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Article

How policymakers' demands for usable knowledge shape science-policy relations in environmental policy in Poland

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Abstract

This article discusses how aspects related to policymakers' demands for knowledge shape preferences for science-policy models such as Mode 1 and Mode 2. It focuses on the demands that Polish policymakers make of science and how they envision their role in the knowledge production process in the field of environmental policy. The article applies a set of criteria on how policymakers define usable knowledge to better understand preference and use in practice of different science-policy models. Results show that preferences for Mode 1 or Mode 2 are in part the result of trade-off between criteria of quality, relevance, conformity, and action orientation. While science can provide truth and usable knowledge in both Mode 1 and 2, Mode 1 is attractive when policymakers have specific political demands: they may use it to avoid responsibility for negative policy outcomes or to discredit undesirable results.

Key words: Mode 1; Mode 2; Poland; science–policy models; usable knowledge.

1. Introduction

Scientists are important providers of expertise: one can say that academia and society have come to an agreement that science is the best knowledge we have of how the world works (Yearley 2004). Accordingly, scientific knowledge is meant to be used and applied in policymaking. Yet, how scientific knowledge moves from production to use is a question without a clear answer. Over the past 50 years, one can witness an intense and evolving debate on how science, policy, and society relations are and should be structured (Kirchhoff et al. 2013). This debate moves from a discussion of the merits and limitations of the linear and mono-disciplinary model (Bush 1945) to the consideration of more complex, interactive, and interdisciplinary models of science production that include user involvement and sensitivity to societal problems (Gibbons 2000; Nowotny et al. 2001; Landry et al. 2003; Jacob 2006; Kirchhoff et al. 2013). The debate emphasizes different aspects of changing relations between science, policy, and society and seeks to understand efforts to enhance the quality, effectiveness, and legitimacy of knowledge and expertise in policymaking (Turnhout et al. 2013).

An influential description of the changing relations between science, policy, and society has been offered by Gibbons et al. (1994) and Nowotny et al. (2003), in the form of the Mode 1 and Mode 2 discussion. They use the term 'Mode 1' to denote the conventional model of knowledge production within scientific disciplines. In this model, science-policy relations are linear and 'problems are set and solved in a context governed by the (largely academic) interests of a specific community' (Kraak 2000: 35). Mode 1 is characterized by knowledge production that draws on homogeneity of skills and hierarchical organization of the scientific endeavour. In contrast, in Mode 2, knowledge is produced in a context of application and can involve a much broader range of social perspectives. Mode 2 is thus based on inter- or transdisciplinarity, heterogeneity, and organizational diversity. Moreover, Mode 2 shows a preference for flatter organizational structures which are transient (Kraak 2000). In both models, peer review serves as quality control, but in Mode 2 it involves a more temporary and heterogeneous set of participants who are interactively involved in discussions on contextualized problems. As a result, Mode 2 is thought to be more socially accountable and reflexive than Mode 1 (see more Gibbons et al. 1994: 3–8, 167; Nowotny et al. 2003).

We consider the Mode 1/Mode 2 discussion to be embedded in multidirectional changes in thinking about knowledge production and use: from mono to transdisciplinary (also captured by a concept of transdisciplinary research by Thompson Klein 2001, Regeer and Bunders 2009); from linear to multidirectional and social processes of knowledge co-production (Jasanoff 2000); from expert-based to democratic knowledge production (also captured by Funtowicz and Ravetz, 1993 in concept of post-normal science); and from an

emphasis on knowledge production to an emphasis on knowledge use, application, and policy relevance (Mode 2 of Gibbons et al. 1994). It is important to emphasize that scholars like Gibbons (1998) have not argued that Mode 2 and other models (transdisciplinarity, post normal science, and co-production) are going to eliminate the old paradigm of Mode 1. Even so, the societal trend is towards more complex and interactive models of knowledge production that include users (Metze and Turnhout 2014).

Notwithstanding the above, Mode 1 remains in use due to various reasons (Turnhout et al. 2014). Scientists who distance themselves from policy find it easier to maintain credibility and authority (Wooster 1998). They do so by drawing on the assumption that knowledge produced in Mode 1 is independent, objective, and free of influences (an assumption still embraced by many). Mode 1 is also still supported by many governmental institutions and policymakers (Kraak 2000). For example, Wesselink et al. (2013) write how global climate change governance is built on a linear approach to science-policy interactions. Moreover, knowledge produced in Mode 1 is perceived by policymakers to be isolated from political considerations and thus useful for policymakers to distance themselves from policy decisions and avoid public responsibility (Gieryn 1983; Flinders and Buller 2006). However, many policymakers acknowledge that knowledge produced within Mode 2 often offers better solutions to societal problems and can deliver relevant, legitimate, and credible knowledge (as defined by Cash et al. 2002, 2003). In Mode 2, there is also more awareness that knowledge is value laden.

We hypothesize that the demands that policymakers make on knowledge—that in turn affect their preference for either Mode 1 or Mode 2—will be shaped by whether they intent to use this knowledge either politically or instrumentally. Accordingly, such demands may lead to preferences for the Mode 1 or Mode 2 model depending on the situation. How to link policy demands to preferences for Mode 1 or Mode 2 is not immediately clear. Kunseler and Tuinstra (2017) found that experts seek to purvey objectivity and authority, while navigating different models in their practices. Weiss (1979) already found in early studies on knowledge use that policymakers expect science to deliver empirical, objective evidence and conclusions that in principle help to solve a policy problem—a typical instrumental use of knowledge. Wesselink et al. (2013) found that when demands for knowledge are linked with political sensitive contexts of use, knowledge becomes ammunition for the side that finds its results supportive and it becomes congenial when it cannot be undermined. In other words, policymakers may benefit from scientific knowledge that is isolated from interactions with policy and therefore give preference to Mode 1, but they may equally benefit from knowledge that is co-produced with users and for a specific context of application and thus give preference to Mode 2. In addition, policymakers may have a preference for one Mode or the other based on broader policy contexts.

This article explores how models such as Mode 1 or Mode 2 may satisfy the demands that policymakers make of knowledge production and use. We use the Mode 1/Mode 2 terminology as an umbrella term to discuss policymakers' preferences for either monodisciplinary and linear models or more complex and interactive models of science, policy, and society relations. To inform analysis, this article draws on the usability criteria of Weiss (1995) to identify different policymakers' demands on knowledge and how these relate to the Mode 1/Mode 2 debate. Accordingly, we discuss the influence of policymakers' demands and preferences on practices of knowledge production and use, a topic less explored in literature (Bielak et al. 2008; Dunn and Laing 2017). Our results are based on an analysis of environmental policy in Poland, where we found both Mode 1 and Mode 2 models (Kowalczewska et al. 2017) to be relevant.

2. Criteria for usable knowledge

Defining criteria for usable knowledge is an important topic in knowledge utilization studies and is emphasized in the literature in relation to many sectors (environment, health care, and education). Scholars have come up with partly overlapping and different sets of criteria of what usable knowledge is (Rich 1991; Weiss 1995; Dunn and Laing 2017) and have also indicated trade-offs between criteria (Cash et al. 2002, 2003). Weiss (1995) and colleagues carried out a research among decision makers, focusing on the community of policymakers in the USA and a broad field of policy subjects, to value the usefulness of actual studies for their own work. This research yielded five main criteria important for usable knowledge: (1) relevance, (2) conformity, (3) quality, (4) action orientation, and (5) challenging the status quo. Although these criteria have been developed more than 20 years ago, they bring together the dimensions of knowledge production and use, both of which are relevant to the science-policy interface (Tangney 2017), especially in Mode 2, where they are considered strongly entwined.

Policymakers' demands on knowledge may place different emphasis on different criteria depending on the intention of use (political or instrumental) as well as the general policy context in which they are situated. These criteria may be satisfied by science-policy relations that may be found either in Mode 1, Mode 2, or both at the same time (Gibbons 1998; Kraak 2000). A recent study by Dunn and Laing (2017) shows that users such as policymakers under certain conditions do not necessarily desire knowledge to be legitimate and credible as much as they prefer it to be policy-relevant. They, therefore, propose that research should consider 'applicability, comprehensiveness, timing, and accessibility' (ACTA) (Dunn and Laing 2017) rather than 'credibility, relevance, and legitimacy' (CRELE). The latter set of criteria have been made popular by Cash et al. (2002) and have indeed been rapidly adopted by the scientific community to serve as a standard by which to evaluate knowledge production and use. Both sets of criteria can be used 'to better understand competing demands at the science-policy interface' (Tangney 2017: 149).

Weiss (1995) and others, already in the 1980s and 1990s, have developed five criteria that includes elements of both ACTA and CRELE. Therefore, we use them as 'heuristic tools' to study how models such as Mode 1 or Mode 2 can produce knowledge of particular characteristics that do or do not satisfy policymakers' demands on knowledge. Below we present descriptions of each of the five criteria as defined by Weiss (1995). In our descriptions of the criteria, we include insights from recent literature on knowledge criteria. Crucially, we provide information for each criterion how Mode 1 or Mode 2 science-policy relations can or cannot satisfy the demands that are related to it.

The first criterion is *relevance*. Relevance is considered a key attribute of science-policy interfaces by a broad range of authors (Cash et al. 2003; Farrell and Jäger 2006; Kunseler et al. 2015; Dunn and Laing 2017). Knowledge is usable to policymakers when it is relevant to the policymakers' own work (Weiss 1995), which means it is delivered timely and relates to topics that are societally relevant and match with policy and societal needs (Sarkki et al. 2015). To increase utility by policymakers, scientists should thus

produce time-critical research rapidly enough to affect policy outcomes (Laurance et al. 2012). In Mode 1, such timely and societal aspects of relevance are often lacking. In the field of conservation science, for example, many studies do not links with real-world conservation outcomes (Knight et al. 2008; Milner-Gulland et al. 2010). Laurance et al. (2012) suggest that this is because the majority of conservation scientists are in academic positions and have limited interactions with conservation practitioners and managers (see also Campbell 2007; Milner-Gulland et al. 2010). While in Mode 1 scientists do research on matters they perceive as urgent and problematic, they do not necessarily follow policy agendas and many studies stay unused (Kirchhoff et al. 2013). According to Laurance et al. (2012), this calls for communication and dialogue between conservation scientists and policymakers and practitioners. This view is shared broadly across policy domains: many studies emphasize that the involvement and participation of users (practitioners) in interactive knowledge production processes (i.e., Mode 2) leads to the production of relevant knowledge for policymakers and improves the level of its usage (Landry et al. 2003; Lemos and Morehouse 2005; Jacob 2006; Chapman et al. 2015).

The second criterion is *conformity* to the prior knowledge, experience, and belief of policymakers (Weiss 1995). Conformity can be achieved through a process of knowledge translation. For example, knowledge translation targeting policy makers should ensure that consideration of research evidence is a key component of decision making, but also recognize that there are other legitimate factors that need to be considered (Grimshaw et al. 2012). Knowledge translation processes thus ensure that policymakers are informed about research results. Knowledge translation in Mode 1 can be done by scientists who translate results into more readable formats, but their translation abilities and understanding of policy language and context is often limited. As Shonkoff and Bales wrote (2011: 30):

> the challenge of translation can be addressed within a mutually respectful, ongoing collaborative process in which developmental scientists, communications researchers, and policymakers can become co-producers of broadly understood yet sophisticated scientific messages that are not 'dumbed down' yet take into account the cognitive shortcuts that non-scientists bring to the discussion of complex issues.

Thus, the argument is that following a Mode 2 model allows scientists to present knowledge that fits the policymakers' specific needs and combines it successfully with their knowledge base (Den Hertog 2002). To support knowledge translation processes and simplify messages for policy it is moreover emphasized (e.g., in Sarkki et al. 2013) that policy briefs, pictures, maps, and figures may be efficient translation tools for policymakers.

The third criterion is *quality*. Useful knowledge should be of high quality, which includes references to scientific standards related to methodology (Weiss 1995). Quality of knowledge has also been discussed in term of credibility (Cash et al. 2002; Farrell and Jäger 2006), which refers to the (perceived) quality, validity, and scientific adequacy of the knowledge exchanged at the interface. It includes credibility both of the knowledge production processes and of the knowledge holders (in Sarkki et al. 2013). In Mode 1, quality research can be achieved through very strict methodology that is used to discover facts and is carried out mainly at universities (Kirchhoff et al. 2013). Science then can be perceived as objective, free from emotions, private interests, bias, or prejudice. This means that scientific knowledge is acquired through systematic experimentation with nature and results can be reproduced to check if they are true or not (Kirchhoff et al. 2013). In Mode 2, quality is more a matter of peer review. One the one hand, Mode 2 science is flexible enough to produce for example multidisciplinary research by involving scientists from different disciplines into the production process and to involve other types of (non-scientific) knowledge holders in processes of co-production (Jasanoff 2000). Many studies emphasize the importance of multidisciplinary research projects because they 'build on theories and previous research from more than one discipline and use methods for data collection and analysis from more than one research tradition' (Locker 1994: 138 cited in Sumner 2003: 2) and lead to more 'socially robust' knowledge (Hegger et al. 2012). However, some knowledge holders may either politicize or technicize expertise (Wesselink et al. 2013) to attach it to political values or actively isolate it from them. Both politicizing and technicizing weaken the credibility of co-production, as criteria of quality within respectively Mode 1 and Mode 2 become undermined. Equally, the credibility and objectivity of science produced may be weakened when scientists become too actively engaged in the policymaking process (Mills and Clark 2001; Wooster 1998).

The fourth criterion is an *orientation to action*. Weiss (1995) stated that decision makers prefer a study that gives them direction for tangible action. Action-oriented research generates knowledge that can be used to address practical concerns of local communities, organizations, and groups, to incorporate local understandings of specific issues (Small and Uttal 2005), and is often small-scale (Burns 2000). Within specific themes, for example adaptation to climate change, a call for action-oriented research is linked to a need for policy interventions to change behaviours across multiple sectors, requiring policy processes to reshape institutional settings (Lahsen et al. 2010). This may be part of Mode 1, as generalized results (e.g., global warming) call for broad policy action (e.g., climate mitigation action). However, action-oriented research is more often associated with Mode 2: it may produce information based on for example case studies that is really focus on the context of application (Small and Uttal 2005). Within all action-oriented research approaches, it is common that it involves some type of collaboration between researchers and users or policy makers (Small and Uttal 2005). How this collaboration takes shape depends on policy demands: more politicized demands will involve global orientation to action and Mode 1 type of quality, whereas policy demands focused on problem-solving may more readily lead to Mode 2 models.

The fifth criterion is for knowledge to be able *challenge the status quo* or the current policy agenda (Weiss 1995). Scientific studies can challenge current policies; especially the independent quality predominantly ascribed to Mode 1 science is associated with this criterion. Knowledge-driven studies (produced in Mode 1 organization) can thus be critical of current policy and offer different policy alternatives. Studies produced in Mode 2 can also bring fresh ideas into a specific problem, but more as a result from processes of co-production than from independent expertise. Thus, including multiple disciplines and types of knowledge may challenge status quo of policymaking, especially is this status quo had previously been based on Mode 1 types of science. Again, environmental science is illustrative here, as debates on science advocacy within this field move between those that find it is the role of scientist to speak out to policy (e.g., 'truth to power') (Wildavsky 1987, also compare Al Gore's latest movie) and those that urge more transparency (Garrard et al. 2016) about normative positions and reflection on the relationship between researcher and policy communities (Small and Uttal 2005).

The above review shows that the first two criteria, relevance and conformity of knowledge, cannot be produced well in Mode 1. The emphasis on these criteria is commonly associated by policymakers with the instrumental use and the literature suggests that this will steer policymakers' preferences towards Mode 2. Review of the quality, action-orientation, and challenging criteria of knowledge paints more complicated picture. Policymakers who have political demands for knowledge often choose Mode 1 because it considers science as independent from policymaking (part of the quality criteria). Mode 1 is also a more likely preference when policymakers' demands are in line with more global and generalized calls to action and when they consider it the task of scientists to challenge the status quo. When more instrumental demands dominate, demands for quality may also be satisfied in Mode 2. Moreover, literature suggests that demands that focus on solutions for concrete localized issues, and policy change that originates from a broad range of stakeholders is also more likely to steer preferences towards Mode 2. Scholars such as Pielke (2007) show that in an interactive mode like Mode 2, science can also be considered independent if the focus of knowledge production and use is on opening up debate rather than closing it down.

In sum, policymakers will value different criteria for usable knowledge based on their policy needs and demands and will also interpret these criteria differently depending on whether their needs are more focused on allocating political responsibility or on being instrumental to achieving policy objectives. Moreover, trade-offs between criteria are likely, for example when demands for quality compete with the need for relevant knowledge. As a result, a combination of policy demands may lead to a preference for either a Mode 1 or a Mode 2 type of science-policy relations. Below, we flesh out this argument with an empirical case study of the knowledge demands of Polish policymakers and the models of science-policy relations that were in use.

3. Case study approach and methods

The empirical case relates to Poland that accessed the EU in 2004. The accession process required many laws to be changed in order to comply with the EU rules. But, complying with the EU rules is a continuous process that refers to all policy sectors and requires production of knowledge for policy convergence with the EU. For policy convergence, knowledge and expertise played an important role, in agriculture and environmental policies in particular (e.g., rural development and nitrates policy), by providing policymakers with data sets, indicators, interpretations, calculations, and new ideas to create policy solutions (Kowalczewska et al. 2017). For these particular policies—rural development and nitrates policy—science–policy relations were dynamically influenced in the period between 2004 and 16 by two factors. Firstly, a great amount of knowledge and expertise was required and produced within these policy initiatives. Secondly, these policies were subjected to political dynamics (Kowalczewska and Turnhout 2012; Kowalczewska et al. 2017).

We adopted a qualitative approach to data collection. Our data derives from fifteen semi-structured and face to face interviews with Polish policymakers (Annex 1) working in the field of agriculture and agri-environment, carried out by the first author. Interviewees were selected based on the prominence of their participation in the implementation processes of rural development policy or Nitrates Directive and their institutional roles. During the interviews, interviewees were asked about: (1) use of knowledge in policy documents and developments, rural development, and the Nitrates Directive in particular; (2) types of knowledge delivered by scientists; (3) quality of delivered knowledge and other criteria important for knowledge to be used in policy; and (4) relation and interactions between policy and science.

As an analytical method we carried out a discursive analysis (Hajer and Versteeg 2005) to systematically study transcripts of interviews. In the analysis, we searched our data for policy discourses that were supporting Mode 1 or Mode 2, to identify preferences for one or the other within the general policy context in which interviewees were situated. In addition, we coded for the framing of policy demands according to the criteria of knowledge described above, including whether demands could be identified as political or instrumental. We used all the data provided in transcripts and coded with support of the QDA Miner Lite software. The next section describes our findings in detail.

4. Knowledge demands of Polish policymakers

4.1 Relevance

Polish policymakers defined relevant knowledge as being in line with European law and stated that relevant knowledge is more likely to be used. Experiences with implementing EU law in the first years after accession (e.g., agricultural policy) showed that scientists were not always fully aware/informed about the EU rules that have to be implemented in policy. Policymakers had an expectation, for example, that when programming the Rural Development Programme for 2007–13, scientists would deliver the data and interpretation of the state of play that could be used directly to design rural development measures. They had been sending specific questions to scientists (according to the policymakers well formulated) but received answers that did not always fit their expectations and therefore could not be used. Similarly, when scientists were asked by policymakers to consult the programmed rural development measures sometimes their comments were not usable because they were not fully complying with EU regulations. Such science-policy communication failures are typical for Mode 1.

Relevant knowledge, for Polish policymakers, was also related to 'fit' and good timing in policy. They stated that information presented according to international standards is more likely to be used. This is important when presenting values of environmental indicators because then it is possible to compare them with the European average or other countries. Good timing was an issue within the implementation of the Nitrates Directive in 2007: there was a problem with synchronization of national implementation guidelines with the EU guidelines. First, the national implementation guidelines were used by regional water authorities (responsible for the Nitrates Directive implementation) to order scientific expertise (via individual legal contracts) with indicators showing levels of nitrates pollutions in waters. Later on, the European Commission sent the European guidelines for all member states and it turned out they differed from the national ones. Scientific expertise that was already acquired by policymakers had to be adapted in order to be used, or changed completely. So, timing was an important issue.

Another example highlighting the relevance of knowledge related to preparing a National Strategic Plan for rural development for 2007–13,[1] for which it was necessary to have a diagnosis of the state of agriculture in Poland. For this diagnosis, statistical data were used although these data did not always meet the requirements

of this document. Therefore, additional information was provided by two scientific institutes subordinate to the Ministry of Agriculture. There was already a group of scientists who worked on this document, so the exchange of information between them and policymakers was interactive and effective (similar to Mode 2). Scientists developed and validated the descriptive and indicative parts so that all strategic goals and priorities described in the document would reflect the current state of agriculture, according to the guideline for the National Strategic Plan. As a result, the delivered scientific information was relevant and could be directly used by policymakers.

4.2 Conformity

We wrote that conformity to the knowledge of policymakers requires the process of translation. Polish policymakers mentioned that they sometimes had difficulties with understanding scientific reports due to their written language which was named by respondents as 'very scientific' or 'too scientific'. Scientists had their own way of presenting scientific standards, regulated by the world of science. Monographs (single long manuscripts) can be painstaking to read for policymakers, said one policymaker. Condensation of results in a shorter document is more desired although this may cause a risk of misinterpretation of the results, according to another policymaker. In the case of Poland, the process of translating research results for policymakers was not mentioned as a common practice which would suggest that a traditional way of knowledge production, like in Mode 1, dominated.

Polish policymakers were fully aware that certain characteristics like visualization and good layout—so more user-friendly elements—are helpful in understanding scientific knowledge. Graphical representations and formats can also positively influence usability, in their views. For example, the way the EUruralis scenario study presented its results (historic and temporary facts, figures and pictures of the EU 27) (Kowalczewska and Turnhout 2012), by using maps, graphs, tables and four contrasting scenarios contributed to usability. Polish respondents appreciated this way of translating the results because it makes it much more attractive than a traditional scientific publication. They emphasized 'the easiness of getting the results of prognosis', that is, they spoke about the simple and colourful maps, graphs, and tables, which makes the project understandable for anyone. Generally, Polish respondents recognized this way of presenting research results as an important feature contributing to the usefulness of research in policymaking.

We found that sometimes Polish policymakers translated scientific information to the policy language themselves to use them in policy process, for example as an input to policy documents. One policymaker said that translation consists of filtering a scientific report to extract the core results. Another policymaker said that cooperation with scientists is needed in the translation process; therefore, he meets or talks with scientists in order to extract the usable information for policy. The translated information was usually used to support policy argumentation or action. The translations had a simpler language and included visualizations like tables or graphs with data. Translation was done according to the policy need, so it was a selective use of scientific knowledge. This finding proves that the challenge of conformity with policymakers' knowledge can be easier addressed within a collaborative process (Mode 2).

4.3 Quality

We found that the methodology and credibility of research as well as having 'trustworthy' scientists and their organizations were critical to usability. Polish policymakers paid attention to several aspects of methodology including: reliable data collection; methods for calculations of indicators and finances; monitoring data and its interpretations; use of indicators/factors that describe a certain problem or state of play; issues of spatial and time scales of the research; availability of data sets; and ways of presenting scientific information. All these aspects were valued because they believed that methodology should not be undermined, as that would also undermine quality of results. This suggests that Mode 1 was much is use. Scientific information/knowledge often informed about the state of play, for example regarding pollution of environment, and this information was crucial for deciding on policy actions. Scientific information was thus considered as objective truth that can serve as justification for policy decisions.

Maintaining relations and interactions with scientists have also been mentioned by Polish policymakers as important for the quality of research. Via interactions: (1) doubts towards methodology can be clarified, (2) access to knowledge is easier, (3) there is more understanding about the limitations of science (how to achieve good quality science and present valid results); and (4) justification for certain policy decisions/positions can be stronger if supported by many scientists, representing different research organizations. In practice, contacts with scientists are being strengthened by involving them as experts into policy working groups (examples were present in the Nitrates Directive implementation and programing of rural development policy). To make knowledge more usable, one policymaker mentioned that involving policy officers into research projects as experts, advisors, or members of a steering committee would definitely improve the usability of the final project results. This because during the research phase modifications could follow regarding methodology, scope of the research, and data collection, so at the end final results could better fit the policymakers needs.

An example of the use of a good quality scientific report according to Mode 1 can be found at the beginning of the Nitrates Directive implementation. A credible research institute—the Institute of Meteorology and Water Management—by request of the Ministry of Environment (in 2004), delivered a report on the state of play of nitrates concentrations in waters for the whole territory of Poland. This report stated—based on monitoring results from the period 1990 to 99—that there was no serious problem of nitrates pollution, that municipal sewage was the main source of high nitrates levels in surface water, and that the current levels of agricultural activity did not justify the designation of nitrates vulnerable zones (NVZs) (Gorton et al. 2005). This information was credible enough to be a basis for a policy decision that nitrates contamination was only a localized problem (which later on proved not to be the case) that could be solved at the local level by local authorities in the regions and farmers themselves. This caused a designation only of a few nitrates vulnerable zones in locations where the problem with nitrates was reported Kowalczewska et al. 2017). In this example, science offered seemingly objective, but ultimately wrong information to decision makers, based on which local actions were planned.

If policymakers have doubts about the quality of research they are reluctant to use its recommendations, especially if this leads to policy change, and they may search for other, more credible expertise on the same subject. During the Nitrates Directive implementation in 2007, an analysis of a foreign, Dutch university (WUR 2007) was published that questioned the Polish designation approach of NVZs. This expertise was not fully based on the Polish national monitoring data; it used other, more local analyses, so it was not

clear how the process of data collection was organized, according to one of the policymakers. Due to the questionable methodology of this analysis, Polish policymakers found it difficult to take recommendations for changes of the NVZs designation approach seriously into consideration. So, to validate the proposed recommendations in this analysis (WUR 2007), an additional analysis was commissioned, in this case by policy officers from the Ministry of Agriculture.

We learned that some aspects of Mode 2 model were also used. A multi-source research was developed jointly (by policy and science communities) within the process of Nitrates Directive implementation after 2007 and used for justification of policy decisions before the European Commission. Almost since the beginning of the implementation process of the Nitrates Directive, the European Commission had been unconvinced with the actions of Poland and intervened several times. These interventions had an impact and led to more multi-level cooperation between institutions, better policy integration, and better integration of research to the policy process. After some time, what was considered quality research offered both instrumental information about the state of nitrates pollution/use and a conceptual frame for revisions of designated NVZs.

4.4 Action orientation

During our interviews, Polish policymakers did not mention action-orientation as a criterion important for usability. Across our investigation, however, we found two strong examples of action-oriented research which produced results for specific situations. In these examples, we noticed collaboration between researchers and policymakers that was helpful in obtaining the expected outcomes. We found there to be no prescribed methodology for action-oriented research, whereas every research focused on different issues/problems and used a different methodological approach. Each example shows that for action-oriented research in environmental policy in Poland, Mode 2 more or less dominated.

One example for action-oriented research related to the design of the rural development measure called 'Adjusting farms to the EU standards' within the rural development programme of 2004–6. This measure required sophisticated calculations of payments for famers. The idea was to grant farmers a lump-sum payment for modernization and investments at the farm instead of reimbursement of costs. It required the preparation of averaged payment rates for different type of farms: (1) in the case of modernizing these were rates for the purchase of slurry tanks and the construction of slabs, (2) in the case of dairy farms these were rates for the purchase of milking machines and milk coolers, and (3) in the case of poultry farms these were rates for purchase of modern breeding systems. Calculations of payments were ordered and later on delivered by two research institutes belonging to the Ministry of Agriculture. Consultations between policymakers and scientists took place while preparing the calculations. Policymakers wanted to have reliable and independent scientific analyses with variations for calculations of payments. The reason of asking two individual scientific institutes for the same analyses of calculations was to consult and validate the calculations in the case of being confronted with allegations or claims regarding unfair rates of payments.

Another example of action-oriented research related to the revision of Nitrates Vulnerable Zones (NVZs) in 2011. The Ministry of Agriculture ordered a special analysis at the Institute of Soil Science and Plant Cultivation in Pulawy to support the designation of NVZs. This analysis, based on a model of nitrates outflows from agriculture, designated three different scenarios of unified NVZs designation. Each scenario was proposing a different percentage of areas covered by NVZs and investigated the nitrate contamination problem within specific contexts of agricultural production in different regions. The idea was that policymakers would choose one of the scenarios as a new approach for NVZs designation. The results of this research were presented and discussed at a meeting with policymakers who represented different policy institutions. At the end, none of the proposed scenarios were used. First, there was a concern by some policymakers inside the Ministry of Agriculture that this scientific report delivered by only a single research organization cannot be a reliable basis for the new designation. Second, policy officers (also from different institutions) had doubts about the methodology of this research and the quality of the monitoring data used for the analyses. Third, each of the scenario presented much larger areas covered with NVZs (at the national level) than the current situation at the time, which was not considered desirable from a political point of view (there was no political will to enlarge NVZs in Poland).

4.5 Challenging

In the views of Polish policymakers, the fact whether scientific knowledge was challenging or not was to a certain extent related to funding instruments. Some respondents had doubts if research can be challenging within the Polish science-policy organization of environmental and agricultural domains. Interviewees reported that policy-relevant knowledge production took place mainly in research institutes that are financed by and subordinate to the Ministries (Ministry of Agriculture or Environment respectively) within frameworks of multiannual research programmes or via ad-hoc contracts. Production of knowledge seldom took place at Universities or other research organizations (who are financially independent of the two mentioned Ministries) and if it did it was via individual contracts. Policymakers commissioned or sought out scientific analyses by formulating research questions/scopes and science was perceived as delivering a service to policymakers.

Some respondents underlined the fact that some research institutes are so much financially dependent on the Ministries makes it hard to present very critical opinions about certain policies, so knowledge is not challenging. This structure between the Ministry and institutes does promote demand-driven production of science. In the eyes of policymakers, scientists in the past exhibited a more passive rather than active attitude, that is, not fully informing policymakers about national or international research projects in which they were involved in. Thus, some policymakers stated that this financial dependency of research institutes to the Ministries actually pushed scientists to become more active in ensuring the relevance and quality of their work in order to maintain funding. Being active includes organizing conferences for policymakers where scientists present results of their particular research areas (informing about all kinds of projects). Being active includes also being creative and presenting science as inspiration to policymakers.

Polish policymakers were mostly critical of research that tends to criticize the current policy approach, so typical knowledge-driven research produced in Mode 1 was not preferred by them if it did not align with their policy and political interests. According to one of interviewees, such research can be very inconvenient. The implementation of the Nitrates Directive in Poland is a case in point: the first designation of NVZs in 2004 was done by various regions and not in a unified way. There were Polish, peer-reviewed articles criticizing this designation approach of 2004. Polish policymakers did not find

this supportive when Polish authorities had to explain and justify the NVZs designation to the European Commission, especially given that the European Commission had many concerns with the Polish implementation of this directive to begin with.

5. Discussion

Our results show that criteria for knowledge such as relevance, conformity, quality, action orientation, and challenging status quo are still highly relevant when analysing the demands that Polish policymakers make of knowledge and expertise. In the case of Poland and environmental policy, we observed that some criteria were more strongly considered than others and that trade-offs occur across different criteria as well. In particular the criteria of relevance and quality were most frequently associated with usability. At the same time, these two criteria were seen to involve a balancing act, as research quality was often assumed to depend on maintaining a distance from policy as in Mode 1 knowledge production, (cf. Sarkki et al. 2013; Huitema and Turnhout 2009). The Mode 1 type of research did decrease the chances of producing knowledge that is relevant, as Mode 2 type of interactions and communication between science and policy were for example needed to address the issue of nitrate pollution.

Both Mode 1 and Mode 2 type of science-policy relations were found in environmental policy in Poland. Our analysis shows how preferences for these models were responsive to policy demands related to usability of knowledge. Obtaining relevant knowledge in Mode 1 was rather problematic, so for this knowledge characteristic Mode 2 was preferred. Polish policymakers stressed a lack of knowledge translation, as a part of conformity, due to the use of Mode 1. In terms of action-orientation, policymakers asked for both basic and applied research; for example to give data on the state of play of a pollution problem or to propose solutions to deal with the designation of NVZs. Action-oriented knowledge was thus delivered to certain policy problems and in that sense was more in accordance with Mode 2 types of science-policy relations. Finally, the criterion of 'challenging the status quo' is difficult to categorize under Mode 1 or 2. Hierarchical structures of research institutes under policy institutions imposed a linear science-policy relation, but critique from independent scientists (via peer-reviewed publications) was not appreciated much.

Demands of policymakers related to quality were especially important in shaping their preference for either Mode 1 or Mode 2 science-policy relations. Policymakers' demands for scientific rigour that is considered free of political interferences led to choices for Mode 1 science-policy relations (similar observation: Funtowicz 2006). In Mode 1, science and policy are seen as separate domains, with science perceived as a uniquely neutral provider of objective knowledge (Van den Hove 2007; Wardekker et al. 2008), and decision-making perceived as the domain and responsibility of policy specialists (Demeritt 2006 in Young et al. 2014). Thus, when policymakers consider scientific facts to be true, objective, and independent, they can basically rely on them for the development of policies without the fear of political backlash (Valente et al. 2014). Considering science and policy as separated is convenient to policymakers as it gives them room to shift blame and avoid political responsibility (Gieryn 1983; Flinders and Buller 2006). Other times, demands for socially robust knowledge favoured relations and interactions between science and policy as in Mode 2 and other interactive science-policy models. In the process of Nitrates Directive implementation in Poland (after 2007) a multi-source research was developed by policy and science jointly and its results were used as justification of Polish policy decisions in front of the European Commission. So, policymakers' demands were framed in such a way that they steered preferences towards Mode 2, in order to have science support policy decisions in front of a third party.

In our case study, the usability criteria of relevance, conformity, and action orientation proved to be more difficult to obtain in Mode 1. Policymakers acknowledged that Mode 1 has its limitations and will not provide the silver bullet to resolve complex and contentious issues (Mills and Clark 2001). In this context, Mode 2 became attractive to policymakers as it can bring relevant and action-oriented knowledge. Quality knowledge, according to Valente (2014: 234), can also be obtained when the client – or policymaker – spells out what is wanted. Increased science-policy interactions may also allow for more open criticism as it could become more constructive and link scientific recommendations with policy actions, although we could not identify this happening in our results.

Our results confirm that neither Mode 1 or Mode 2 types of science-policy relations are panaceas that can satisfy all the demands of policymakers for usable knowledge. While it is the case that knowledge is something better understood when socially co-produced (e.g., see Cash et al. 2006), we found important trade-offs in producing knowledge that seeks to be simultaneously credible, legitimate, and relevant (Cash et al. 2003). Sometimes, rushing results to meet pressing policy demands and thereby addressing their relevance involves a risk of less quality, and in turn credibility of the knowledge produced (Sarkki et al. 2013). Equally, increased collaborations with policymakers during the knowledge production process can decrease the problems of value-laden science, by opening up uncertainties and promoting inclusiveness in knowledge production Pielke (2007), but also carries the risk of politicizing science and expertise to the point that it can no longer address policy issues effectively. The reverse can also hold, when knowledge becomes so technicized that its underlying values are overlooked, which erodes the social robustness of policy (as was the case when NVZs in Poland where initially determined).

Summarizing, the question of where policymakers' demands for usability could be best addressed in Mode 1 or Mode 2 strongly depended on how these demands were framed and what policy contexts they were parts of. As showed in the example of Polish policymakers, knowledge can be used instrumentally to solve a particular problem such as providing an assessment of the 'state of the environment'. In a closed, politically sensitive environment, it is often considered crucial that knowledge presents an objective truth so that political responsibility is (at least partly) avoided, corresponding to a Mode 1 type of science-policy relations. Such relations however may not hold when pressure to come up with policy solutions mounts, as we saw in examples where the EU intervened on the process of the designation of the NVZs. In response, credible and multi-source research was developed by various policy and research organizations jointly in Mode 2. In sum, we noticed that Mode 1 was predominantly preferred when policy decisions required high quality research (in sense of scientific rigorous) to avoid responsibility in political sensitive issues. Mode 2 was more used when science was used to support certain policy measures because the scientific results were easier to translate, relevant, and action-oriented.

6. Conclusions

This article has illustrated the demands for usable knowledge of Polish policymakers and how those demands shaped preferences for

science-policy models. Those preferences, in turn, shape science-policy relations in practice. Thus, the criteria of scientific knowledge that policymakers consider usable are of high relevance for our understanding of why Mode 1 models of science-policy relations often persist as well as why Mode 2 models in other cases are finding their way to reality. Our case study confirmed that interactive and complex science-policy models do serve better to produce knowledge that is considered relevant, action-oriented and conforming with policymakers' background knowledge and beliefs. At the same time, we noticed that other criteria of knowledge—especially quality—strongly link to diverging preferences for either Mode 1 or Mode 2, depending on the context of the policy case.

While Mode 2 may seem to be a better candidate to respond to multiple demands that policymakers make on the usability of knowledge, it often fails to make a convincing response to policymakers' need to base their decisions on knowledge that is considered objective. Therefore, Mode 1 remains attractive to policymakers, even when it has received considerable—some say even destructive—critiques (Balconi et al. 2010). The linearity that is at the basis of Mode 1 supports maintaining the separation of science from policy so that science can be isolated from too high levels of politicization (Metze and Turnhout 2014; Valente 2014) and thus provides what on the face of it appears as objective knowledge on which decisions can be built (Van den Hove 2007; Metze and Turnhout 2014). Policymakers consider this objective knowledge as difficult to be undermined by other parties and therefore a good basis for legitimation of their policy decisions. As long as societal discourse on the role of science in society supports the linear model, the perception of policymakers is that quality and credibility of knowledge remain strongly tied to Mode 1 science-policy relations, even when Mode 2 may offer a type of quality that is more socially robust.

In the end, the choice for one or another science-policy model depends on the context of the policy case and the particular usability criteria that are deemed important in those contexts. In that weighing of criteria, trade-offs appear to be inevitable. Policymakers are often seen to place most value on relevance and quality of knowledge. While limiting knowledge production to Mode 1 alone decreases production of knowledge that is relevant, balancing trade-offs between relevance and quality can also imply tradeoffs between different modes of science-policy relations. Thus, a trade-off between Mode 1 preferences for 'objective' quality and Mode 2 preferences for relevance and robustness may be observed.

Today, most scholars take a normative position that advocates for a shift from the 'traditional' Mode 1 to a 'modern' Mode 2 in order to align knowledge supply with demand and to improve democratic processes. While this position is understandable from an ethical point of view, a more realistic perspective is that Mode 2 will not replace Mode 1 but more likely work in tandem with it (Gibbons et al. 1994; Kazancigil 1998). Policymakers are willing to use both science-policy models to tailor knowledge production processes to their demands for knowledge, making Mode 1 here to stay for at least a little while longer.

Note

1. National Strategic Plan 2007–13: this is an official document prepared according to the Council Regulation 1698/2005 on support for rural development. This document embraces the rural development perspective of 2007–13 and was necessary to be prepared and submitted to the European Commission for acceptance. Only after approval of this document, the Rural Development Programme 2007–13 for Poland could be submitted to the European Commission.

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Annex 1

List of interviews

- 7 interviews with seven different policy officers involved in the implementation of rural development policy, Ministry of Agriculture and Rural Development, Warsaw, Poland, April 2007.
- 1 interview with a policy officer involved in the Nitrates Directive implementation, Ministry of Agriculture and Rural Development, Warsaw, Poland, December 2008.
- 1 interview with two regional policy officers responsible for Nitrates Directive in their region, Regional Water Management Authority, Poznań, Poland, December 2008.
- 1 interviews with two regional policy officers responsible for monitoring of waters at the national level, preparing monitoring network for the Nitrates Directive, commenting on national reports of Nitrates Directive implementation, Chief Inspectorate for Environmental Protection, Warsaw, Poland, January 2009.
- 1 interview with two regional policy officers responsible for Nitrates Directive in their region, Regional Water Management Authority, Warsaw, Poland, April 2009.
- 2 interviews with a policy officer involved in the Nitrates Directive implementation and rural development policy, Ministry of Agriculture and Rural Development, Warsaw Poland, April 2010 and December 2016.
- 1 interview with a policy officer responsible for national coordination of the Nitrates Directive, National Water Management Authority, Warsaw, Poland, May 2010.
- 1 interview with a policy officer involved in the Nitrates Directive implementation, Ministry of Agriculture and Rural Development, Warsaw, Poland, September 2016.