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Conflicting knowledge

Why is joint knowledge production such a problem?

Arwin van Buuren and Jurian Edelenbos

Analysing knowledge use in policy processes around contested topics requires a new research approach. Traditional research on knowledge for policy assumes a one-to-one relationship (which is often imperfect) between science and policy as two separate worlds. Science, technology and society studies teach us that knowledge for policy is a joint construct of the research and the policy community and is not produced in isolated worlds. This article argues that the main problem for knowledge use lies in the subdivision between different competing 'knowledge coalitions' of researchers and policy-makers. Conflicting knowledge is the result.

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TODAY THERE ARE a number of fundamental insecurities in the knowledge acquisition process. Three changes in current society can be distinguished that have consequences for acquiring knowledge (Gallopín *et al*, 2001). First, changes of an ontological nature can be perceived in the increasing complexity and interdependence of the world around us (Castells, 2000). Interventions cause a 'response chain' that is very difficult to survey.

Uncertainty is a basic feature of information gathering and knowledge production, because reality is impossible to depict. The time-honoured strategy that was always followed in the past to make phenomena more transparent, by reducing the units perceived, has proved inadequate. The failure to take all sorts of related phenomena, cross-connections, and so on, into account trivialises the explanatory and predictive value of models (Haag and Kaupenjohann, 2001).

Second, there are changes of an epistemological nature that refer to the way we arrive at knowledge. Each knowledge-generating institute has its own epistemological value system. The values constituting this paradigm include those about serving the client (the user of knowledge), maintaining credibility in the academic community, maintaining the image of independence, and getting follow-up orders.

Also the values of research institutes are more fundamental: questions about, for instance, how to reach valid information, and how to reach usable recommendations (Shackley *et al*, 1998; in't Veld and Verheij, 2000). Moreover, it is recognised that knowledge is produced collaboratively. Knowledge production involves the participation of laymen and needs attention to be focused on the use of different sources of, and perspectives on, knowledge. Scientific

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knowledge should be developed in interaction to achieve an effective problem-solving capacity (Lindblom and Cohen, 1979).

Third, the method of decision-making has been subject to changes. The traditional institutions of state and market, as epicentres of decision-making, have lost their importance (Kickert *et al*, 1997). Decision-making has become a social issue, and the mobilisation of knowledge has increased tremendously: knowledge has been de-monopolised and democratised. Knowledge is no longer the sole province of society's élites, because nowadays nearly everyone has received at least some form of (higher) education. Knowledge has become public property.

Furthermore, it has become easy for citizens to obtain information from various media channels and to form their own perspective. The increased amount of knowledge present in society enables more people to put the aura and superiority of scientific knowledge in perspective by asking clever questions, to criticise and debunk this knowledge.

> "Although we must begin any inquiry with prejudgements and can never call everything into question at once, nevertheless there is no belief or thesis, no matter how fundamental, that is not open to further interpretation and criticism." (Bernstein, 1991, page 327)

The rise of knowledge fights

The non-recognition of uncertain knowledge as a fact of life can lead to certain problems in the production of knowledge for policy-making. In practice we see that it is very difficult to produce knowledge that is acceptable for most parties involved (Lindblom and Cohen, 1979; van Bueren *et al*, 2003). In complex processes, actors spend most of their time deconstructing each other's research, trying to prove that suppositions are contestable, a database inadequate and so on. This leads to 'knowledge fights', with piles of reports as a result, in which contradictory conclusions are presented. This greatly hampers the quest for well-negotiated and shared knowledge as a basis for policy-making.

In this article, we take a closer look at the origins of 'knowledge conflicts' in complex policy-making processes. In the next section we argue that the main problem in the production and transfer of knowledge lies not so much in the division between a scientific world and a policy world as traditionally is argued, but more in a departmentalisation of different knowledge coalitions that consists of both knowledge providers (scientists, advisors and so on) and users (such as policy-makers). We then use the case study of the Betuweline to make this statement plausible. We revisit the knowledge production problem in the following section and design a framework for further analysis. We conclude by briefly going into boundary management strategies to cope with the departmentalisation problem of knowledge production.

Knowledge as a product of interaction

Contextualised knowledge

Knowledge production is very complicated when we take into account that policy processes have to deal with many participants — not only policy-makers but also private companies and societal groups — with conflicting opinions about the desired course of action (Teisman, 1995; Edelenbos *et al*, 2002). Environmental groups, private companies, and non-governmental organisations (NGOs) try to influence the policy process and therefore mobilise different resources. One of these resources is knowledge (de Bruijn and ten Heuvelhof, 1999; van Eeten, 1999).

The mobilisation of knowledge is usually not very difficult for these actors. There are many research institutes, experts, advisors and academic departments that could produce facts and figures. Experts can often provide specific kinds of knowledge on request. The naïve vision of neutral advisory bodies "speaking truth to power" should be renounced (Jasanoff, 1990). The expert mediates between 'outside' scientific knowledge and the practical knowledge that he or she acquires by being 'within' the policy process, part and parcel of its formulation and implementation (Kazancigil, 1998, page 74).

Scientific knowledge has become increasingly contextualised; a necessary development if it wishes to retain its relevance in a changing society (Nowotny *et al*, 2002). Knowledge production is essentially plural and contextual, and its outcomes will be contextual and, generally, multiple: in that respect, this approach shares pledges for

moving from uniformity and objective knowledge towards diversity and contextual knowledge (Hoppe, 1999; Teisman and Edelenbos, 2002). Society is increasingly capable of confronting scientists with questions and criticism. Nowotny *et al* (2002, page 166) advocate a contextualised form of scientific research: interaction with interested parties as being crucial to produce the type of science that benefits society.

> "The increasing emphasis on the contribution of science to wealth creation (and social improvement), the growing deference to so-called 'user' perspectives, the great weight now attached to ethical and environmental considerations, are all examples of the intensification of what we call contextualization."

Traditional utilisation research studies the way in which knowledge is used in policy processes (Weiss, 1977; Caplan, 1979; Huberman, 1994). The main results of these studies can be summarised briefly by saying that the use of knowledge in policy processes is often not very impressive and can be characterised in different ways, for example, strategic use, instrumental use, and enlightenment. Many factors are important for the utilisation and impact of information (for instance, the presentation of it, the timing, and the (dis-)similarities with policy-makers' beliefs).

Although these studies pay a lot of attention to the influence of the formulation of the research question by the funding agency, and the impact of the interventions in the research process by this actor, they underestimate the importance of the processes by which knowledge is created. Science, technology and society studies have taught us much about the social mechanisms by which knowledge is created (see Woolgar, 2000).

In this body of research, knowledge is the outcome of social processes and institutional guided actions of researchers. Funding agencies, users and audiences are implicitly involved in research projects. More explicitly, we can consider the impact of peer review procedures, the procedures for funding research projects, academic 'rules of the game' and paradigmatic routines. Important authors in this stream are Latour (1999), Knorr-Cetina (1999) and Bijker (2001). Science is not the objective procedure by which facts are uncovered, but the way of life in which facts are made.

Table 1 shows the differences between the traditional and the sociological vision on the process of generating science (see Bijker, 2001).

Table 1. A traditional and a sociological view on generating science

Standard view of science and technology	Constructivist view of science and technology
Clear distinctions between the political and the scientific/technical domain	Both domains are intertwined; what is defined as a technical or as a political problem will depend on the particular context
Difference between 'real science' and 'trans-science'	All science is value-laden and may, depending on the context, have implications for regulation and policy; thus there is no fundamental difference between 'real science' and 'trans-science', 'mandated science' and 'policy-relevant science'
Scientific knowledge is discovered by asking methodologically sound questions, which are answered unambiguously by Nature	The stabilisation of scientific knowledge is a social process
Societal issues can be reduced to the social responsibility of individual scientists and engineers	Development of science and technology is a social process rather than a chain of individual decisions; political and ethical issues related to science therefore cannot be reduced to the question of social responsibility of scientists and technologists
Technology develops linearly, for instance, conception → decision → operation	Technology development cannot be conceptualised as a process with separate stages, let alone a linear one
Clear distinction between technology's development and its effects	The social construction of technology is a process that also continues into what is commonly called the 'diffusion stage'; the (social, economic, ecological, cultural, …) effects of technology are thus part of the construction process and typically have direct vice versa implications for technology's shaping
Clear distinction between technology development and control	Technology does not have the context-independent status that is necessary to hope for a separation of its development and control; its social construction and the (political, democratic) control are part of the same process
Clear distinction between technology stimulation and regulation	Stimulation and regulation may be distinguishable goals, but need not necessarily be implemented separately
Technology determines society, not the other way around	Social shaping of technology and technical building of society are two sides of the same coin
Social needs and social and environmental costs can be established unambiguously	Needs and costs of various kinds are also socially constructed — depending on the context, they are different for different relevant social groups, varying with perspectives

Source: Bijker (2001, page 13)

We assume that the production of knowledge is a social process, whereby the world of policy-making and the world of research and science meet and work together in producing policy-relevant information, produced especially as input to the policy process

Worlds of science and policy-making

In this article we assume that the production of knowledge is a social process, a social construc tion, whereby the world of policy-making and the world of research and science meet each other and work together in producing policy-relevant information, which is the sort of knowledge produced especially to serve as input to the policy process (see Dunn, 1994).

This is in flagrant opposition to the more traditional view of science–politics, in which they are interpreted as two clearly distinct communities (Caplan, 1979), or two totally different cultures (Snow, 1964). Wiltshire (2001) speaks of a dichotomy between research and policy. The timeframe of both, their language and mutual images, their notion of rationality, differ fundamentally. Stehr (1992) speaks of the notion of instrumentality, underlying the picture of two totally different worlds. The strict division between the two worlds is inspired by two considerations:

- Cultural/empirical: there are two totally different cultural systems, two different ways of life;
- Functional/normative: there has to be a clear distinction for safeguarding objective, neutral information.

In these utilisation studies, we can find multiple explanations for the under-utilisation of research in policy, in line with the two communities theory. Wiltshire (2001, page 627) gave a good example:

> "Scientists failed to comprehend that the most 'rational' form of behaviour for a politician was to behave 'irrationally'. If the prime end or goal of a politician is survival, then the ends/means relationship begins to look very different."

The process of creating basic or fundamental knowledge has been studied extensively. The process of creating policy-relevant information or, in the terms of Hunt and Shackley (1999), "fiducial knowledge" (referring to knowledge produced for the practical purposes of the questioner of knowledge, see below) has, more recently, also been studied, but until now to a lesser extent (see Groenewegen, 2002; Woolgar, 2000).

Authors such as Jasanoff (1990), Gieryn (2002), and Hunt and Shackley (1999) stress the mutual influences of the worlds of science and politics that play a role in the creation of policy-relevant information. We can argue that the social processes surrounding the production of policy-relevant information are more in terms of quantity and of intensity than in the case of production of fundamental research, because knowledge is constructed in close contact, and sometimes even interactively with, end users. Policy-relevant research is often contract research. The social and institutional aspects in the process of creating policy-relevant information are very important in understanding the content and impact of knowledge. For example, the construction of the research question is of great importance for the outcomes of the research (in't Veld and Verheij, 2000).

Until recently, the dominant paradigm of knowledge use in policy processes could be characterised as the injection-pump metaphor: knowledge institutes produced policy-relevant information, which is used, more or less, good or bad, instrumental or strategic, in policy processes. This metaphor is, at first sight, instructive but, when we look at the process of creating knowledge for policy, the metaphor is misleading. Science and politics are more and more interconnected and intermingling processes that cannot be studied as a one-to-one relationship.

A convincing example of this intermingling is offered by van der Sluijs *et al* (1998). They addressed the interesting question of how it can be explained that the climate sensitivity, the parameter (interval in degrees Celsius) representing the rise of temperature when CO_2 in air is doubled, remains very stable over a long period, while the scientific uncertainties and diverging points of view were remarkable. In all the important reports about climate change, the same climate sensitivity interval is mentioned: when CO_2 in air doubles, temperature rises between 2.5 and 4.5 degrees Celsius. This parameter functions as an anchoring device for the scientific world and for policy-makers. It became a sign of credibility of scientific results and a hallmark for policy-makers that the information provided was a stable basis for policy decisions.

Relationships between researchers and policy-makers

The relationships between scientists and policy-makers can be characterised in different ways. Hunt and Shackley (1999, page 147) distinguish three essential types of interrelationships:

> "1. Interaction: refers to a loose coupling. Coalitions [of policy-makers on the one hand and scientists on the other] co-exist

and exchange information, but retain clear boundaries and identities, have an independent existence, and do not reshape each other.

2. Integration: refers to a close fit, an intermingling or interleaving. Boundary work reshapes each by the other. Mutually acceptable identities characterising the integrated coalitions of research and practice begin to emerge. Agendas change in response to the perceived needs of the other. Some sharing of tacit knowledge (or cross-recognition of the tacit components of the other) takes place.
3. Hybridisation: occurs when the association produces something that is more than the sum of the parts, a 'knowledge spiral'. Boundaries dissolve. … Mutual construction occurs."

An important explanatory variable for the level of integration is the sharing of tacit knowledge among the different domains: science, advice or policy participants.

> "A highly significant aspect of the association between science and policy is the extent to which the tacit elements of bureaucratic knowledge co-exist and are recognised by, and across, different institutions. … Thus, it is the understanding of the needs of the policy realm, and the ways in which it operates, by scientists, alongside the recognition by the policy world of the form, functioning and limitations of science, which leads to a closer relationship and the production of more effective knowledge." (Hunt and Shackley, 1999, page 148)

These authors focus on the fruitfulness of close relationships between policy-makers and researchers. The other aspect, cognitive and social closing as a consequence of tight relationships, can hinder progress and goal achievement in policy processes and can lead to bad and biased policy decisions (Janis, 1972). We will elaborate further on this point. First, we present a short case study. Then we make some conclusions about the relationship between policy and science. Finally, we give some recommendations for preventing knowledge fights by means of forms of joint knowledge production.

Case study: the Betuweline

To make our point more clearly, we look in more detail at a case study — the Betuweline. We want to give some examples of distinct forms of knowledge production and the different relationships that exist between scientists and policy-makers. After describing this short case study, we propose an analytical framework for studying these phenomena.

Introduction to the case

The initiative for the construction of the Betuwe goods transport track (the Betuweline) was taken by Dutch Railways to realise a better connection to the hinterland (and Germany) from Mainport Rotterdam. Together with an influential Rotterdam port lobby and (at a later stage) the Ministry of Traffic and Waterways, it started a campaign to construct a railway that would have to be able to process millions of tonnes of freight. The railway lobby had no problems in generating knowledge to support this proposal. This investment would generate huge profits for NS Cargo (the freight department of Dutch Railways) and for the port of Rotterdam, would reduce road traffic and the pollution associated with it.

However, when the Betuweline entered the planning stages, 'counter-knowledge' was produced from many sides. Some 140 reports and countless opinions and observations were published. Virtually every aspect of the policy proposal was the subject of debate. The level of emissions from freight trains proved to be high after all, certainly if diesel locomotives were used and if speeds were high. The standard measurement of noise pollution (based on models) appeared to deviate significantly from actual measurements. The extent to which road traffic would be reduced was said to be negligible. The lack of safety of the transport had been consistently underestimated.

In addition, many alternatives were presented: a drilled tunnel, a lowered tunnel, transport pipes for containers and (one of the most promoted and most elaborate alternatives) internal navigation. The capacity of the biggest container ship in internal navigation, the *Jowi*, became proverbial in comparison with a goods train. Uncertainty about knowledge reached its peak in the discussion on the macroeconomic impact of the Betuweline. Estimates varied by tens of billions of Euros (Bomhoff, 1995; CPB, 1995).

Typical of the use of knowledge surrounding the Betuweline was its strategic nature (Pestman, 2001). In much of the research, the outcome was largely determined by the problem definition. In

In the case of the Betuweline, several decisions were taken without the knowledge to justify them; and much research was open to several different interpretations, causing parties to arrive at different conclusions on the basis of the same figures

addition, several decisions were taken without the knowledge being available that was actually needed to justify them. Remarkably enough, commissioned research appeared to play a bigger role in policy considerations than does scientific research. Much research appeared to be open to several different interpretations, causing parties to arrive at different conclusions on the basis of the same figures.

Scientists did not adhere to their role as 'fact suppliers'. Researchers also played a major role in the policy offensive. Not infrequently they had their own political agenda (as did the civil engineers who advocated underground construction (Boom and Metze, 1997). Sometimes, knowledge prod ucers were dependent on data that could only be supplied by interested parties (Pestman, 2001, pages 198–200).

This 'knowledge fight' generated virtually no exchanges of knowledge, let alone shared knowledge. The Ministry and Dutch Railways ditched many alternative proposals as being unrealistic, unaffordable, unfeasible and undesirable. This case does show, however, that the Ministry and Dutch Railways no longer hold the knowledge monopoly in railway infrastructure. Many other actors were able to produce and deploy serious knowledge on this subject.

The report by the Hermans Committee put an end to the discussion — not because it answered all the questions, but because the political leadership committed itself to the report — and the Betuweline was approved. The work of the Committee was criticised because the internal navigation alternative had been insufficiently investigated (Roscam Abbing, 1999). Also, the report included overly optimistic conclusions on the environmental impact (see the letter from the Sustainable Mobility Foundation [*Stichting Duurzame Mobiliteit*] (1999) to the Dutch House of Commons).

So the discussion about the knowledge produced certainly did continue, but it no longer had any repercussions on the outcome of the political debate and the final decision. For a while, it looked as though this would be the case; uncertainty about the profitability of the project had meanwhile risen to such an extent that the halting of construction threatened to become a real issue at the recent parliamentary elections. However, this threat was averted as well.

Three actor groups

We can distinguish at least three more or less stable groups of actors in the policy process for the Betuweline, formed around concrete policy themes. Within these groups, different coalitions of actors mobilise their own policy-relevant information to influence or determine policy decisions. The three most important actor groups in the are (Pestman, 2001; Frissen, 2000; Boom and Metze, 1997):

- the Mainport coalition: the Department of Transport, the Dutch Railways, a couple of advising offices, the coalition parties in Parliament;
- the inland shipping coalition: organisations of bargemen, the Socialist Party, the Sustainable Mobility Foundation, the committee "Let the Betuweline sail", and others;
- the environment coalition: local and regional authorities, the Nature and Environment Foundation, and others.

Within these groups, concentrating on concrete themes, there were often at least two distinct research coalitions composed of actors from the policy world (policy-makers, other participants in the policy process) and the research world (consultants, researchers, advisors) that helped in the struggle for a specific goal by generating and providing research information. There are multiple examples of these conflicting coalitions in the case. We will look more closely at two examples. The first is about the research on inland shipping as an alternative for transportation by rail. The second deals with the investigation on how serious the noise pollution of rail transportation is.

Inland shipping: a serious alternative?

With respect to inland shipping as an alternative to rail transportation, two coalitions can be distinguished (see Figure 1). The first arena was constituted by the organisation of the bargemen, a private foundation called the Sustainable Mobility Foundation and technicians from the University of Delft. This arena tried to promote inland shipping as a serious alternative for the Betuweline. The central Government, the Cabinet and the coalition parties in Parliament, and the advisers of Knight Wendling (a consulting agency) formed the second arena. They opposed the inland shipping alternative.

This latter coalition produced a report, written by the consultants to Knight Wendling, which presented a very optimistic view of the possible economic rents of the Betuweline, based on a very positive scenario for economic growth in Europe (Roscam Abbing, 1999; Boom and Metze, 1997). The alternative

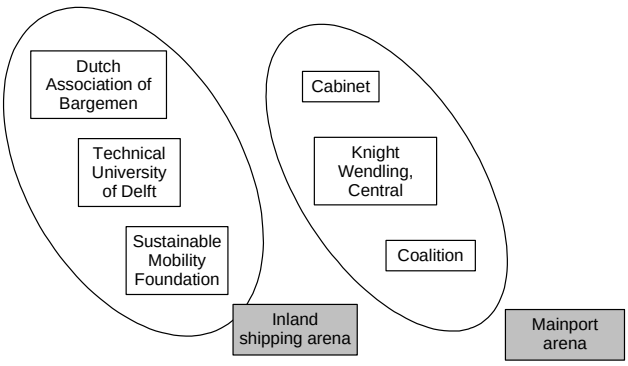

Figure 1. Knowledge arenas around alternative options for the Betuweline

option of inland shipping was not considered seriously in this study. Later on, the study was attacked for not being independently commissioned.

The Ministry of Transport had asked for a report about the shifts that would occur in the macroeconomic and societal costs and returns, if the construction of the Betuweline was not carried out (Roscam Abbing, 1999, page 65). The harm done by not building the Betuweline was taken as the point of departure for this study and the report sketched a real doomsday scenario for the port of Rotterdam. Alternative options were not taken into account.

The other arena also produced knowledge; this strongly favoured inland shipping as an alternative to the Betuweline. The Minister of Transport could ignore this information, because of the effective backing by the coalition parties in Parliament. As a consequence, transport by inland shipping rather than rail did not play an important role in the policy process. In the final advice of the Hermans Committee, the inland shipping option was not studied seriously at all.

How serious is the noise pollution?

The second example of knowledge fights is conflicting knowledge about the noise generated by the new railway. When the subject of noise pollution became an issue, two other coalitions were formed (see Figure 2). A private actor (who had a commercial interest in drilling railway tunnels!) and the regional government of the Province of Gelderland asked a private research institute to calculate the possible sound pollution of the Betuweline. The results were disturbing and did not correspond with those given by the environmental impact assessment (EIA), initiated by the Dutch Railways and the Ministry of Transport. The EIA is obligatory and is incorporated in the policy process.

A few months later, the Sustainable Mobility Foundation presented a report from the Bureau Ulehake (see Figure 3). In this, the noise pollution calculated by the EIA was questioned. The bureau gave totally different research results. Later on, Ulehake published a report, commissioned by local authorities, wherein the formal figure methods for noise pollution where compared with actual measurements. However, these research results played a minor part in the political assessment process. There was not enough political support for taking measures to prevent noise pollution.

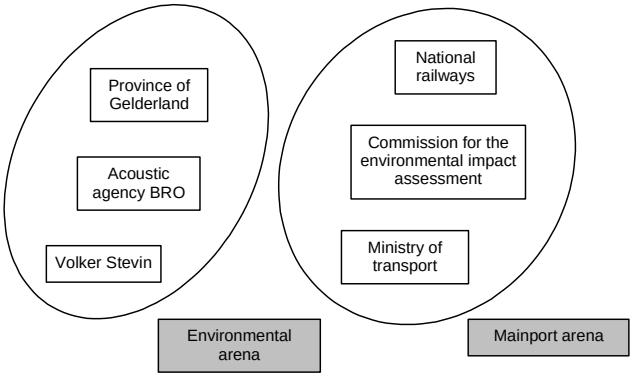

Figure 2. Knowledge arenas around noise pollution caused by the Betuweline

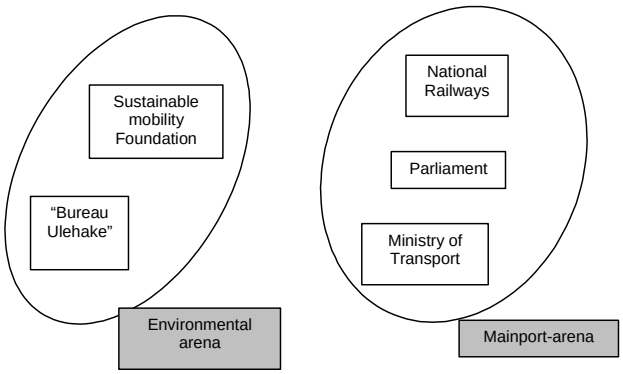

Figure 3. Knowledge arenas in progress: a new report war about sound pollution

The EIA 'won' both knowledge fights, because of the dominant status of the EIA in the political decision-making process of the Netherlands. The EIA fitted effectively with the ideas, values and interests articulated in the policy process. The way it was conducted was an effective sharing of mutual tacit knowledge, which was integrated in the research design (ten Heuvelhof and Nauta, 1996). The EIA fits well in traditional policy processes around investments in infrastructure. The assessment procedure fits well in classical forms of policy-making with one dominant, central policy-maker, but not in a more participatory policy processes in which knowledge is produced collaboratively (see also Deelstra *et al*, 2003).

Conclusion

In the case of the Betuweline, we see that actors from both the academic and the policy domain gravitate towards each other and form a coalition to produce information in order to defend a particular point of view. We used the concept of coalition to define the explicit and implicit structures of a social process, in which different actors work closely together to produce policy-relevant information. In complex policy processes around infrastructural projects (such as the Betuweline), there are multiple conflicting research coalitions in action at the same time. Actors involved in the policy process want to mobilise their own 'scientific' arguments to defend their goals in the policy process.

Sometimes, there can be very clear boundaries in a knowledge coalition. The researchers want to defend their objectivity and neutrality and the policy-makers do not try to influence the research process. This does not imply that mutual influences do not exist. Social influences are always, to some extent, present.

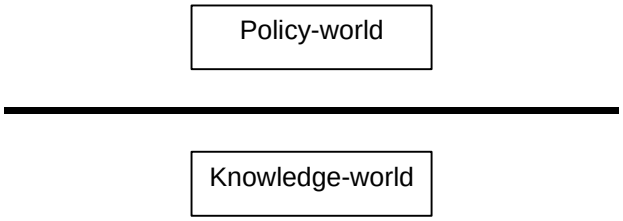

Figure 4. Classic description of main problem in relation to policy–knowledge
Note: The thick line represents the main barrier in transferring knowledge

The knowledge production problem revisited

The main problem, when we look at the utilisation of knowledge in policy, is not so much (as supposed by traditional utilisation studies) the communication and understanding problems *within* a research coalition (see Figure 4), but more the communication and knowledge stream *between* coalitions (see Figure 5).

The case of the Betuweline has shown us how knowledge is generated in parallel and by separate operating knowledge coalitions; it is then strategically used in the direction of other knowledge coalitions. Knowledge is produced in close interaction between producers and potential users. In complex decision-making situations this phenomenon leads to a large number of distinct coalitions in which different knowledge is created. This can result in 'knowledge fights'.

Knowledge is produced from a single organisational perspective; actors who hold a different view on the issue will find this perspective non-authoritative and therefore the generated knowledge non-authoritative. The other parties will then counter with knowledge delivered from their own perspective. This is the genesis of 'knowledge fights', in which actors fire from one trench (or perspective) at the other. In projects, the use of knowledge appears to be aimed mainly at convincing the opposition and substantiating one's own perspectives. The resulting communication pattern can be characterised as a "dialogue of the deaf" (van Eeten, 1999).

The classic distinction between the two worlds — of knowledge and of policy-making (Figure 5) — is questioned in this article. Sociological analysis of knowledge-generating processes does not leave room for such a clear-cut distinction between politics and science, although we do not want to go so far as to say that the problems of knowledge use are not present in these coalitions. There is a problem in sharing cultural characteristics between the different worlds of politics and science (see Watkins, 1994). Nevertheless, the problem of knowledge coalitions that exist in parallel and operate in isolation is more important, but often not recognised.

Thus we can conclude from our short case study that knowledge is often produced in separate coalitions in which different researchers, policy-makers and stakeholders work closely together in producing knowledge. This separation enables several forms of logic and paradigms to exist side-by-side. This, in turn, is one of the main reasons why knowledge fights exist. Several constellations of knowledge institutes and users exist side-by-side.

The consequence is that, while knowledge is accepted within the coalition because knowledge producers and consumers have developed a workable relationship and logic, that same knowledge is not seen as credible in a different constellation of knowledge institutes and users; because the knowledge supplied does not correspond to the paradigm and the institutional context prevailing in this constellation, it is contested and rejected.

This point fits closely with that made by Sabatier (1988; 1993). In a policy discussion, we can find different, tightly integrated actor coalitions — Sabatier calls them "advocacy coalitions" or "belief subsystems" — which hold conflicting policy arguments. Not only policy actors can be distinguished in different coalitions, but also knowledge providers that choose their own position in the coalition.

Within the actor coalitions that can be distinguished using the framework of Sabatier, we see different policy–knowledge circuits, normally consisting of two or three actors, one or two from the policy world (interest group, local government, political party) and one from the research world (advice bureau, scientist, consultant), willing to answer their specific research question within the specific conditions set by the policy actor. We focus (more than Sabatier does) on the role of the knowledge providers in the advocacy coalition in this article and on how they fuel the fights among the different advocacy coalitions.

The knowledge providers deliver their clients the relevant facts, which can serve as ammunition in the policy discussion. Within such a circuit, ready-made policy-relevant knowledge is generated for the different clienteles. This process is stimulated by

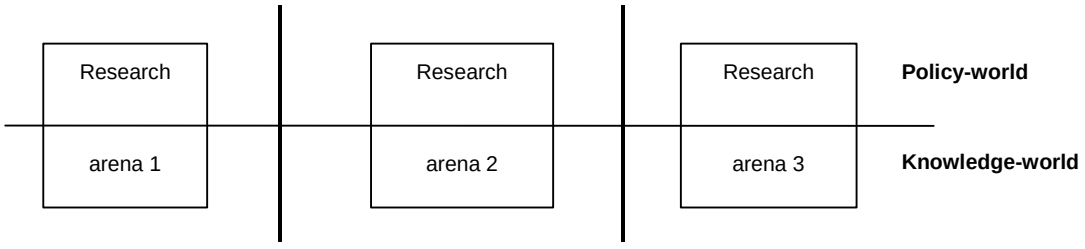

Figure 5. Revisited description of main problem in relation policy–knowledge
Note: The thick lines represent the main barriers in transferring knowledge

autonomous developments within the world of knowledge and research (Nowotny *et al*, 2002).

Different knowledge coalitions develop in which different actors (policy-makers, researchers, and so on) have a certain relationship with each other. In some cases, the relationship is stabilised for a longer time; in other words it has become institutionalised. We refer here to the distinction of Hunt and Shackley (1999) among interaction, integration and hybridisation as levels of intermingling between researchers and policy-makers (or other participants in the policy process).

Each knowledge coalition has constructed its own 'rules of the game' and 'roles in the game', which lead to certain relationships (March and Olson, 1989). Further research for these rules and roles has to be conducted in order to understand the specific relationships *within* a specific knowledge coalition and *among* separate knowledge coalitions (see Horlick-Jones and de Marchi, 1995; Krueck and Borchers, 1999; Miller, 2001). There is also to some extent a shared language within these knowledge – policy circuits (see van den Boogerd, 2002).

Tight and institutionalised relationships within knowledge coalitions lead (among other things) to the absence of inter-coalition communication. In the Betuweline case, we see time and time again situations in which conflicting research coalitions do not listen to each other's opinions and statements. For example, supporters of the inland shipping alternative felt themselves not taken seriously by policy-makers. The information generated by this coalition was not sufficiently taken into account in the report of the Hermans Committee, underlying the formal governmental 'go' decision for the construction of the Betuweline (Roscam Abbing, 1999).

The main problem concerning knowledge production and use concerns the use of knowledge in coalitions other than the one in which it is generated. In the last section we give some recommendations for the organisation of the knowledge-finding process around controversial policy processes, to prevent 'fact-fighting scenes'.

Concluding: boundary management

We have argued, both theoretically and empirically, that today's knowledge production in complex multi-actor settings (for example, for infrastructural and environmental issues) takes place in separate and closed actor coalitions that declare war on each other. A knowledge management strategy is needed to prevent these 'knowledge battles'. A department cannot propose a policy option, and defend it with data from its own research office without political and societal discussion about the policy problem, the proposed solution and the data used. In nearly all policy processes nowadays, the facts are the subject of discussion, and contra-evidence is provided from many sides.

Today's knowledge production in complex multi-actor settings takes place in separate and closed actor coalitions that declare war on each other: a knowledge management strategy is needed to prevent these 'knowledge battles'

The main challenge is to establish links among different knowledge production coalitions in order to prevent 'knowledge battles'. There are many solutions offered in literature. Joint fact-finding (Ehrmann and Stinson, 1999), participatory policy analysis, collaborative dialogues (Innes and Booher, 1999), collaborative analysis (Busenberg, 1999), 'interactive social science' (Caswill and Shove, 2000) and so on.

All these solutions try to make connections between separated knowledge coalitions. These links should enable knowledge to have an impact in other coalitions and networks and ultimately in policy-making. Meaningful knowledge can only be created on the basis of a process of joint knowledge production. In this process, separate coalitions of scientists and policy-makers and other stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinions, and, finally, use the information they have developed to reach decisions together. They develop and implement a research strategy and approach in mutual interaction, to answer questions on knowledge.

The organisation of links among separate knowledge coalitions can be labelled 'boundary management' (compare Guston, 1996; 1998). We are aware that we use this term in a different way from Guston. Since we see the main problem being the existence of different and conflicting knowledge coalitions at the same time, we state that boundary management has to concentrate more on the interaction *among* different knowledge coalitions. We abandon the idea that it has to concentrate only on the facilitation of the interaction between the world of science and the world of policy-making *within* a knowledge coalition.

Boundary management is about the concentration on the spanning of multiple knowledge coalitions and the integration of research and decision-making in the early stage of a knowledge-production process. It tries to restructure the relationships among different knowledge networks as an interactive, two-way and adaptive process.

The interrelation of different knowledge coalitions can be organised and managed in different

ways. First in terms of interaction (Hunt and Shackley, 1999), linking mechanisms have to be designed among the different knowledge coalitions. At certain moments, actors of these coalitions meet to co-ordinate researchers, clarify interests and try to find common ground for the production of knowledge.

Second, in terms of integration and hybridisation (Hunt and Shackley, 1999), a totally new knowledge coalition is formed in which different actors of different knowledge coalitions participate and in which the research agenda and the research process are designed co-operatively. First, there will be a discussion on the research agenda, on which topics needs to be addressed and what questions are to be answered through research. Second, actors search in mutual interaction for workable methods in the quest for knowledge and the guiding principles, assumptions and suppositions on which these methods are based.

Also, the (fundamental, temporal and geographical) system boundaries and the scope of the study (for instance, when will it begin? when will it be concluded? which effects will be included? on the basis of which criteria will these effects be evaluated? which subjects will be part of the study, and which will not?) must be ratified by mutual agreement. In short, the research agenda and the research design are the outcome of a process of discussion and negotiation between stakeholders and external experts rather than something that has been given in advance.

In case the stakeholders are unable to decide which methods should be used, they may decide to use several (competing) methods and/or sensitivity analyses to analyse to what extent the outcomes will vary for the different assumptions on which the various methods are based. They may also decide to integrate various research models. Finally, they may decide to set up a 'Committee of Wise Men' composed of independent experts from various disciplines, charged with the task of settling persistent knowledge conflicts.

Third, the results of the knowledge-production process can always be subjected to an "extended peer review" (Ravetz, 1999) in which the results are tested by interested parties, scientists, experts and decision-makers together. Needless to say, a purely scientific arsenal of testing criteria is not sufficient here. It is precisely the multiplicity of criteria by which the results are tested that will give this review its added value.

This kind of boundary management can lead to salient and credible knowledge production. It can lead to saliency of the knowledge, because different stakeholders participate and have the opportunity to express their knowledge needs. It also can lead to credibility of the knowledge, because stakeholders can contribute to the design of the research that ultimate leads to authoritative knowledge production.

However, there still remain different interests. A simple plea for co-operation and collaboration is not sufficient to resolve enduring knowledge battles. A new way of knowledge production requires a new way of policy-making. Governance strategies have to start with an open problem definition and an open policy agenda in order to reach collective agreement about policy options and the underlying argumentation.

Joint fact-finding in a situation in which the policy problem is already fixed cannot prevent disagreement about the arguments that will be used to defend the policy proposal. After all, disagreement is a fundamental characteristic of our society. The challenge is to make the disagreements productive. We have tried to give some ways for bridging the gap between different knowledge generating coalitions.

References

Bernstein, R J (1991), The New Constellation. The ethical–political horizons of modernity/postmodernity (MIT Press, Cambridge MA).

Bijker, W (2001), *Research and Technology for Development (RTD) through a EU–ACP Policy Dialogue. Scientific background, methodology and toolbox* (University of Maastricht, Maastricht).

Bomhoff, E J (1995), "With the spade on the shoulder. Infrastructure and economic growth" (in Dutch), Nijenrode Forum for Economic Research, special studies 1.

Boom, H, and M Metze (1997), *Battle of the Betuweline* (Uitgeverij Balans, Amsterdam, in Dutch).

Busenberg, G J (1999), "Collaborative and adversarial analysis in environmental policy", *Policy Sciences*, 32, pages 1–11.

Caplan, N (1979), "The two communities theory and knowledge utilization", *American Behavioral Scientist*, 22, pages 459–470.

Castells, M (2000, first edition 1996), *The Rise of the Network Society: economy, society and culture* (Blackwell Publishers, Cambridge)

Caswill, C, and E Shove (2000), "Introducing interactive social science", *Science and Public Policy*, 27(3), pages 154–157.

CPB, Central Planning Office (Centraal Planbureau) (1995), "Economic effects of the Betuweline based upon recent information", (in Dutch), working paper, The Hague.

de Bruijn, J A, and E F ten Heuvelhof (1999), "Scientific expertise in complex decision-making processes", *Science and Public Policy*, 26(3), June, pages 179–184.

Dunn, W (1994), *Public Policy Analysis. An introduction* (Prentice Hall, New Jersey, 2nd edition).

Deelstra, Y, S G Nooteboom, H R Kohlmann, J van den Berg and S Innanen (2003), "Using knowledge for decision-making purposes in the context of large projects in The Netherlands", *Environmental Impact Assessment Review*, 23, pages 517–541.

Edelenbos, J, M W van Buuren and G R Teisman (2002), "Sustainable development as a joint fact-finding process: overcoming institutional barriers through process management", paper for the 2002 Berlin Conference on the Human Dimensions of Global Environmental Change.

Ehrmann, J R, and B L Stinson (1999), "Joint fact-finding and the use of technical experts", in L Susskind, S McKearnan and J Thomas-Larmer (editors), *The Consensus Building Handbook. A comprehensive guide to reaching agreement* (Sage, London) pages 375–400.

Frissen, P H A (2000), "Knowledge and the Betuweline" (in Dutch), in in't Veld (2000).

Gallopín, G C, S Funtowicz, M O'Connor and J Ravetz (2001), "Science for the twenty-first century: from social contract to the scientific core", *International Journal of Social Science*, 168(2), pages 219–229.

Gieryn, T F (2002), "Boundaries of science", in S Jasanoff; G E Marklem, J C Petersen and T Pinch (editors), *Handbook of Science and Technology Studies* (Sage Publications, Thousand Oaks CA, revised edition).

Groenewegen, P (2002), "Accommodating science to external

demands: the emergence of Dutch toxicology", *Science, Technology and Human Values*, 27(4), Autumn, pages 479–498.

Guston, D H (1996), "Principal–agent theory and the structure of science policy", *Science and Public Policy*, 23, pages 229–240.

Guston, D H (1998), "Technology transfer and the implementation of CRADAs at the National Institute of Health", in L M Branscomb and J Keller (editors), *Investing in Innovation* (MIT Press, Cambridge MA) pages 221–249

Haag, D, and M Kaupenjohann (2001), "Parameters, prediction, post-normal science and the precautionary principle — a roadmap for modelling for decision-making", *Ecological Modelling*, 144(3), pages 45–60.

Hoppe, R (1999), "Policy analysis, science and politics: from 'speaking truth to power' to 'making sense together'", *Science and Public Policy*, 26(3), June, pages 201–210.

Horlick-Jones, T, and B de Marchi (1995), "The crisis of scientific expertise in fin de siècle Europe", *Science and Public Policy*, 22(3), June, pages 139–145.

Huberman, M (1994), "Research utilization: the state of the art", *Knowledge and Policy: the international journal of knowledge transfer and utilization*, 7(4), Winter, pages 13–33.

Hunt, J, and S Shackley (1999), "Reconceiving science and policy: academic, fiducial and bureaucratic knowledge", *Minerva*, 37, pages 141–164.

Innes, J E, and D E Booher (1999), "Consensus building and complex adaptive systems: a framework for evaluating collaborative planning", *Journal of the American Planning Association*, 65, pages 412–423.

In't Veld, R J (editor) (2000), *Willingly and Knowingly. The role of knowledge in environmental policy processes* (Lemma, Utrecht)

In 't Veld, R J, and T Verheij (2000), "Willingly and knowingly" (in Dutch), in in't Veld (2000),.

Janis, I L (1972), *Victims of Groupthink* (Houghton Mifflin Co, Boston MA).

Jasanoff, S (1990), *The Fifth Branch; advisers as policy makers* (Harvard University Press, Cambridge MA).

Kazancigil, A (1998), "Governance and science: market-like modes of managing society and producing knowledge", *Unesco*, 50, pages 69–79.

Kickert, W J M, E-H Klijn and J Koppenjan (editors) (1997), *Managing Complex Networks. Strategies for the public sector* (Sage Publications, London).

Knorr-Cetina, K (1999), *Epistemic Cultures. How the sciences make knowledge* (Harvard University Press, Cambridge MA).

Krueck, C P, and J Borchers (1999), "Science in politics: a comparison of climate modelling centres, *Minerva*, 37, pages 105–123.

Latour, B (1999), *Pandora's Hope. Essays on the reality of science studies* (Harvard University Press, Cambridge MA).

Lindblom, C E, and D K Cohen (1979), *Usable Knowledge. Social Science and Social Problem Solving* (Yale University Press, New Haven and London).

March, J G, and J P Olson (1989), *Rediscovering Institutions* (Free Press, New York).

Miller, C (2001), "Hybrid management: boundary organisations, science policy, and environmental governance in the climate regime", *Science, Technology and Human Values*, 26 (4), Autumn, pages 478–500.

Nowotny, H, P Scott and M Gibbons (2002), *Re-thinking Science. Knowledge and the Public in an Age of Uncertainty* (Polity Press, Cambridge).

Pestman, P (2001), *In the Footsteps of the Betuweline. Mobilisation, Decision-Making and Institutionalisation about a Complex Infrastructural Project* (Rozenberg Publishers, Amsterdam, in Dutch).

Ravetz, J R (1999), "What is post-normal science?", *Futures*, 31(4), pages 647–653.

Roscam Abbing, M (1999), "How rails the water? Derailed decision-making Betuweline; an analysis of ignored alternatives", Working paper TU Delft, SISWO, in Dutch.

Sabatier, P A (1988), "An advocacy coalition framework of policy change and the role of policy-oriented learning therein", *Policy Sciences*, 21(1), pages 129–168.

Sabatier, P A (1993), "Policy change over a decade or more", in P A Sabatier and H C Jenkins-Smith (editors), *Policy Change and Learning: an Advocacy Coalition Approach* (Westview Press, Boulder CO) pages 13–40.

Shackley, S, J Risbey, P Stone and B Wynne (1998), "Adjusting to policy expectations in climate change modeling: an interdisciplinary study of flux adjustments in coupled atmosphere-ocean general circulation models", Massachusetts Institute of Technology, Center for Global Change Science, Report 53.

Snow, C P (1964), *The Two Cultures and a Second Look. An expanded version of the two cultures and the scientific revolution* (Cambridge: University Press, Cambridge, 2nd edition).

Stehr, N (1992), *Practical Knowledge. Applying the social sciences* (Sage Publications, London).

Sustainable Mobility Foundation [Stichting Duurzame Mobiliteit] (1999), letter to the Dutch House of Commons, January, available at <http://geen.betuweroute.nu/stdm.htm>.

Teisman, G R (1995), *Complex Decision-Making. A Pluralistic Perspective on Decision-Making about Spatial Development* (Vuga, The Hague, 2nd edition, in Dutch).

Teisman, G R, and J Edelenbos (2002), "Getting through the 'twilight zone': managing complex system innovations through process governance", paper for the interdisciplinary international expert meeting on Transitions to Sustainability through Systems Innovations, held at the University of Twente, the Netherlands, 4–6 July.

ten Heuvelhof, E F, and C M Nauta (1996), *(M)ERKENNING* [*On the effectiveness of Environmental Impact Assess ments*] (Evaluatiecommissie Wet Milieubeheer, the Hague, in Dutch).

van Bueren, E M, E H Klijn and J F M Koppenjan (2003), "Dealing with wicked problems in networks: analyzing an environmental debate from a network perspective", *Journal of Public Administration Research and Theory*, 13(2), pages 193–212.

van den Boogerd (2002), "The interwovenness between future explorations and policy" (in Dutch), The Netherlands Scientific Council for Government Policy [Wetenschappelijke Raad voor het Regeringsbeleid], working document no 127, The Hague.

van der Sluijs, J, J van Eijndhoven, S Shackley and B Wynne (1998), "Anchoring devices in science for policy: the case of consensus around climate sensitivity", *Social Studies of Science*, 28, pages 291–323.

van Eeten, M J G (1999), "'Dialogues of the deaf' on science in policy controversies", *Science and Public Policy*, 26(3), June, pages 185–192.

Watkins, J M (1994), "A postmodern critical theory of research use", *Knowledge and Policy: the international journal of knowledge transfer and utilization*, 7(4), Winter, pages 55–77.

Weiss, C H (editor) (1977), *Using Social Research in Public Policy Making* (Lexington Books, Toronto).

Wiltshire, S (2001), "Scientists and policy-makers: towards a new partnership", *International Social Science Journal*, 170, pages 621–635.

Woolgar, S (2000), "Social basis of interactive social science", *Science and Public Policy*, 27(3), June, pages 165–173.