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KNOWLEDGE UTILIZATION IN WATER MANAGEMENT IN THE NETHERLANDS RELATED TO DESICCATION[1]

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ABSTRACT: The use of scientific knowledge in environmental policy making is an important topic. However, the relation between knowledge producers and policy makers is not a straightforward producer-user relationship. The development of a national desiccation policy in the Netherlands and the implementation of desiccation plans in local situations are used as a case study to investigate the knowledge policy relationship. Three theoretical explanations were used to analyze this case: a difference between the cultures of producers and users; a different rationality of the policy making and research processes; and processes of social construction of problem definitions which imply that different knowledge stocks are used depending on the framing of the policy problem. Emergence of the policy issue at the national level is demonstrated to develop in close interaction between knowledge producers and policy makers, while the interactions at the local level were more based on integration of expert knowledge through personal expertise and closely tied to the development of management plans. This case study thus reveals a difference between general knowledge supporting measures at the national policy level and the way in which specific knowledge is applied in local cases. Therefore more attention should be paid to the translation of policy problems from rather high levels of political authority to the conceptualization at lower management levels. A final conclusion is that knowledge use in Dutch desiccation policy can be understood by pointing to multiple theoretical perspectives. The rational actor model and a constructivist perspective turned out to be especially useful in explaining the different ways knowledge was used at the national and the local level.
(KEY TERMS: desiccation; knowledge use; water policy; decision-making; water management; water conservation.)

INTRODUCTION

The readiness of science to be used in policy making is an important issue for environmental policy. Current problems such as ozone depletion and global warming demonstrate an intricately linked network of scientists and policy makers where scientific information is crucial to the reaching of closure on policy actions. The issue has two sides. On the one hand, "Research reports are lying in dusty drawers of policy makers or elsewhere and never used." This is one of the frightening visions of scientists with concerns about the deterioration of environmental quality. In addition, scientists might have the idea that their results are interpreted wrongly or prematurely. On the other hand, policy makers are concerned with the question whether the right scientific knowledge is introduced at the right time. In practice, dynamic interaction exists; scientists push information and sometimes policy makers pull for scientific information (Lambright, 1995). These two sides form the background of this paper directed at the role of science in the emergence, formulation and implementation of desiccation ("verdroging") policy in the Netherlands.

In this article desiccation is defined as ecological damage because of groundwater depletion. Since the mid-50s a drop of the ground water level has occurred in the Netherlands varying from 20 cm to 1 meter locally (Rolf, 1989). The effects of ground water depletion are severe in the Netherlands because the ground water table is just below ground level and it influences the root system of the vegetation strongly. Rare vegetation types such as peat bog systems or oligotrophic water systems have been replaced by more common vegetation types.

Desiccation provides an interesting case because there is multiple-actor involvement at both the

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national and local level of public administration. This paper addresses the following question: *In what way was scientific knowledge used in the emergence of national Dutch desiccation policy, and does the way of use remain the same in the ongoing process of local policy development and implementation?* In order to answer this question, we use three different perspectives from the literature on factors that foster or inhibit knowledge use. Section 2 of this paper discusses these perspectives. Section 3 describes the history of desiccation policy in the Netherlands, including the use of scientific knowledge. Section 4 focuses on knowledge use in a local case of implementation of desiccation policy. Both Sections 3 and 4 draw upon the analysis of policy documents, research reports and stakeholder interviews. Section 5 compares the findings on national and local policy, and discusses the implications for the theory of knowledge utilization, followed by the conclusions in Section 6.

KNOWLEDGE UTILIZATION: SOME INSIGHTS FROM A POLICY SCIENCE PERSPECTIVE

Notions on how scientific knowledge can be used and explanations for inadequate or non-use of science knowledge by public policy have been developed by policy scientists from many disciplines (Dunn and Holzner, 1988). This multidisciplinary involvement has contributed to a quite fragmented field. Theory building on knowledge use is considered to be not very well developed (Rich, 1991, pg. 322). Knowledge use is usually meant to refer to scientific knowledge having an observable impact on policy. Basically, knowledge use is to be understood as a process of interaction between knowledge producers and users. Research on knowledge utilization therefore focuses on identifying what factors foster and inhibit this social and political process.

The scientific literature on knowledge use points to three major perspectives on bottlenecks in the flow of knowledge from producers to users. The first perspective explains non-use in terms of communication between scientists and policy makers and is usually referred to as the two-cultures or two-communities debate (Caplan *et al.*, 1975; Caplan, 1979). According to Hofstede (1991, pg. 5), culture is learned and is at least partly shared with people who live or lived within the same social environment. It is the collective programming of the mind which distinguishes the members of one group or category of people from those of another. The two culture debate identifies factors such as a great distrust and even antagonism between the two cultures because of different rules, values, reward systems, and language. Furthermore, researchers and policy makers operate under substantially different conceptions of time (Rich, 1991, pgs. 323-324). Policy makers are accustomed to working on immediate problems and meeting deadlines, whereas scientists see no harm in delivering a "better" report a week later. In this perspective, the question to be answered is whether there have been bottlenecks in the utilization of knowledge due to a cultural gap between the scientists and policy makers dealing with the problem of desiccation.

The second perspective relates to the mismatch between the policy making process and the research process. This one is quite compatible with the two-cultures theory, but it takes a different point of departure which is the rational actor model. Policy makers are expected to use information according to what they believe is in their own interest and ignore or abuse other information (Downs, 1967; Rich, 1981). Hence, the so-called enlightenment function of science (Weiss and Bucavalas, 1980) is usually confined to confirm already prevailing values and beliefs. Scientific information always competes with other sources of information, especially with the kind of knowledge that has been referred to as 'tacit knowledge' (Polanyi, 1958), 'belief systems' (Hoppe and Peterse, 1993) or the 'policy making framework' (Lindblom and Cohen, 1979). Policy makers will not use scientific information unless this information yields recommendations which they consider by intuition politically feasible and easy to implement (van de Vall and Bolas, 1982; van de Vall, 1988). Rich (1991, pg. 326) points out that the rational actor's information search will generally be limited, as institutions show a strong preference to confining the information search to their own organization or, if necessary, to the policy network closely connected to their organization. Scientists, in turn, compete for funds to be obtained through agencies which serve conflicting policy interests. Depending on the mission guiding their work, scientists can disagree on the merit of scientific information collected by competing scientists. If this happens, the social impact and policy impact of information from science is likely to be less relevant (Collingridge and Reeves, 1986). The questions to be answered regarding this perspective are whether policy actors preferred information produced by their own organization or within closely related networks, and whether policy makers relied more on their own tacit knowledge than on scientific knowledge.

The third perspective, which, according to us is encompassing the two perspectives above, is that knowledge on policy problems can be considered as socially and politically constructed. In this view there are multiple perspectives with regard to complex policy problems and it may be difficult if not impossible to determine 'the scientific truth' (Pretty, 1994). The legitimacy of perspectives does not merely relate to the multiple interests involved in policy-making, but also to (epistemological) differences in scientific approach (Funtowicz and Ravetz, 1994). The main feature of this perspective is a focus on processes of problem finding, defining and redefining rather than problem solving (Hisschemîller and Hoppe, 1996). Problem finding and problem solving cannot be considered separate processes in the sense that the former precedes the latter. Rather, they are parallel processes: problems are signaled, recognized, and framed at both national and local levels of public administration. The question which follows from this observation is whether implementing decisions at a lower level of public administration required a new process of problem definition, including actors and information needs that differ from those at the higher administrative level. To test the differences, we borrow from Dunn and Holzner (1988) the notion that interdependent knowledge stocks along with the social actors by which knowledge is produced, disseminated and used constitute a knowledge system. Knowledge stocks can embody scientific knowledge such as technology or ecology, bureaucratic knowledge, local knowledge or everyday knowledge (Arce and Long, 1992; van Rooy, 1995). The dynamics of knowledge systems can be understood as a process of priority setting and integrating knowledge from different stocks in the knowledge system. Our proximate answer to the question about social construction is whether we observe different knowledge stocks explored by the policy making actors at the national and local level.

DESICCATION AS A POLICY ISSUE IN THE NETHERLANDS: THE NATIONAL LEVEL

Before analyzing the policy processes at the national level, we provide a brief overview of the manner in which water policy is divided over the different ministries in the Netherlands as well as the early signals of the problem of desiccation in the Netherlands. In the Netherlands, three ministries are involved in the desiccation problem, the ministry responsible for water management (Verkeer and Waterstaat, V&W), the ministry responsible for the environment (Volkshuisvesting, Ruimtelijke Ordening en Milieu, VROM) and the ministry responsible for agriculture and ecology (Landbouw, Natuurbeheer en Visserij, LNV). Furthermore, once the policy is defined, parliament has to approve of the desiccation policy. The Ministry responsible for the environment was concerned with protecting ecological values but at the same time with the drinking water supply. Extraction of ground water for drinking water production was considered one of the possible causes of desiccation. This department therefore embodied two actually conflicting interests. The Ministry responsible for Agriculture and Ecology (LNV) also had two conflicting stakes: the natural environment suffered the effects from desiccation, while the Department for Agriculture stimulated improved draining of large areas for agriculture. The Ministry for Water Management (V&W) is responsible for all the water systems including ground water and its policy is to coordinate all the claims of the different interests on the water system (integrated water management).

Desiccation as a phenomenon is nearly as old as the emergence of nature conservation. As early as 1898 it was mentioned that the extraction of ground water for drinking water production in the dunes along the coast in the western part of the Netherlands since the end of the 19th century would lead to the disappearance of dune lakes and to a change in the vegetation (van Dijk, 1989; see Figure 1). Other wet areas were drained in order to allow agriculture. In the 60s and 70s, some organizations and agencies in charge of nature conservation signaled desiccation as a serious problem (e.g., Boerboom, 1960; Londo, 1966), but they were not heard. Until the early 80s, policy makers at government level knew about drought impacts on the natural environment but they did not perceive it as a major policy problem (personal communication). Awareness of a fresh water availability problem arose in 1976. A summary of the subsequent events is given in Table 1.

In fact our case starts in 1976, when a dry winter was followed by a very dry and hot summer and agriculture suffered losses because of drought. By then, policy makers started to recognize drought impacts on agriculture as a problem for national policy; however, drought impacts on the natural environment were not yet on the agenda. Both the ministries responsible for water management and for agriculture and ecology initiated internal studies to estimate the fresh water need for agriculture and other purposes, including the cost of several infrastructural works to cover the fresh water need.

Following these studies, the Second Policy Plan on Water Management (V&W, 1985) warned that there might be a severe structural decline of the ground water table due to the extraction of ground water and drainage for agriculture. An official at the Ministry responsible for the environment was the first to recognize the possibly detrimental effects on the natural environment and the national drinking water supply. The Environmental Policy Program (IMP, 1986-1990; VROM, 1986) then introduced the term 'desiccation' ("verdroging"). It stated that desiccation was a potential environmental issue.

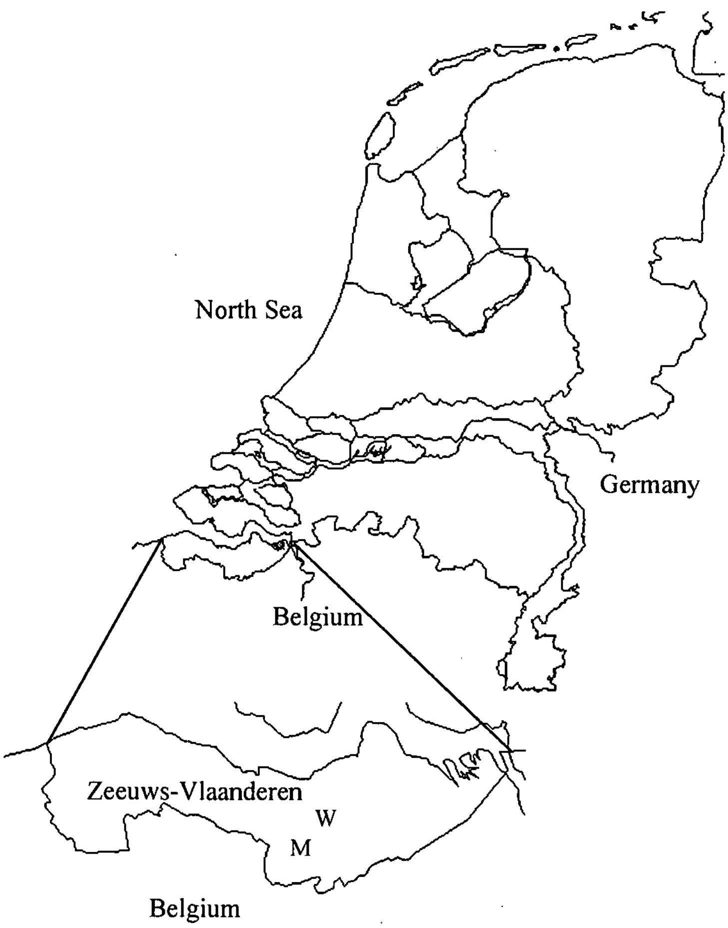

Figure 1. The Netherlands and an Enlargement of Zeeuws-Vlaanderen (W = Case Waterspil; M = Case Moerspui).

Thus, by the mid-1980s desiccation was recognized by several government agencies as a policy issue with potentially severe impacts. Policy-oriented research, sponsored by the various departments, contributed to the emerging shift in the government position. As the three Ministries in charge of Water Management, the Environment, and Agriculture and Ecology had different stakes in the problem, coordination of policy was deemed necessary. A joint task force was formed. The main responsibility of this task force was to further identify the problem and to coordinate the policy of the different Ministries with regard to desiccation.

The major problem the joint Task Force had to face was the framing of the policy problem in such a way that all stakeholders could agree upon. At first, the task force was not able to do so, because not all members of the Task Force were equally convinced that drought impacts on the natural environment were that serious. Therefore, it ordered a preliminary study, which was conducted by the Institute for Environmental Studies at the Free University in Amsterdam (Braat *et al.,* 1987). The research project made it clear that desiccation is a serious problem. In order to align the various interests, the Task Force followed the line of argument that drought impacts not related to the natural environment, such as in the case of agriculture, were already taken care of in other areas of national policy. Therefore, it was decided to restrict the concept of desiccation to ecological values: only wildlife, woodlands and landscapes featuring specific water dependent ecological values can suffer from desiccation. The first policy definition of desiccation was "all unintended direct and indirect effects due to a decrease of the ground water table on the natural environment such as parching and a change in upward seepage" (Minutes of the interministrial task force; Braat *et al.,* 1989). At that time, another important point concerning the framing of the problem was how damage should be ascribed to various environmental problems. In the environment various problems simultaneously caused a decline of flora and fauna and therefore it was difficult to assess which problem causes what amount of damage to the environment. For example, in many areas lowering of ground water table reinforced the effects of acidification. The interministrial task force, not scientists, concluded that such damages should be attributed to acidification.

The task force further concluded that a policy to stop desiccation had to be developed. Therefore, the task force ordered more research, one project being aimed at estimating the decrease in the ground water table caused by human factors (Rolf, 1989), and the other one being carried out by an interdisciplinary team of ecologists and hydrologists to figure out the relation between ground water depletion and damage to ecological values and to estimate the total desiccated area in the Netherlands (Braat *et al.,* 1989). In these two projects, drinking water production from ground water and land drainage were considered to be the most important causes. Both actors claimed that, although it was known that their measures would decrease the ground water table, they never intended to harm nature. That is why only unintended effects on the natural environment due to ground water depletion are included in the definition of desiccation in the National Environmental Policy Plan (VROM, 1989). Later researchers and the department for nature conservation of the ministry responsible for Agriculture and Ecology added that introducing foreign surface water in nature areas was not a good solution to solve the desiccation problem. Foreign surface water never has the same quality as the local ground water, and quite often it is polluted as well.

All projects were supervised closely by the interministrial task force; both the policy makers and the researchers mentioned the close interaction constructive. The interministrial task force took care of

TABLE 1. Timetable of the Actions Concerning Desiccation at the National and Local Level.

Date	National	Local
1976	Dry summer; awareness of fresh water need for human purposes, and general water management, notably abatement of salt intrusion	Dry summer; awareness of fresh water need in agriculture
1977-83	Research to solve fresh water need for human purposes, within the ministries	
1977-88		Concept of water conservation gradually evolves
1984	Warning for ground water level decline in national policy document	
1985	Concept of integrated water management is launched	
1986	Fresh water need for ecology is signaled: establishing joint task force of three ministries	
1987-89	Further research fresh water need for ecology + framing of the policy problem	Start using concept of integrated water management, ecology gets more attention
1989	Formulating policy targets for the desiccation problem; provinces are responsible	First small scale experiments in raising the ground water level
1990		Start Moerspui
1991-92	Launch regulation to stimulate desiccation projects	Research Moerspui
1993		Start Waterspil; planning Moerspui
1994-95		Research Waterspil; implementing Moerspui
1995		Concept plan Waterspil

good contacts between these projects and the policy preparing team regarding the Third Policy Paper on Water Management. The description of the desiccation in the first Environmental Policy Plan (NMP; VROM, 1989) was also based on the study of Braat *et al.* (1989). The definitions and policy goals were set in the NMP and the Third Policy Paper on Water Management (V&W, 1989). The main conclusion was that the situation of 1985 should be restored.

However, nature conservation organizations started to lobby among the members of parliament to gain attention for the desiccation problem. This led to an amendment on the environmental policy plan by the Second Chamber of Parliament adding the demand to reduce the surface of desiccated areas by 25 percent compared to the situation in 1985. This amendment caused a lot of pressure on the different ministries and the provinces that were responsible for solving desiccation in their area. This action shows that interest groups attempt to influence solutions of problems directly.

In the construction of desiccation as a policy problem at the national level, two distinct phases can be recognized. The first has to do with signals about the existence and seriousness of the phenomenon, the second with the translation of research findings into a policy problem. The main output of the second phase was the common definition of desiccation as a policy problem, and the start of efforts to fill in the general lack of knowledge.

IMPLEMENTING DESICCATION POLICY: KNOWLEDGE USE AT THE LOCAL LEVEL

The policy development at the national level had to be elaborated further by the provinces and implemented by the water boards. The water boards have the same status as municipalities, but they are governed directly by the social groups who have an interest in water management such as citizens, industry and landowners, and they are supported by levies from these groups. The provinces are intermediately between the national government and the local authorities. It took some time before the provinces included desiccation as an issue in their environmental policy plans and ground water plans (Bles, 1988), after which the local water boards started projects to restore the natural environment which suffered from desiccation. Traditionally the water boards took care of water quantity management only. An important development in the background of the desiccation policy was the increased attention to environmental problems in water management as integrated water management was introduced as an integrating concept at all levels of policy. Consequently, water boards have to take care of water quantity, water quality, and the ecological aspects of a water system.

In order to assess what kind of knowledge is used in local water authorities, we choose to study two projects where additional knowledge was required by a water board in Zeeuws-Vlaanderen in the South West of the Netherlands ("Waterschap De Drie Ambachten"; see Figure 1). Since a few decades, the surface water level in this region, and therefore the ground water level as well, has been adjusted to the optimal level for use of the lowest parts of the region for agriculture (Grontmij, 1993). This has benefited agriculture as a whole, but both agriculture at the higher grounds and ecology have been suffering from water shortage, especially in summer. One project, "Moerspui," was initiated by the CWO ("Commissie Waterbeheersing en Ontzilting," which means committee for water management and reclamation of salt affected soils). The former CWO was an entity at the provincial level in the Province Zeeland. At the moment of the start of the Moerspui project, it was financed by the National government (ministry responsible for agriculture), the Province Zeeland, and all water boards in Zeeland. The main target of this commission was to stimulate research to regulate the optimal fresh water availability for agriculture. The other project, "Waterspil," was initiated by the district "Zeeland" of the ministry responsible for Agriculture and Ecology. First we will give the common background for these two projects. Then we will focus on the Moerspui project, followed by the Waterspil project (Boogerd, 1996).

In the early 90s, projects were started to restore ecology and benefit agriculture on the higher grounds as well. Both Moerspui and Waterspil deal with the restoration of a system of creeks in the southwest Netherlands. The main function of the region is agriculture. The creeks serve a nature function and are referred to as connecting nature reserves in the ecological main structure and provincial ecological plans, but they are small in comparison with the surrounding agricultural area (Waterschap De Drie Ambachten, 1994; Provincie Zeeland, 1994). Besides having an ecological value, the creeks are also used in the water system of the area to discharge the surplus of rain water to the sea.

The idea of freshwater conservation had gradually developed since 1976, when a very dry winter followed by a long hot summer caused severe drought problems for agriculture. This was the first time the water board realized that maintaining a low water level was not only causing damage to the natural environment, but could also lead to damage for agriculture. Therefore, from the mid-80s onwards the water board started some small scale experiments with their infrastructure to raise the surface water level.

The Moerspui project started at the above-mentioned CWO who were thinking of conserving the surplus good quality fresh water from Belgium, which the Netherlands had to let pass through to the sea. Because, this was a more complex project, research was carried out by a consultancy bureau in 1992. The consultants collected the hydrological and ecological knowledge of the area in order to estimate the effects of raising the water level for agriculture, ecology and the neighboring area in Belgium (Grontmij, 1993). They computed three different scenarios. In all three scenarios, ecology would benefit. In scenario A, agriculture would benefit as well; in scenario B, there would be water damage for agriculture; in scenario C, this damage would even be worse. However, ecology benefited increasingly in scenarios B and C. As the water board feared that farmers would not accept a rising water level at all because they would be afraid of water damage, they chose to implement the measures from scenario A. Only a small area owned by one farmer would probably suffer severely because of the rise of the water level. The damage was estimated before hand by an external consultant and the farmer agreed to accept the compensation. The project was carried out by the end of spring 1995. Although the system functioned too late to profit fully from the winter and spring rains, both farmers and organizations in charge of nature noticed benefits during the hot and dry summer of 1995. The effects of the project for the natural environment will be monitored for five years after the project has been finished. In this project, agricultural and ecological interests were linked by the water board to the solution to gain support for this project.

In 1992, preparations were made for a pilot study, "Waterspil," in order to optimize the water quantity for both the main function, agriculture, as well as the secondary functions of the area, such as ecology. In this project both economic and ecological damage of ground water depletion have been taken into account (Waterschap De Drie Ambachten, *et al.*, 1996). Waterspil is linked to a land consolidation program. Hydrological models were made to simulate the project area. New in these models was that the surface water level was linked with the ground water level. These models were used to calculate the benefits for both agriculture and ecology in case the winter ground water level is raised. Three ground water level increases were calculated. The outcome of these simulations shows that it will be possible to serve both agriculture and ecology. In the most cost-effective option for agriculture, the price is that the lowest parts of the area near the creeks are taken out of production. In this case the water level can be adjusted optimally to the higher agricultural areas, which will be profitable for the natural environment as well. The actual research was ready by the end of 1994. The research leaders decided not to publicize the results at that time as Waterspil was coupled to a land consolidation project. At that moment there was an anti-ecology attitude among the farmers involved in the land consolidation project. The project leaders feared that the farmers would obstruct Waterspil as they would not be willing to invest additionally for the environment.

In the summer of 1995, the water board chose a combination of the three scenarios for further elaboration. For the largest part of the area they chose the most cost-effective one for agriculture because the land consolidation project should be cost-effective for the agricultural part of the area. A more refined infrastructure of devices regulating the water level is needed to attain the calculated ground water level rises. Although agriculture as a whole will benefit from this plan, parts of the area will have damage because of a surplus of water. It will be quite difficult to match this difference in interests. Though the representative parties welcome this pilot study, the problem that still has to be coped with is that some individual farmers have an emotional binding with their land. They refuse to exchange their land with other parts so that the lowest parts can be taken out of production in order to create a nature area. Another problem is that, although the making of the models has provided a good insight in the effects of ground water level increase, the models have not been validated. Therefore, outcomes of the models have been compared with the expert knowledge of staff members of the water board. As the outcomes of the models reflected the expert knowledge of the water board, the results were not questioned by the water board. Nevertheless, the only way to test the validity of the models is carefully monitoring of the effects. Monitoring is also necessary in order to be flexible to attain the real optimum water level and in case unforeseen problems arise.

In both cases the water board explored local expert knowledge, which involves both physical aspects and the people who live there. Most of the expert knowledge was gained from experience in their own area. Knowledge gained in one project was carried over to the next project. In every project some new knowledge was added as well. If necessary, consultancy bureaus or divisions of the national government were asked to do additional research; these institutions acted as intermediates to deliver tailor made scientific knowledge. In addition, employees of the water board attend symposia or seminars to retrieve the latest scientific insights which can be applied to their own area (F. Verhaar, Water Board De Drie Ambachten, personal communication).

The water board had to link different local social interests in order that all social groups can see that their money is spent for their own benefit. This linking of interests is in accordance with the notion of integrated water management. In the above mentioned projects, ecology was successfully linked with agriculture, which had as a result that the projects could or will be carried out.

ANALYSIS

This section compares the findings of Dutch desiccation policy at the national and local level and relates them to the different perspectives on knowledge use in public policy that were outlined in Section 2. The first question addressed is whether a cultural gap between the science and policy communities can be held responsible for non-utilization of scientific knowledge. Next, we will point to factors in the utilization process that can be related to the rational actor perspective. Finally, we analyze how different constructions of the problem relate to dynamics in the knowledge system.

The first major conclusion is that in Dutch desiccation policy, since the mid-80s, scientific knowledge has frequently been used. Although knowledge was not communicated to the policy makers in the 60s and 70s, the doom scenario of research reports lying in the dusty drawers of policy makers certainly did not apply for this area at the interface between environmental policy and water management as soon as the issue appeared on the national agenda. Thus, while not all science input was used in policy making, communication barriers disappeared after priority status was gained. At the local level, a gap was existent between policy makers and university scientists in the sense that the local policy makers simply did not consider to consult them. They needed tailor-made knowledge to solve every single desiccation problem. They preferred to consult provincial agencies or consultants with applied scientific knowledge. Both at the national level and the local level there was intensive communication between those who carried out the contract research and the policy makers. This explains the use of the results by the policy makers.

Real obstacles, because of a difference in culture, did not emerge between the policy makers and researchers as indicated in the theory as long as the research questions dealt with clearly defined issues. This observation yields to conclude that the two-communities perspective is of minor relevance for explaining the way in which knowledge was used.

If there is something that can be referred to as a cultural gap, it is the gap between the national and the local level of policy-making rather than a gap between the science and policy community. At the national level, policy and science had an interest in joining forces to put an issue on the agenda. The practical knowledge concerning water conservation for agriculture gathered at the local level already led to planning projects before the existence of a national policy. In this planning, the problems taken into account show a more integrated character than the final definition at the national level. Thus, at least to some degree, there is a difference between the culture of local coalitions between experts and policy makers, and the national coalitions. At the national level, general knowledge of the desiccation problem was needed in order to define targets and timetables, whereas at the local level tailor-made knowledge was needed for water management plans in every individual case. This cultural gap shows similarities with the gap between donors and receivers of projects in developing countries (e.g., Arce and Long, 1992; DGIS 1994, pgs. 207-209, 212-214; Mihyo, 1995). Although, it is not the scope of this article to elaborate these similarities, it is striking that in these projects often both a struggle between types of general knowledge such as economic or technical knowledge versus local knowledge can be observed.

With regard to the rational actor perspective, we can conclude that although the topic was known among scientists and nature conservancy agencies (van Dijk, 1989), the topic was not recognized at the national level before it had been signaled in their own information networks. Universities were involved after a conflict of interests in the national task force had become evident. As the rational actor perspective predicts, the policy makers did not start to look for external knowledge until they really needed to do so. Knowledge use at the national level benefited from the fact that the different research outcomes pointed in the same direction as soon as the problem was restricted to damage to the natural environment. At the local level, the decisionmakers from the water boards relied heavily on their 'tacit knowledge,' especially on their knowledge of the people of the area, the physical aspects of the area (by experience) and some scientific knowledge, gained by education or symposia. They did not take the time and effort to search for scientific literature or contact universities. For additional information, they relied on consultants already in their network rather than scientific institutions. The research results fitted well in their existent knowledge system. In fact, the results of Waterspil were evaluated against their own expert knowledge of the area, and were found to be in the same range as their own expectations about the effects of the proposed measures. This phenomenon is in accordance with the observation that science knowledge which fits in the policy making frameworks is more readily accepted and used (van de Vall and Bolas, 1982; van de Vall, 1988).

In Sections 3 and 4, we have observed that actors with divergent interests, both at the national and the local level, have constructed the policy problem in different ways. It is striking that on the national level desiccation was finally focused on damage to the natural environment only. Links with other interests suffering from drought damage were excluded. By defining the problem as an ecological one, it was easier for the actors at the national level to gain support for the problem, as environmental policy was booming at that moment. The local authorities had to figure out how to implement the nationally defined policies. To address the issue, the problem had to be redefined in order to fit into the tacit knowledge and experience of the local actors. The local policy makers linked desiccation and drought damage to gain support by various interest groups, including the farmers, in order to solve the desiccation problem.

Although actors at both levels used scientific knowledge as well as personal knowledge of decisionmakers, the framing of the issue differed. This is made clear through comparing the use of knowledge stocks. Table 2 shows the composition of the knowledge stocks used at the two levels of administration. At the national level there was a knowledge pull from fundamental science and strategic scientific knowledge to describe and analyze the problem. This knowledge was too general, and more suitable for abstract policy aims than for specific local projects. Here the local policy makers were confronted with the physical and social context, into which the abstract policy goals had be to fitted. As a difference in the ground water table of a few centimeters can have a huge effect on the ecosystem, more site specific knowledge concerning the topographic, ecological and hydrological characteristics which could be applied directly, was needed. That is one of the reasons that the local level had hardly any attention for science knowledge produced at universities for the national desiccation policy (especially biological and hydrological knowledge). Furthermore, it is important to keep in mind that, especially at the local level, consensus and public support are as important as knowledge, if it comes to implementing new policy. In order to solve

TABLE 2. Stocks of Knowledge Used in Policy Making at the National and Local Level [(s) = science knowledge stock; (ns) = non science knowledge stock].

National	Local
Ecology (s)	Applied hydrology (s)
Hydrology (s)	Agricultural economy (s)
Policy makers' knowledge on how to accommodate a difficult multi-actor issue (ns)	Expert knowledge of physical aspects of the area (s)
	Personal knowledge of physical aspects of the area (ns)
	Personal knowledge on 'mentality' of population in the area (ns)

desiccation within the concept of integrated water management, local authorities need to define a win-win concept, as was done in Waterspil.

CONCLUSIONS

The two-culture debate explains to some extent why knowledge is not used, but fails to explain why knowledge is used. However, the culture gap between the national level and the local level is important to explain the problems of implementing abstract national level policy goals at the local level. The rational actor model explains both the information search behavior at the local and national level as soon as the problem is defined and the actors' preference for their own tacit knowledge. The perspective of social construction of the desiccation problem appeared to be especially important at three levels. First, on the level of science policy interaction, at the point that there is communication between the policy makers and scientists, a process of defining and redefining the problem is started. Second, in order to align the multiple interests both at the national and local level, the problem is conceptualized in a way that takes into account the stakes held by all different actors. The best illustration at the local level is that desiccation was recognized as an issue adjacent to fresh water need for agriculture. Finally, social construction turns out to be important in comparing the perspectives taken at different levels of public administration. The cultural gap between relatively high levels of policy making and the local level explains why policy made at the higher level usually is not received with open arms at the local level. The people at the local level seldom reject it because they are stupid. But they know their own situation and have already established a network of experts. As a consequence, the national level and the local level used different knowledge stocks to solve their "own" desiccation problem. This case study thus reveals reasons why more attention should be paid to the translation of policy problems from rather high levels of political authority to the conceptualization at lower management levels. By paying attention to the social and technical characteristics at the local level, problem closure at the higher levels should be crafted more carefully.

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