientific evidence played an important role in policymaking or policy implementation. For example, the Health Council of the Netherlands recommended that the Dutch Minister of Health, Welfare and Sport should include the HPV vaccine in the National Vaccination Programme, and the National Government's climate policy was based largely on the IPCC's reports. Policymakers often employed long-standing practices, such as statutory procedures (environmental impact assessments), or called in the advice of institutes (National Institute for Public Health and the Environment), advisory bodies (Health Council) or scientific platforms (IPCC) founded specifically for that purpose.

In their attempts to allay the public's fears, the policymakers or companies involved often referred to the very same scientific evidence or experts again. For example the National Institute for Public Health and the Environment (RIVM) responded to the uproar concerning the HPV vaccine by once again pointing to the scientific arguments in favour of including the vaccine in the vaccination programme.

Counter-discourse

In none of the cases, however, did the scientific evidence soothe the public's fears. The individuals and groups involved felt that their worries had not been taken seriously, and they rejected both the 'official', government-approved interpretation and the underlying scientific arguments. The unrest was aggravated by other experts announcing that they had reached a different assessment (of the risk), and by alternative sources of information accessible on the Internet. The scientific uncertainties - i.e. the uncertainty concerning detrimental effects on the environment and health - are one of the main causes for critical groups to question the authorities' arguments. As a result, a counter-discourse emerged in opposition to government's interpretation.

Stages of learning

In some of the cases, the debate then shifted to finding further evidence in support of policy, for example by contracting out new studies meant to remove any existing scientific uncertainties. This often included creating platforms for discussion between proponents and opponents and involving critical groups in designing the new round of research.

These new stages and modes of consultation are interesting and can be regarded as innovative approaches to dealing with criticism, but in fact they mainly led to the parties resuming their previous positions. In most of the cases, they were only introduced at a very late stage of the process, after the various parties were already entrenched in their positions and the controversy seemed unresolvable. Although the new arrangements served to broaden the research agenda, the issue itself continued to be framed in scientific terms. As a result, other concerns and interests, for example visual pollution or plummeting property prices, were ignored - even though they were partly causing the unrest.

Part II Case studies

The six summarized case studies follow below. We have based these on the detailed case studies written by external authors, available on the Rathenau Instituut website (http://www.rathenau.nl/publicaties/publicatie/wetenschap-als-strijdtoneel.html).

The abbreviated case studies focus on the factual sequence of events. They document the cases until approximately 2012. The shale gas case study also covers more recent events.

1 Electromagnetic radiation by mobile telephone masts

original case study written by Marijke Hermans, Marjolein van Asselt and Wim Passchier

Unrest about siting of mobile telephone masts

At the end of the 1990s, there was growing public unrest about the siting of mobile telephone masts. There were various concerns: concerns about their effects on health and visual pollution, questions about the necessity of siting masts, and the ‘why here?’ question. Local residents felt caught off guard when masts began appearing in their area; they needed more information, wanted their concerns to be taken seriously, and demanded a say in the decision-making. The public further distrusted the profit motives of the telecom operators and the role of the National Government, which stood to earn billions of euros from the sale of licences. Some local authorities also began to oppose the proliferation of masts.

Research on health risks

In response to the unrest, the National Government drafted a new policy on masts in 2000, and two years later signed the Antenna Agreement putting the new policy into effect. The new policy covered health aspects, the visual adaptation of the masts, and the right of consent for occupants of rented housing.

In addition, the Dutch government contracted the Netherlands Organisation for Applied Scientific Research (TNO) to study the masts’ effects on health. The study (known as the COFAM study) revealed that subjects exposed to UMTS signals suffered a diminished sense of wellbeing. The researchers were surprised by the outcome and called for more research. The Health Council of the Netherlands found that the research was properly conducted, but it raised questions about TNO’s interpretation of the results.

The COFAM findings caused a public stir concerning the health risks of mobile telephone masts. The protests continued unabated between 2003 and 2006. The local authorities of the municipalities of Spijkenisse, Tilburg, Leeuwarden and Blaricum banned the siting of new masts. Critical groups (e.g. Stichting Milieuziektes and StopUMTS) also questioned what they considered to be the limitations of the COFAM study, or doubted the impartiality of TNO

because of its relationship with the National Government and KPN (formerly the state-owned fixed-line operator, now a private landline and mobile telecommunications company).

In response to the continuing unrest and to gain greater clarity about the masts' effects on health, the National Government ordered an additional study (in part on the recommendation of the Health Council), known as the 'Swiss study'. In a memorandum to the House of Representatives, the Dutch State Secretary for Housing, Spatial Planning and the Environment, Pieter van Geel, stated that '… the results of the COFAM study are such that replication and additional research are desirable and necessary.' The Swiss study's results, which showed that UMTS radiation did not have any negative impact on health, failed to convince the local authorities, however. They claimed that the study had not taken the long-term risks of electromagnetic radiation into account. They also grew suspicious when the results of the study were held back from publication.

Liaison Group

In response, in 2005 the Ministries of Economic Affairs and Housing, Spatial Planning and the Environment contracted the Netherlands Organisation for Health Research and Development (ZonMw) to carry out a multi-year follow-up study on the effects of electromagnetic radiation. In addition, the Electromagnetic Fields and Health Knowledge Platform (EMV&G) was founded, whose task was to consolidate relevant expertise and make it available to professionals working in the field.

Part of the EMV&G Knowledge Platform was the Liaison Group, which brought together civil society organisations, experts and policymakers. The Liaison Group served as the 'social conscience' of the EMV&G Knowledge Platform. In the group, proponents and opponents debated ZonMw's interim research results and the histories of those whose health had been adversely affected by radiation (or who believed it had been).

The Liaison Group meetings did not, however, result in consensus on the findings. In fact, the meetings mainly ended in deadlock, with neither party able to persuade the other of its views. The discussion then turned to ZonMw's research design, the criteria on which a literature review was based, or the way in which the research was funded. For example, the critics argued in favour of studying the cumulative effects of everyday exposure to electromagnetic radiation, whereas the researchers pointed out that such exposure could not be measured in the laboratory. That failed to convince the civil society organisations, however: '… this is not what the public is expecting…,' in the words of the Liaison Group chairperson.

Electrohypersensitivity

The deadlock in the Liaison Group caused the focus to shift to a new issue: help for people suffering from electrohypersensitivity. 2011 saw the founding of the ElectroHyperSensitivity (EHS) Think Tank, which looked into complaints ascribed to electromagnetic fields. That led to another study by ZonMw meant to arrive at an accurate definition of electrohypersensitivity and its incidence in the Netherlands. The Think Tank recommended assisting electrohypersensitivity sufferers even in the absence of scientific evidence for their symptoms.

2 Inclusion of the HPV vaccine in the Dutch National Vaccination Programme

original case study written by Albert Meijer, Paulus Lips and Huub Dijstelbloem

National Vaccination Programme

At the request of the Minister of Health, Welfare and Sport, the Health Council of the Netherlands published a report in 2008 concerning the inclusion of a vaccine against human papillomavirus (HPV) in the Dutch National Vaccination Programme. Certain HPV types can cause cervical cancer. Approximately 600 women in the Netherlands contract cervical cancer every year; about a third of these cases are fatal. In its report, the Health Council advised the Dutch Government to include the HPV vaccine in the National Vaccination Programme. The Minister adopted its advice. As customary, the National Institute for Public Health and the Environment (RIVM) was responsible for implementing the vaccination policy. In early 2009, RIVM sent a letter to the target group, twelve-year-old girls in the Netherlands, inviting them to be vaccinated. The letter, which was addressed to both the girls and their parents, pointed out the importance of lowering the number of deaths caused by cervical cancer.

Public uproar

Contrary to the expectations of the Ministry and RIVM, the vaccination campaign led to a huge public outcry. Parents felt as if the vaccination was being forced on them and that they were 'bad parents' if they advised their daughter against it. They felt that they were being forced to choose without having enough information about the need for the vaccine, its effectiveness, and its risks.

The public's disquiet was fuelled by the critical comments of various experts. A number of specialists criticised the Health Council's recommendation in an article in the foremost Dutch medical journal (*Nederlands Tijdschrift voor Geneeskunde*) and during a broadcast of *Zembla*, a television documentary programme. The Council, they said, had not taken various uncertainties into account, including the vaccine's possible side-effects. The vaccination was also too expensive and its effectiveness had not been sufficiently proven. They concluded that the Council should have advised against the vaccine. The producers of *Zembla* also claimed that the scientists involved in writing the Health Council's report had ties with the pharmaceutical industry.

The role of the Internet

These criticisms were widely disseminated on the Internet. Websites (for example verontruste-moeders.nl, i.e. 'worriedmothers') and YouTube clips pointed out the (presumed) hazardous side-effects of the vaccine. For example, stories were circulated that the HPV vaccine could cause paralysis, and images of young girls were posted on websites with such captions as 'Please think carefully' and 'Don't be a test rabbit'.

Of particular note was one Anneke Bleeker, a florist with no medical background, who took up arms against the established experts on the ‘worriedmothers’ website. She referenced articles that - according to the case study authors - ‘came across as scientific’. Worries about potential side-effects played a major role in this context. During the *Zembla* broadcast, Bleeker referred to the Thalidomide and DES scandals of the 1960s and 1970s, whose side-effects were unknown at the time. Bleeker gradually became the voice of a concerned public.

Deepening controversy

Initially, the Ministry of Health, Welfare and Sport and RIVM scarcely responded to the online criticisms, if at all. Later, however, Roel Coutinho, Director of the Centre for Infectious Disease Control at RIVM and the spokesperson for the vaccination campaign, did respond. He defended the Ministry’s decision in television and newspaper interviews. He called the online accounts of side-effects and uncertainties about the vaccine ‘tall stories’ and said that the experts who had criticised it were ‘damaging’ the campaign.

Coutinho’s reaction only deepened the controversy. The critics felt that they were not being taken seriously and viewed RIVM’s information as ‘propaganda’. The public outcry about the vaccination eventually meant that in 2010, only 45 per cent of girls had had the full set of three vaccinations, whereas more than 80 per cent had been expected. RIVM considered the vaccination campaign a ‘failure’.

Misunderstood

The interviews conducted for the case study revealed that the Ministry of Health, Welfare and Sport and RIVM had vastly underestimated the impact of the online criticisms on the public’s willingness to submit to the vaccination programme. Looking back at the torrent of public criticism and the disappointing turnout, the experts and policymakers involved said they felt misunderstood: hadn’t they done everything possible to improve public health? Interviewed in a popular Dutch daily news show, RIVM’s Roel Coutinho expressed his astonishment at the uproar and the fact that his authority, accumulated over the course of many years, no longer seemed to count.

Unpredictable controversies

The difficulty of predicting how the public will respond to new vaccinations became clear in 2009, when the Health Council recommended including a vaccine against hepatitis B in the National Vaccination Programme. In an interview, Coutinho commented: ‘We thought then that the Council’s recommendation and the Minister’s decision to include the vaccine in the programme would lead to public unrest, because we figured it would be another controversial issue. But nothing happened.’

3 Underground storage of carbon dioxide

original case study written by Suzanne Brunsting, Eefje Cuppen and Ynke Feenstra

A new technology

Carbon capture and storage (CCS) is a process whereby carbon dioxide (CO_2) emissions, for example from coal- and gas-fired power plants, are captured and stored or sequestered underground, in depleted gas reserves. The process is controversial because the effects of CO_2 gas on substrata are not entirely clear. There are fears of gas leaks, for example. CCS can, however, prevent the release of large quantities of CO_2 into the atmosphere, making it an effective way of meeting CO_2 emission reduction targets.

In 2007, the Ministry of Housing, Spatial Planning and Environment, the Ministry of Economic Affairs and the intermediary organisation SenterNovem put out a call for tenders for demonstration projects involving land-based CCS. Royal Dutch Shell was one of those that submitted a tender and in November 2008 it was awarded 30 million euros in funding for its project.

In July 2007, various authorities, energy companies and consulting engineering firms published a joint report on the general environmental impact of CCS. The purpose of the report was to provide background information about the potential for land-based CCS in the Netherlands, a subject about which the country had very little knowledge or experience, either technical, policy-related or legal. Shell used the report to prepare its Environmental Impact Assessment (EIA) scoping document for the project, which was to be sited in the Municipality of Barendrecht.

Public unrest

At the start of the EIA procedure, in February 2008, Shell organised an information meeting for the residents of Barendrecht. Present at the meeting was a representative of the Ministries of Economic Affairs and Housing, Spatial Planning and the Environment, who was there to explain the government's policy on reducing CO_2 emissions and what role CCS would play in that policy. After the meeting, the media began to report on the concerns of local municipal councillors and residents. They questioned whether the Municipality of Barendrecht was the right location, given its population density and the many industrial sites already located there. There were also worries about health risks and the potential negative effect on property prices.

The signs of disquiet led Shell to organise a second information meeting a few months later. This time, a representative of the Netherlands Organisation for Applied Scientific Research (TNO) was present to explain the technical side of the project. TNO had been contracted by Shell to carry out research for its EIA. The representative of national government who had been invited to the information meeting cancelled at the last minute. At that time, the tender procedure was still under way.

CO_2 Government Consultation Group

In mid-2008, the Minister of Economic Affairs, the Minister of Housing, Spatial Planning and the Environment, and a Provincial Executive Councillor for the Province of Zuid-Holland (in which the Municipality of Barendrecht is located) decided to set up a CO_2 Government Consultation Group (BCO_2) of municipal, provincial and national government representatives. The purpose of the group was for the participants to inform one another about the decision-making process and about the project communication activities. Shell also took part in the latter.

The BCO_2 participants agreed that each of them would continue using its own communication channels. Shell, however, then decided to cease all public communication temporarily and to no longer respond to local media reports in order to avoid stirring up any more public unrest.

Knowledge Forums

The BCO_2 participants agreed to set up Knowledge Forums and to invite external experts to join them. The forums would take the form of four meetings intended to discuss the substrata, choice of location, external safety, and risk monitoring.

At the same time, comments by experts began appearing in the media. Hydrologist Cees den Akker, who also participated in the Knowledge Forums, was critical about the safety of CCS. In his view, it would be better not to carry out the demonstration project in a densely populated area. Krijn de Jong, chemistry professor, called CCS beneath Barendrecht an ‘irresponsible experiment’.

In March 2009, a CCS information centre funded by the Ministry of Housing, Spatial Planning and the Environment opened at a shopping centre in Barendrecht. It offered information boards and publications by the national government, the project developers, TNO, Greenpeace and other parties. Its purpose was to inform local residents. The local authorities refused to communicate at this location and set up their own information centre in the town hall.

Growing public resistance

The Ministers of Economic Affairs and Housing, Spatial Planning and the Environment visited the Municipalities of Barendrecht and Albrandswaard various times in the course of 2009 to talk to local public administrators and residents. The Ministers hoped to explain why they found CCS so necessary in addition to energy efficiency and renewable energy, and to emphasise that safety would be a priority for the project.

Local public administrators turned against the project, however. Opposition among local politicians grew in September 2009 when a railway accident in Barendrecht cost an engineer his life. The local authorities pointed to the accident as evidence that Barendrecht already accommodated enough high-risk activity within its borders. In their view, the municipality was already doing more than enough in the nation’s interest. Although the National Government had the power to put the nation’s interests above local interests (by means of a National

Coordination Scheme), the government nevertheless decided to have the National Institute for Public Health and the Environment (RIVM) investigate the health risks posed by CCS. RIVM concluded that the National Government should communicate openly with the public about any health risks.

In November 2009, the Provincial Council of Zuid-Holland also turned against the CCS project. Emotions ran high at a third information meeting, attended by the Minister of Housing, Spatial Planning and the Environment, Jacqueline Cramer. The Minister stated on this occasion that CCS was 'absolutely safe'. When the Balkenende Government fell in February 2010, the decision concerning CCS had to be postponed. After the new Government took office, the new Minister of Economic Affairs, Agriculture and Innovation, Maxime Verhagen, decided in November 2010 that there would be no land-based CCS. Instead, he would investigate the option of CO_2 sequestration in depleted gas reserves in the North Sea.

4 Exploratory drilling for shale gas

original case study written by *Tamara Metze*

'Sweet spots'

Shale gas is a fossil fuel that can be recovered by means of a special drilling technique (hydraulic fracturing, popularly known as 'fracking') from layers of shale rock deep below the surface of the earth. Fracking involves injecting a chemical mixture into horizontal layers of shale rock at high pressure, causing the rock to fracture apart and release shale gas. Shale gas extraction could help the Netherlands supplement its dwindling gas reserves in the northern part of the country. It can also be regarded as a transitional fuel, i.e. one that will keep the Netherlands supplied with energy until renewable sources are sufficiently developed. Shale gas extraction could also generate considerable revenues for the national treasury.

UK energy company Cuadrilla identified a number of 'sweet spots' in the Netherlands that were likely to prove favourable for drilling. After the Municipality of Boxtel granted Cuadrilla a licence to do exploratory drilling in 2010, residents of Boxtel and the Municipality of Haaren (both in the Province of Noord-Brabant) grew worried. Their concern was fuelled by reports from the United States that fracking had led to groundwater contamination.

People living near the intended drilling site in Boxtel and in nearby Haaren banded together in two protest groups, Shale Gas-free Haaren and Shale Gas-free Boxtel.

Public unrest

The protest groups were concerned about the health risks and environmental damage that fracking could cause. They were also afraid that their house prices would fall and that the drilling rigs would spoil their view. As time went on, the campaigners gained the support of environmental organisations in the Provinces of Noord-Brabant and Gelderland, Greenpeace, Friends of the Earth Netherlands, and a number of MPs. Scientists also spoke up in the media, among them Ko van Huissteden, a physical geographer employed by VU University

Amsterdam. The water supply company Brabant Water and Rabobank Bank, which had a data centre in Boxtel, were also concerned about the exploratory drilling programme.

Initially, the public disquiet did not cause the Ministry of Economic Affairs, Agriculture and Innovation or the Municipality of Boxtel to change track. The national and local licence applications had gone according to procedure, after all. Later, however, they changed their minds. In response to worrisome reports, the National Energy Council, the state-owned gas exploration company EBN, the Netherlands Organisation for Applied Scientific Research (TNO), the Ministry of Economic Affairs, Agriculture and Innovation and the State Supervision of Mines agency (SSM) pointed out that the relevant incidents in the United States had taken place in circumstances entirely different to those in the Netherlands. In their view, neither the legislation nor the geological conditions were comparable. For example, supervision was much better organised in the Netherlands than in the US. Exploratory drilling would show whether shale gas extraction was economically viable in the Netherlands and what environmental risks were involved.

Differing opinions

In addition, stated these parties in May 2011, studies conducted by Royal Haskoning engineers and TNO had produced very promising results with respect to the geological conditions and potential for extraction. The studies involved adapting American research data to the situation in the Netherlands. Critics, however, expressed doubts about the geological conditions and thought that there should be no drilling whatsoever because of the negative impact on the environment. They pointed out that the Province of Noord-Brabant also had a much higher population density than the United States.

It was around this time that geologists involved themselves in the debate about shale gas extraction. They discussed the effects of fracking on substrata in the Netherlands and on the quality of the groundwater, and they also raised questions about the quantity of gas to be extracted. The uncertainties led to ever-louder calls to postpone drilling by local public administrators, the Province, Brabant Water, environmental organisations and local residents. TNO and EBN countered the resistance by stating that it was precisely such questions and uncertainties that demonstrated the need to conduct exploratory drilling.

In the same period (May 2011), the Province and the municipal authorities pressed for an independent investigation into the consequences of fracking for the environment. In the view of the Municipality of Boxtel, the investigation should demonstrate that fracking would not cause any damage to public health and the environment. In response, Cuadrilla asked two firms of consulting engineers, Royal Haskoning and Oranjewoud, to adapt the results of research on Cuadrilla’s British drilling operations to the Dutch situation. After an initial rejection, the Ministry of Economic Affairs, Agriculture and Innovation was persuaded of the importance of a postponement.

Calls for independent study

September 2011 saw the television broadcast of the American documentary film *Gasland*. The

film led to greater public distrust of the information provided by the Ministry. Secretiveness about the chemical substances used in fracking played an important role in this respect. Some opponents questioned the Ministry's impartiality and followed its every move. As a result, there were growing calls for an independent study.

In early October 2011, the administrative court in 's-Hertogenbosch (capital of the Province of Noord-Brabant) ruled that exploratory drilling for shale gas should not proceed. The court found that the authorities had not followed the correct procedure and had erroneously issued a temporary exemption from the zoning plan in order to permit drilling in deep, hard-to-reach clay strata.

Faced with public unrest, the court's ruling and the scientific uncertainties, the Minister decided in late October 2011 to suspend drilling and to order an independent study to assess the risks.

Consultation meetings

The discussion then moved on to the independent study and how it should be conducted. At the Ministry's request, stakeholders attended four consultation meetings to hammer out the research agenda and decide who was eligible to conduct the study. Critics believed that TNO's ties with the Ministry were too close for it to be candidate. The suggestion was to engage research agencies that had not previously worked for the Ministry or the industry. The Ministry and Cuadrilla agreed to this.

The research agenda also led to dispute. Critics wanted the study to cover data on the quantities of shale gas to be extracted and the potential financial revenues. They also wanted the study to investigate the desirability of shale gas as a transitional fuel en route to a sustainable energy supply. The Minister, on the other hand, felt that any assessment of the usefulness and necessity of shale gas extraction should be a political matter and not an issue for research agencies to decide. The study as defined by the Ministry was restricted to an investigation of the safety and risks of drilling. The issue of the usefulness and necessity of shale gas extraction was not included on the research agenda. In spring 2012, the Municipality of Boxtel declared itself 'shale gas free'.

New study

The new study was subject to a European public procurement procedure. In early 2013 the contract was awarded to a consortium made up of the engineering firms Witteveen+Bos, Arcadis and Fugro.

The study focused on the potential risks and consequences of shale gas drilling (exploratory drilling) for nature, human health and the environment. It was to form the basis for further political decision-making about shale gas extraction. A liaison group of stakeholders was assembled to supervise the study. When the Ministry of Economic Affairs, Agriculture and Innovation attempted to retain some control over the study results by asking the liaison group to treat them with confidentiality and discretion, the representatives of environmental organisations and local government (e.g. the Municipality of Boxtel) handed in their resignations (De Vries, Van Est & Van Waes 2013).

5 IPCC climate assessment reports

original case study by Monique Riphagen

Greenhouse effect

In the 1980s, a new subject found its way onto the political agenda: the greenhouse effect. In order to furnish policymakers with scientific evidence related to climate change, the United Nations set up the Intergovernmental Panel on Climate Change (IPCC) in 1988. Thereafter, the IPCC climate assessment reports, published every five or six years, provided the Dutch government with an important basis for its climate policy.

Policy summaries compiled by scientists working in conjunction with policymakers were published at the same time as the reports. The contents of the policy summaries were adopted by the United Nations General Assembly in a plenary meeting. The expectation was that this would provide a broad basis for climate policy. After the first report, each subsequent IPCC assessment spelled out the need for stringent climate policy in increasingly harsh terms.

The fourth assessment report, published in 2007, minced no words about the influence of human activity on climate change. It gave progressive parties the ammunition they needed to push for policy measures. The Dutch Minister of Housing, Spatial Planning and the Environment, Jacqueline Cramer, agreed with them and referred in that regard to the IPCC reports.
Other politicians disputed the need for policy measures meant to mitigate the greenhouse effect, however. In particular the right-wing Party for Freedom (PVV) objected to the way in which the Minister invoked the IPCC reports. According to this political party, the need for a strict climate policy had not been sufficiently demonstrated.

Climategate and Himalayagate

Two incidents involving the IPCC reports, ‘Climategate’ and ‘Himalayagate’, led to an emotional political debate in the Netherlands.

The Climategate scandal occurred in 2009. It began when an unknown attacker hacked the server at the University of East Anglia (UK) and copied the e-mails of climatologists there to other locations on the Internet. The e-mails suggested that these scientists had attempted to conceal information disproving climate change and had refused to include publications by climate change sceptics in the IPCC report.

This incident was followed by a second scandal in 2010, known as Himalayagate. The scandal began with the discovery of an error in the IPCC’s fourth assessment report. The report stated that the glaciers in the Himalayas would melt away completely by 2035. The year should have been 2350. Other errors also came to light. One of the underlying reports made an erroneous statement about the percentage of the Netherlands that lies below sea level. According to information provided by the Netherlands Environmental Assessment Agency (PBL), 55 per cent of the country was below sea level. That turned out to be untrue: 26 per cent of the Netherlands is below sea level and 29 per cent is susceptible to river flooding.

IPCC under fire

Because the Dutch government's climate policy leaned heavily on IPCC findings, the IPCC came under heavy fire from the House of Representatives. A number of political parties suspected the IPCC of manipulating the facts to support its preconceptions. The supposed errors, they said, also showed that the IPCC was ignoring the evidence of climate change sceptics.

The Minister, Jacqueline Cramer, asked PBL to investigate whether the report by the relevant Working Group contained other errors. PBL discovered a number of further errors and inaccuracies, but none that it believed undermined the main conclusions of the 2007 report.

More transparency

PBL did, however, recommend that the IPCC be more transparent about the way in which it reached the conclusions set out in its policy summaries. It also recommended minimising the risk of error, tightening up quality control procedures, and ensuring a balanced evaluation of climate change effects.

The InterAcademy Council (IAC) was asked to evaluate the IPCC's working methods on behalf of the United Nations. The IAC concluded that the IPCC had not adjusted sufficiently to the changing demands of society. It recommended improving its management structure, review process and transparency. According to the Council, the IPCC had to communicate more effectively about scientific uncertainties. It had also failed in its communication about the errors it had made.

The IPCC took the IAC's conclusions to heart. It undertook to make adjustments to its processes and procedures.

6 Food safety: the EHEC bacterium

original case study written by Franck Meijboom

Serious illness

In spring of 2011, the EHEC bacterium was identified as the cause of several cases of serious illness in Germany. The EHEC bacterium is a type of *Escherichia coli* (E-coli) and can lead to haemolytic uremic syndrome (HUS), a kidney disorder that can be fatal. The only thing that was clear at the time was that food had caused the outbreak. Several German research institutes launched separate investigations into the source of the infection. At the same time, the outbreak spread rapidly across the borders of the German federal states. The World Health Organisation (WHO) estimated that fifty people ultimately died of HUS; most of the fatalities were in Germany.

Source of infection unclear

The German research institutes involved communicated uncertainties in the research results in various different ways. In a very short space of time, the institutes made several announcements concerning the cause of the infection: Spanish cucumbers (Hamburger Institut für Hygiene und Umwelt), meat (WHO) and beansprouts contaminated with excrement (Robert Koch Institut).

Confusion ensued, both in Germany and elsewhere. Had the contaminated food come from Spain, Germany itself, or the Netherlands? With no clear answers in sight, international relations also came under pressure. After all, no country wanted to see a key export product accused of being the source of a dangerous bacterial infection. When German researchers identified the Spanish tomato as the source, tensions between Spain and Germany flared, with Spain's Deputy Prime Minister Alfredo Pérez Rubalcaba threatening to take legal action against Germany.

After the German research institutes had failed to trace the source of the bacterium, the European Union set up an EHEC task force. The task force took over the work of the German institutes and also played a coordinating role. Ultimately, Egyptian fenugreek seeds were identified as the culprit, although some parties claimed that this was never conclusively proven.

The National Institute for Public Health and the Environment (RIVM) reported an outbreak of EHEC infection in the Netherlands in 2011. The Dutch government called on RIVM to trace the source of the infection. RIVM concluded that all of the Dutch cases of infection were related to the outbreak in Germany. No additional investigation was therefore ordered into the source of the infection.

Economic losses

European vegetable growers - especially of cucumbers and beansprouts - suffered enormous economic losses. In the Netherlands, the ongoing uncertainty about the cause of the infection - cucumbers, tomatoes and leaf lettuce were all identified at one point or another - led to losses of 157 million euros for vegetable growers and 85 million euros for dealers.

The case mainly demonstrates under how much pressure scientific researchers can be put when they are obliged to furnish policymakers with evidence, particularly when the stakes are high and time is of the essence. We will return to this subject in Part III of this report.

Part III Analysis

Patterns of unrest

As we indicated briefly in the introduction, in each of the foregoing cases the policy intentions or policy measures provoked public unrest. The unrest had various causes. For example, it involved differing parties, ranging from local residents - in some cases united in local protest groups - to local and provincial-level politicians and public administrators, national organisations such as Greenpeace or Friends of the Earth Netherlands, critical scientists, and online groups such as the 'worriedmothers'.

The unrest was further fuelled by a wide range of different concerns. They included the fear of environmental or health risks, both short-term (gas leaks, earthquakes) and long-term (side-effects of vaccine, effects of electromagnetic radiation) and worries about declining property prices and visual pollution.

In some of the cases, unrest grew because events unfolded in a way that left various groups feeling as if decisions had been forced on them without their concerns or interests being taken into account. An atmosphere of distrust quickly took hold, not only with respect to licences being issued for exploratory shale gas drilling or the siting of mobile telephone masts, but also in the uproar about the IPCC climate assessment reports. (And what the latter case demonstrates is that critics do not always fault the 'official' interpretation for *under*estimating the risks; in the IPCC case, they claimed that the climate assessment reports and the policy based on them had in fact *over*estimated the risks posed by large-scale CO_2 emissions.)

Public dissatisfaction and unrest were also expressed in differing ways: at locally organised information meetings, by local residents or groups taking action, or in interviews in local or national media or on the Internet.

The variety of different response patterns and spontaneous forms of organised protest made it difficult for policymakers and scientists to understand or predict the public's unhappiness. The unrest that arose concerning the HPV vaccine is a good example. At first, the Ministry of Health, Welfare and Sport and RIVM ignored the anxious reports on the Internet about the potential side-effects of the vaccine. That was not only because they failed to take the reports seriously but also because they customarily refrained from involving themselves in online discussions, which were more difficult to manage than their exchanges with established interlocutors such as patient interest groups. The unpredictability of opposition became clear when RIVM launched a vaccination campaign against hepatitis B not long after the uproar about the HPV vaccine. It had anticipated protests about this campaign as well, but nothing happened.

Relying on established scientific advisory practices

In the cases described above, policymakers responded to the unrest by relying on established

scientific advisory practices and evidence-gathering routines. To substantiate their policy measures, they pointed to properly conducted licensing procedures (shale gas and CCS), the recommendations of the Health Council of the Netherlands (HPV vaccine), or the IPCC's climate assessment reports. In other words, they did not simply call on a random group of experts; they brought in research institutes and advisory councils with longstanding reputations for excellence. For example, RIVM has for decades been responsible for implementing the National Vaccination Programme, and the IPCC is a platform established by the United Nations to analyse data collected worldwide about the earth's climate. It seemed no more than logical for policymakers to respond to public unrest by turning to these procedures and established advisory practices. After all, they had already shown themselves to be valuable.

Counter-discourse

What is therefore all the more striking is that policymakers were unable to dispel the unrest by referencing advisory councils and research institutes founded especially for that purpose. The critics were not satisfied with the official, government-backed interpretation and rejected or in any event questioned the authority of the experts called in to resolve the issue. A counter-discourse arose that cast doubt on the evidence produced by the policymakers and relevant experts in support of policy. That counter-discourse was fuelled by a variety of different sources.

One important source was the uncertainties involved in scientific risk estimation. Scientists could say nothing definitive or conclusive about the long-term side-effects of vaccines, the risk that shale gas extraction would lead to groundwater contamination, or the impact on health of electromagnetic radiation. Critical experts played an important role in this respect, for example doctors' comments on the Health Council's HPV recommendation, or the questions experts raised about the environmental risks and possible output of shale gas extraction. In addition, critical groups made use of alternative sources of information such as the Internet. In the debate about the HPV vaccine, for example, Web forums referred to the vaccine's (alleged) harmful side-effects. The American documentary *Gasland*, initially only available online in the Netherlands, warned about the risk of fracking leading to groundwater contamination. In all these cases, scientific uncertainties gave the critics crucial ammunition for questioning the legitimacy of the science underpinning the policy intentions.

Another source was the broader motives and broader interests underlying the unrest, for example visual pollution, plummeting house prices or the discomfort that parents feel talking to their 12-year-old daughter about her future sexual behaviour. These worries could not be removed by the results of a scientific study on environmental or health risks.

The third source was the distrust that critical groups felt towards the National Government or businesses. After all, the National Government stood to earn a great deal of money selling licences for mobile telephony or shale gas extraction. Businesses (telecom operators, Shell, Cuadrilla) cared mainly about earning a profit. That distrust extended to the research outsourced by government or businesses, and to the (presumed) ties that research institutes such as TNO had with industry or the National Government. The latter played a role in the cases involving contract research on the health effects of mobile telephone masts or the environmental risks of shale gas drilling.

In none of the cases was it sufficient for policymakers to rely on established scientific advisory practices in response to public unrest. In fact, things often appeared to go wrong right from the very start. When policymakers claimed that they were ‘right’ because their science was self-evident, local residents, parents or municipal councillors felt ignored. The way in which RIVM rejected criticisms as ill-informed or discounted them as rumours for which there was not a shred of proof made the groups involved feel that they were not being taken seriously. That was also true when the Minister, Jacqueline Cramer, claimed in Barendrecht that CCS was ‘absolutely safe’. It is no wonder that the critics were not convinced.

Focus on the scientific debate

In many of the cases, a shift then occurred: the debate began to focus increasingly on substantiating the scientific findings. That was partly because the relevant groups and experts expressed criticism of the scientific evidence presented by the policymakers. It was also partly because of the way in which the policymakers responded to the continuing criticism: by ordering yet more research meant to remove the scientific uncertainties. This response fell into the same category as their earlier response, i.e. relying on established advisory practices. For example, in the mobile telephone mast case, the ‘Swiss study’ was meant to clarify the health effects of electromagnetic radiation. At a later stage, the government even contracted ZonMw to conduct a multiyear follow-up study. And in the shale gas case, Royal Haskoning and TNO were asked to adjust American research data on the effects of shale gas drilling to the situation in the Netherlands.

But the new research results did not settle the controversy. Instead, the critical groups once again raised questions, this time about the design of the follow-up studies: the Swiss study had incorrectly failed to consider long-term health risks, and the situation in the United States differed too much from that of the Netherlands to draw any useful comparisons.

New arrangements

In both cases, the differences of opinion led to calls for more research. And in both cases, the critics were involved in designing the research or in interpreting the research data.

In the shale gas case, the critics’ calls for an independent study led to their being invited to consultation meetings organised to establish the research agenda and select the research agency. In the mobile telephone mast case, a Liaison Group was established in which interest groups debated with policymakers and experts about the interim results of a multiyear research programme investigating the effects of electromagnetic radiation and the histories of those whose health had been adversely affected by radiation (or who believed it had been). A similar development occurred in the CCS case, with Knowledge Forums being created in which stakeholders and experts discussed matters such as safety and choice of location.

But these initiatives did not succeed in resolving the controversy. The consultation meetings concerning the follow-up study on shale gas drilling mainly led to another disagreement about the scope of the research agenda. Whereas the critics felt the study should also concern the quantities of shale gas that would be extracted and the financial revenues, the Minister of

Economic Affairs, Agriculture and Innovation opposed this. In his view, ‘usefulness and necessity’ was a matter to be discussed in the political arena. However, even if the Minister had agreed to extend the scope of the research agenda, the controversy had likely become so entrenched that the critics would only accept one answer.

The end was also not yet in sight in the debate about the mobile telephone masts. The Liaison Group meetings merely led the parties to resume their previous positions, with neither one able to persuade the other of its views. The limitations of scientific research played a role in this context. For example, the scientific method used (a laboratory setting) meant that it was impossible to measure the cumulative effects of everyday exposure, but that was precisely what the critics wanted.

The consultation meetings, Liaison Group and Knowledge Forums were new arrangements meant to get the opposing parties talking to one another. They widened the circle of interlocutors. But there was no way out of the impasse. The proponents and opponents were unable to meet each other halfway. Some of the new arrangements did lead to a broader research agenda, for example by including the histories of people with electrohypersensitivity in the mobile telephone mast case. But they did not alter the fact that the issue was framed in scientific terms. Broader concerns and interests that were difficult to address by means of scientific research - for example visual pollution, declining property prices or the relationship between local costs and national benefits - were ignored, whereas these concerns partly caused the public unrest. In addition, the new arrangements were only introduced late in the process, after public resistance had already become entrenched, critical groups had begun to distrust policymakers’ intentions, and the parties’ positions had become intransigent.

Serviceable truths

The cases do not indicate any broad public distrust of science. They confirm the outcome of the survey cited in the introduction, carried out by the Scientific Council for Government Policy and the Rathenau Instituut. The case studies indicate that both proponents and opponents of policy measures use scientific arguments to substantiate their positions. For example, critics emphasised the scientific uncertainties and limitations of the research agenda when critiquing the scientific evidence underpinning the policy measures. In some of the cases they also requested further research in order to remove existing uncertainties.

What the controversies show is that there are limits to the ability of policymakers to rely on established advisory practices. Those limits are in fact closely related to the supportive and advisory role of such practices in policymaking. Advisory councils and research institutes such as the Health Council, RIVM or the IPCC need to supply policymakers and politicians with evidence-based reports and recommendations that can actually be used in policymaking. The experts involved thus need to identify and assess the relevant scientific evidence in a particular area, including the uncertainties and risks involved, in a manner that is useful to policymakers. Sheila Jasanoff, Professor of Science and Technology Studies at the Harvard Kennedy School, refers to science that supports policymaking as ‘serviceable truths’ (Jasanoff 1998).

The IPCC’s policy summaries are a good example of this. Climate experts work with policymakers on writing a brief summary of the scientific evidence of climate change, tailored to

policymakers' need for relevant policy options. The Health Council's recommendations concerning the HPV vaccine met a similar need: the Council must inform the Minister of Health, Welfare and Sport about the pros and cons of policy measures, assess the pros and cons, and reach a final conclusion - a recommendation - based on its assessment. This process of interpretation and assessment inevitably involves accentuating important findings and omitting certain nuances and uncertainties. That makes the work of the advisory councils and research institutes vulnerable to the accusation that they have not taken those nuances and uncertainties sufficiently into account. The cases show that critical groups and experts can use the uncertainties to call the planned policy measures into question.

In conclusion, then, policymakers' custom of relying on established advisory practices is vulnerable to criticism, by definition. And the more policy relies on such practices, and the less leeway the underlying reports and recommendations leave for alternative views, the more vulnerable that custom is. The uproar caused by the errors - relatively minor ones - found in the IPCC's assessment report must be seen in the light of such vulnerability. After all, the Netherlands' climate policy was based on the IPCC reports and there seemed to be little room for doubt or discussion. When the InterAcademy Council evaluated the controversy surrounding the IPCC's climate assessment reports, it therefore called on the IPCC to be more transparent about its working methods and to communicate more openly about scientific uncertainties.

In assessing and interpreting the available scientific findings, time pressure can also play an important role, as seen in the case of the EHEC contamination. The deaths in Germany put the research institutes responsible under immense political and public pressure to identify the source of the infection. Although the case study does not say it in so many words, the suspicion is that the various experts reached incorrect and contradictory conclusions about the source of the infection because they were under pressure to produce answers quickly and because of faulty coordination between the research institutes involved. This led to immense confusion and unrest among consumers, policymakers and the vegetable growers affected by the outcome. There were obviously too many uncertainties to identify the precise source of infection, but the experts gave in to pressure and reached premature conclusions without having sufficient evidence to back up their claims. The urgent circumstances asked too much of them.

The role of 'serviceable truths' in supporting and advising on policy is marked by the tension between scientific accountability and policy relevance. Scientific recommendations or reports that are too far removed from the needs of policymakers lack relevance and make themselves superfluous. But experts who are too eager to meet the needs of policymakers run the risk of being labelled by other experts or critical groups as insufficiently accountable to science and, therefore, untrustworthy.

Research agenda

The role of science in supporting and advising on policy is also vulnerable from the perspective of civil society. As soon as policymakers call on advisory councils or research institutes and set them a particular advisory task or research assignment, the question is whether that assignment accurately reflects the public issue in question.

Some of the cases show that the groups involved criticised the planned or executed research agenda for being too limited. That was true for the Swiss study, accused of ignoring the long-term health risks of electromagnetic radiation, and the follow-up study on the effects of shale gas drilling ordered by Ministry of Economic Affairs, Agriculture and Infrastructure, faulted with failing to study the usefulness and necessity of the drilling operation. These sorts of questions also arose during the meetings of the EMV&G Knowledge Platform's Liaison Group.

The cases show that, time and again, the public raises questions about the breadth of the research agenda. That makes the work of advisory councils and research institutes meant to support policy vulnerable to the criticism that their research agenda does not take all the relevant factors into account. At the same time, the cases also indicate that it is not useful to conduct scientific research on every public issue. For example, it is impossible to prove scientifically that shale gas drilling will not have a negative impact on the environment, as the Municipality of Boxtel demanded. There are always situations imaginable that involve a certain risk. It is equally impossible to measure the cumulative effects on human health of everyday exposure to electromagnetic radiation in the laboratory.

Broader public concerns

The cases also involved broader public concerns that the policymakers and scientists failed to address. They ranged from worries about visual pollution, declining property prices and the discomfort of parents having to discuss their teen-age daughter's (future) sex life with her to the feeling that a decision was being forced through in which economic or (in the IPCC case) political and ideological motives took precedence over other interests. In some of the cases, the groups involved felt that the local community was having to sacrifice too much in the national interest, and that the costs and benefits were thus unfairly distributed. Scientific research cannot remove these broader concerns. However, because they are partly causing the public unrest, they too must be addressed.

Part IV Conclusions and recommendations

In this study we explored the role of scientific evidence in public controversies about policy measures by looking at six cases in the Netherlands. In this final section, we draw conclusions and make recommendations concerning the way that scientists and policymakers should deal with such controversies.

Conclusion I: Invoking scientific evidence is not a satisfactory response to public controversies

In each of the cases we have studied, the problem was framed in scientific terms, reducing the discussion to a scientific issue that had to be resolved. Such reductionism came about because the relevant policymakers relied on established advisory practices to substantiate their policy, and it was aggravated by the heavy emphasis placed on scientific uncertainties during the controversies. Both proponents and opponents of the proposed policy measures wanted to remove the scientific uncertainties by ordering research or follow-up research.

The focus on scientific research falls short for two reasons. First of all, because research can never remove all scientific uncertainties, uncertainties will continue to fuel controversies. Even when groups and experts critical of a policy are involved in designing the new research, the impasse remains. Second, focusing on research means that the discussion does not pay sufficient attention to the broader concerns that play a role in the controversies. These concerns must be addressed if the policy measures are to gain the public's support.

Conclusion II: The authority of science is no longer self-evident

The custom of invoking science also falls short because the very use of science becomes controversial. The scientific evidence in support of policy and the scientific advisory practices that policymakers customarily rely on to substantiate their decisions are no longer automatically authoritative. Individuals and groups appear to have cast off any remaining timidity when it comes to debating policymakers and scientists. The public demands a say in the debate. That is undoubtedly because people are better educated than ever before, and because for every assertion, a search on the Internet will turn up the opposite assertion. Such alternative views can be used to question the claims of experts involved in policymaking.

Conclusion III: Scientific uncertainties require openness

Policymakers and scientists should respond to public opposition by being more open about scientific uncertainties. Time and again, uncertainties played a key role in the controversies we have studied. Scientific claims about environmental or health risks are inevitably accompanied

by scientific uncertainties. To a major extent, the recommendations and substantiation provided by scientific advisory committees and research institutes that support policymaking involve interpreting and assessing those uncertainties with a view to the relevant policy decisions.

Interpreting and assessing scientific uncertainties is a precarious process that is always vulnerable to criticism. In our cases, critical experts interpreted the uncertainties differently and arrived at a different assessment of the associated risks. There is therefore little point in denying scientific uncertainties or in making research results appear more certain than they are. Sooner or later, concealed uncertainties will come to light and only fan the flames of the controversy, giving the critics reason to distrust.

Policymakers and experts involved in policymaking must be more open about the scientific uncertainties that play a role in policy measures. The policymakers must refrain from asking the experts for certainties that do not exist; conversely, the experts must not permit policymakers to pressure them into making claims for which there is insufficient scientific evidence.

Conclusion IV: Parties in civil society should be involved in developing the research agenda at the earliest possible stage

The cases show that ordering yet more research will never remove all the scientific uncertainties. There will always be new questions to ask that may be relevant when analysing certain risks. There are limits to what scientific research can in fact investigate. For example, it is impossible to use current scientific methods to measure the cumulative effects on human health of everyday exposure to electromagnetic radiation. Science can also never entirely exclude the risk of shale gas drilling leading to environmental damage. Safety can never be one hundred percent.

The foregoing begs the question of how to identify the boundaries of what science can usefully investigate. The boundaries will have to be drawn primarily by the most knowledgeable experts. After all, they can provide the best estimate of whether science can answer a certain question. Such experts can be either ‘established’ or ‘critical’ scientists. To determine which questions should be at the heart of a research agenda, other parties - policymakers, businesses and public interest groups - should also provide input. The research agenda should reflect the interests and concerns of stakeholders - although always within the boundaries of what is scientifically possible.

This means that a platform should be created that enables groups to influence the research agenda. Examples of such platforms are the new consultation structures or arrangements that were introduced in the various cases, such as the consultation meetings to discuss research on the effects of shale gas extraction, or the Knowledge Forums set up in connection with CCS.

The cases also show that these new arrangements were only introduced at a very late stage of the process, after the various parties were already entrenched in their positions and the controversy seemed unresolvable. The arrangements did not lead to the proponents and opponents meeting each other halfway. Too much had already happened for them to compromise. The new consultation structures should therefore be introduced much earlier in

the process. Parties in civil society should therefore be involved in developing the research agenda at the earliest possible stage

Conclusion V: Parties should be involved in developing the public agenda at the earliest possible stage

Given our first conclusion, it is not likely that a broader research agenda will suffice as a response to public controversies. Time and again, controversies are fuelled by broader interests and concerns that are difficult to address in a research agenda. These broader interests and concerns are partly the cause of the public unrest and must be given a platform if the policy measures are to win enough public support.

Once again, it is important to acknowledge these interests and concerns at the earliest possible stage. If that does not happen, then local residents may, for example, feel that their interests are subordinate to the profit motives of telecom operators or the financial interests of the National Government, quickly leading them to distrust the licensing or decision-making process.
To prevent this from happening, policymakers should take the time early on in the process to investigate - in cooperation with all the relevant parties involved, both proponents and opponents - what concerns and interests merit a place on the public agenda and how the worries can be removed. For example, one way to address the issue of declining property values is to offer financial compensation if that value does in fact decline. And the debate about the government's climate policy merits more in-depth political discussion than a mere reference to the IPCC's policy summaries.

Final comment: good enough science

The cases we have studied show that civil society groups grow unyielding in their criticism of proposed policy measures and the related scientific findings. Early on, these groups often grow suspicious and sceptical of the intentions of businesses, policymakers and the experts involved. The case studies leave the impression that the tenacity with which critical groups continue to latch on to scientific uncertainties in order to criticise policy measures is due in part to that suspicion and scepticism.

Scientific research can never remove every uncertainty. That has repercussions not only for how policymakers and the relevant experts deal with such uncertainties, but also for how other stakeholders do. Civil society organisations, interest groups and local residents will also have to accept that scientific research cannot answer every question, and that it is very difficult to rule out every risk.

Daniel Sarewitz, Professor of Science and Society at Arizona State University, has developed an interesting proposition in this connection: he believes that the willingness of civil society groups to accept scientific uncertainties depends on the extent to which their concerns and interests are taken into account in decision-making. Sarewitz refers in this connection to 'good enough science' (Sarewitz 2013). If the parties involved have enough confidence in the

decision-making process, they will be more likely to accept a certain level of scientific certainty as ‘good enough’. This insight may be the key to dealing more successfully with public unrest.

There is much to be said for following Sarewitz’s suggestion and embarking early in the decision-making process on a discussion with all the relevant parties about the concerns and interests that merit a place on the public agenda, about which research agenda should be drawn up based on that public agenda, and about what is needed to remove the other concerns that science cannot address. It is only under these conditions that policymakers can gain the public’s trust concerning complex evidence-based policy.

Good enough science can be regarded as a more robust form of serviceable truths. In the case of good enough science, policymakers must once again depend on scientific advisory councils and research institutes to substantiate their policy measures. The vulnerability of this system to criticism, both scientific and public, will not be removed, but such vulnerability can be made manageable by dealing more openly with scientific uncertainties and by acknowledging broader public concerns and interests in policymaking.

Recommendations

The above conclusions can be summarised as follows: by giving the public a platform for expressing its views (and opposition) and by ceasing to make scientific findings appear more certain than they are, we can create a basis of public trust that enables the parties involved to accept the scientific underpinnings of policy measures as ‘good enough’.
Based on the foregoing, we make the following recommendations to help policymakers and experts involved in policymaking to deal with public controversies about complex evidence-based policy:

Policymakers should not allow public issues to be framed exclusively in terms of science. Broader concerns that cannot be addressed by science always play a role in public controversies.

Policymakers should acknowledge the broader concerns and interests during the policymaking process. Parties in civil society should be given a platform for expressing their views at the earliest possible stage, before the controversy becomes entrenched.

Policymakers should also involve parties in civil society in developing the research agenda. Public controversies about evidence-based policy also always involve public concerns that *can* be addressed by science. The research agenda should reflect those concerns.

Experts should communicate more openly about scientific uncertainties. They should not allow policymakers and parties in civil society to pressure them into making claims for which there is insufficient scientific evidence. If policymakers or other parties assert that scientific findings are more certain than they actually are, the experts should distance themselves from such assertions.

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About the authors

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Marlous Blankesteijn has worked as a researcher in the Rathenau Instituut's Science System Assessment department since 2012. She is interested in the relationship between knowledge and policy and the role of public, non-academic research institutes. Marlous studied Arts and Sciences at Maastricht University. From 2004 onwards, she lectured at the University of Amsterdam and Maastricht University. In 2011, she obtained her doctorate from the University of Amsterdam for her research on the role that knowledge plays in driving transition in the Dutch water management system. Based on that research, she contributed to the Rathenau Instituut's report on co-producing knowledge as input for major social issues (*Kenniscoproductie voor de grote maatschappelijke vraagstukken*).

Geert Munnichs

Geert Munnichs has worked in the Rathenau Instituut's Technology Assessment department since 2002, initially as a senior researcher and, since 2010, as coordinator. He is involved in a variety of different areas, ranging from ICT to security and privacy, the future of cities, biomedical advances, nutrition and animal welfare. His main research interest is the way in which politicians and policymakers deal with public worries about science and technology. Geert studied environmental studies, philosophy and history at Wageningen University. He obtained his doctorate from the University of Groningen in 2000 for his dissertation *Public discontent and political credibility: democratic legitimacy in a post-traditional society.* He then accepted a position as a post-doctoral researcher at Wageningen University, where he studied risk societies, public concerns and the role of scientific experts.

Leonie van Drooge

Leonie van Drooge has worked at the Rathenau Instituut since 2008. She is a senior researcher in the Science System Assessment department and is interested in the relationship between science and society. She is the author of the reports Valuable - *Indicators for valorisation* and *Twenty years of research evaluation.* She also gives workshops and training courses and advises the staff of research institutes on the subjects of valorisation and research evaluation. Leonie studied chemistry and science dynamics at the University of Amsterdam. As a student, she played an active role in making university research and researchers available to the non-profit sector. She also lectured on the topic of 'chemistry and society'. She began her professional career as a technology transfer officer at the University of Amsterdam.

Who was Rathenau?

The Rathenau Instituut is named after Professor G.W. Rathenau (1911-1989), who was successively professor of experimental physics at the University of Amsterdam, director of the Philips Physics Laboratory in Eindhoven, and a member of the Scientific Advisory Council on Government Policy. He achieved national fame as chairman of the commission formed in 1978 to investigate the societal implications of micro-electronics. One of the commission's recommendations was that there should be ongoing and systematic monitoring of the societal significance of all technological advances. Rathenau's activities led to the foundation of the Netherlands Organization for Technology Assessment (NOTA) in 1986. On 2 June 1994, this organization was renamed 'the Rathenau Instituut'.

The Rathenau Instituut promotes the formation of political and public opinion on science and technology. To this end, the institute studies the organization and development of science systems, publishes about social impact of new technologies, and organizes debates on issues and dilemmas in science and technology.

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