NERC Open Research Archive sharing our research

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Article (refereed) - postprint

Carmen, Esther; Nesshöver, Carsten; Saarikoski, Heli; Vandewalle, Marie; Watt, Allan; Wittmer, Heidi; Young, Juliette. 2015. **Creating a biodiversity science community: experiences from a European Network of Knowledge.**

Crown copyright © 2015
This manuscript version is made available under the CC-BY-NC-ND 4.0 license http://creativecommons.org/licenses/by-nc-nd/4.0/

This version available http://nora.nerc.ac.uk/510619/

NERC has developed NORA to enable users to access research outputs wholly or partially funded by NERC. Copyright and other rights for material on this site are retained by the rights owners. Users should read the terms and conditions of use of this material at http://nora.nerc.ac.uk/policies.html#access

NOTICE: this is the author's version of a work that was accepted for publication in *Environmental Science & Policy*. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in *Environmental Science & Policy* (2015), 54. 497-504. 10.1016/j.envsci.2015.03.014

www.elsevier.com/

Contact CEH NORA team at
noraceh@ceh.ac.uk

The NERC and CEH trademarks and logos ('the Trademarks') are registered trademarks of NERC in the UK and other countries, and may not be used without the prior written consent of the Trademark owner.

Creating a biodiversity science community: Experiences from a European Network of Knowledge

Esther Carmen[1]

NERC Centre for Ecology and Hydrology, Edinburgh, UK

Carsten Nesshöver

UFZ Helmholtz Centre for Environmental Research, Department for Conservation Biology, Leipzig, Germany

Heli Saarikoski

SYKE, Helsinki, Finland

Marie Vandewalle

UFZ Helmholtz Centre for Environmental Research, Department for Conservation Biology, Leipzig, Germany

Allan Watt

NERC Centre for Ecology and Hydrology, Edinburgh, UK

Heidi Wittmer

UFZ Helmholtz Centre for Environmental Research, Department for Environmental Politics, Leipzig, Germany

Juliette Young

NERC Centre for Ecology and Hydrology, Edinburgh, UK

Keywords: Science-policy interfaces, European research, biodiversity, IPBES, Network of Knowledge

[1] Corresponding author: Esther Carmen, NERC Centre for Ecology and Hydrology, Bush Estate, Edinburgh EH26 0QB, UK, esther.carmen78@yahoo.co.uk

Highlights

- Evaluation of an initiative to bring together knowledge to inform decision making
- Identifies challenges and tangible options for improvement
- Benefits from broadening and organising knowledge communities are recognised
- Coordinated action, new methods and behaviour change is required
- Facilitating knowledge exchange can build capacity to bring knowledge together

Abstract

As biodiversity continues to decline despite our increased knowledge of the drivers and consequences of biodiversity loss, much of the current focus is on strengthening interfaces between biodiversity knowledge and policy-making. While many of the challenges associated with science-policy interfaces are well known, what is less well studied is the more specific issue of how to integrate the broad range of knowledge relating to complex issues such as biodiversity and ecosystem services, to inform decision-making at regional and global scales. Based on a formative evaluation of the development of a European Network of Knowledge on biodiversity and ecosystem services, we identify key themes to build a broad biodiversity science community capable of developing integrated knowledge to inform decision-making. Based on these findings we outline future steps for the successful integration of knowledge in decision-making at the European, and also the global scale, in particular the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES).

Introduction

Our understanding of the causes and consequences of biodiversity loss has greatly increased but despite this biodiversity has continued to decline (GBO3 2010, Liu et al. 2011) resulting in the recognition that new approaches are needed (Butchart, Walpole et al. 2010).

Many of these approaches have focussed on the apparent disconnect between science, decision-making, and sustainable management, but often continue to follow the 'linear model' of transferring facts to solve problems as perceived by policy-makers (Young et al., 2014). Such a model has a number of drawbacks, including potential mismatches with user needs or concerns, ill-adapted or untimely communication means and lack of engagement of key knowledge holders (Vogel et al. 2007, Young et al., 2014, van den Hove, 2007). The model fails to realistically capture the complexity of both science and policy, ignoring the socially constructed nature of knowledge (Cash et al. 2006).

Complex and broad issues around biodiversity encompass a wide range of values and knowledge (Young et al., 2014), which can make understanding and two-way communication problematic (Rothman et al. 2009) and are unlikely to lead to simple 'solutions' (Laurance et al. 2012, Pielke 2007, Stirling 2010).

The recognition of the complexities of both science and policy processes, and the challenges associated with the linear model have led to an increasing focus on strengthening interfaces between science, policy and society involving a process of knowledge sharing and co-production for mutual benefit (Spierenburg 2012, van den Hove 2007, Young et al. 2014, Fazey et al 2012). One key part of this process involves bringing together different knowledge types and forming a broad knowledge community. Integrating this social dimension of biodiversity has the aim not only of better informing decision-making (Adams and Sandbrook 2013) but importantly of initiating changes in behaviours (Sarrki et al. 2013). This has been the backdrop for the development of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Koetz et al. 2012), which was created in 2013.

The broad challenges of science-policy interfaces are well understood, as are issues over the institutional design of intergovernmental science-policy initiatives such as IPBES (Vohland et al. 2011, Koetz et al. 2012). However, what is less well studied is the more specific issue of how to best bring together relevant knowledge types to develop more joined-up large-scale approaches involving a process of coproduction with the aim of informing decision making on biodiversity and ecosystem services.

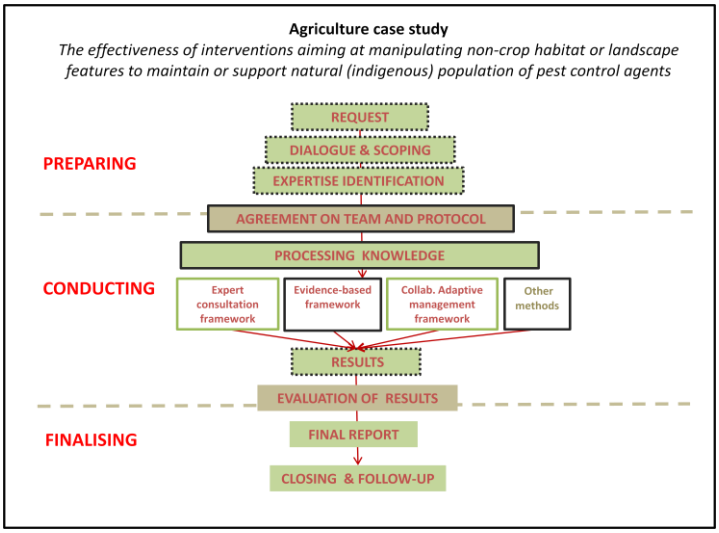
The concept for a Network of Knowledge (NoK) was outlined in an interactive workshop in May 2009 involving 80 experts from across Europe (EPBRS 2009), which led to the development of a proposal to the European Commission to explore turning this concept into practice. Building on existing knowledge transfer structures the NoK aimed at developing a joint community of interest and facilitating the interaction between knowledge holders and knowledge users by establishing transparent and rigorous procedures to bring together and organise knowledge whilst balancing the need for credibility, relevance and legitimacy (CRELE) (Cash et al. 2003, Sarkki et al. 2013). Led by a consortium of researchers involved in major networks of biodiversity expertise in Europe and with wide experience in interdisciplinary biodiversity research and science-policy interface work on the national, European and international scale, in 2011 a pilot European Network of Knowledge (NoK) on biodiversity and ecosystem services was developed and tested. The aim of this was to bring together all relevant forms of knowledge to answer specific questions jointly formulated with decision makers and other knowledge users. This involved a two-way, open consultation with a range of knowledge

holders and knowledge users from across Europe encompassing research institutions, existing networks, practitioners and decision makers from different governance levels. Although peer reviewed science was recognised by participants of the NoK as a key knowledge source, biodiversity knowledge was defined more broadly, involving knowledge from a wide range of sources including field, local and indigenous knowledge, grey literature and knowledge in languages other than English (KNEU consortium 2014). Thus, a key part of developing the NoK was the ability to bring together the diversity of actors holding and using knowledge on biodiversity and ecosystem services.

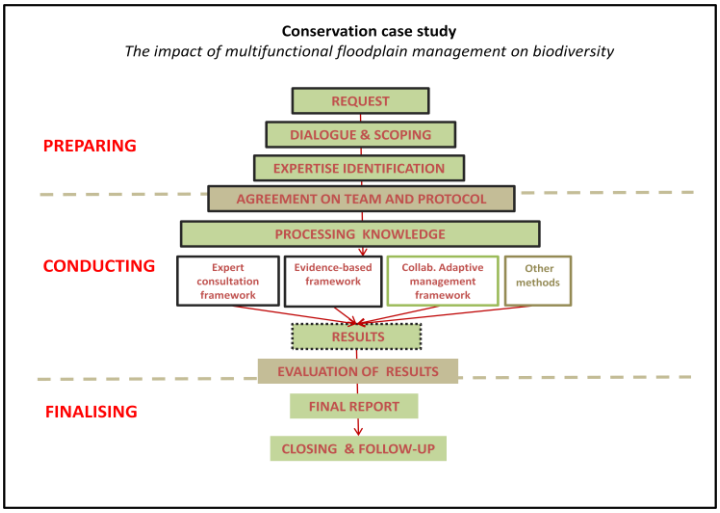
Through a series of participatory workshops the NoK developed a procedure to respond to requests for knowledge that included three key phases: preparing, conducting and finalising (see Figure 1 below). The preparing phase involved a dialogue and scoping process between the decision maker requesting knowledge from the NoK (the requester) and knowledge holders to define the requester's needs and identify appropriate methods to respond to these needs – this phase aimed to increase the relevance of the question, methodology and subsequent response. The conducting phase involved the establishment of an ad-hoc working group made up of experts based on the methods chosen and the expertise needs identified. The role of this group was to gather, evaluate and use the knowledge available from a range of sources to meet the needs of the requester – this phase aimed to increase the credibility and legitimacy of the knowledge produced. The finalising phase involved a review process by a broad range of both knowledge holders and knowledge users to ensure the outputs were of sufficient quality, relevance and understandable by all concerned – this final phase aimed to strengthen the relevance and credibility of the NoK outputs.

The NoK tested the above procedure using three case studies initiated and designed by the coordinators to assess different components of the NoK. The 'conservation' case study had a policy requester and focused on a policy driven issue, whilst the 'marine' case study was science driven, and the 'agriculture' case study had a mixture of both. In practice each one tested different parts of the NoK, with different people from different fields of expertise involved and different methods applied. The phases developed for the Nok and the different components of the NoK tested in the three case studies are outlined in figure 1 below.

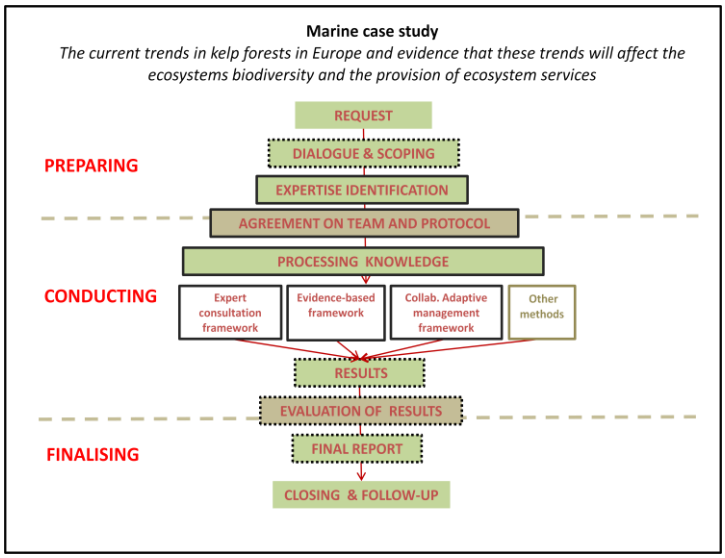
Figure 1: Phases developed and tested to conduct a detailed knowledge analysis for policy requests



113



114



115

Key: Tested | Partially tested

116

The process of developing and testing the NoK was accompanied by a formative evaluation of the case study processes and outcomes, as well as the general NoK process. A formative evaluation differs from other types of evaluation in so far as it involves an ongoing process of evaluation during the development of a programme or intervention. Whereas summative evaluations examine effectiveness against stated objectives and are therefore conclusion orientated, formative evaluations focus on improvement and are action orientated. The formative evaluation approach is helpful to clarify goals, understand the nature of implementation processes and how they come together in practice and identify outputs and outcomes from the process (Clarke and Dawson 1999). This enabled an iterative, dynamic approach with information feeding back in to directly contribute to the development of the NoK and build a more robust, practical process. The aim of the evaluation was to carry out i) an assessment of the process of setting up a NoK; ii) an evaluation of the process of carrying out case studies; iii) an evaluation of the outputs and outcomes of the case studies and iv) a detailed analysis of the difficulties encountered and how they were overcome. With this study, we aimed to support the development of the NoK, but also to further specify the challenges of SPIs on biodiversity and ecosystem services and other complex topics. The results of this formative evaluation, following a brief explanation of the methods used, are presented here. This empirical evidence highlights key themes for bringing together and transmitting existing knowledge into decision-making processes.

Materials and methods

As highlighted in the introduction, while the NoK had the overall aim of improving the science-policy interface on biodiversity and ecosystem services, the key objective within this aim was to better bring together a range of relevant knowledge, or in other words a range of different actors holding and using knowledge across Europe. Specifically, the development of the NoK was responding to a current lack of an inclusive enabling environment of better structured interactions that acknowledges the roles of existing knowledge holders in biodiversity science-policy interface across Europe (KNEU Consortium 2014). The focus of this evaluation therefore was the ability to bring together different actors and their knowledge, as a key factor towards strengthening science policy interfaces. The literature best suited to provide the most relevant theoretical framework for the evaluation was therefore based on criteria from the literature on public participation and stakeholder engagement in the field of environmental management (Rowe and Frewer 2000, Beierle and Konisky 2001) (see Table 2) which recognises the inseparable link between people and knowledge (Fazey et al 2012). This formed a baseline to evaluate who was engaged in the NoK, how

150 they were engaged (in terms of integrating knowledge), and the social and environmental outcomes
151 of their engagement.
152 The main method of data gathering was 75 semi-structured interviews (Table 1) guided by, but not
153 restricted to, the evaluation criteria. Interviewees were selected to include participants in the
154 project who were involved in developing and/or testing the process and participants who advised or
155 actively contributed to the process, from different areas of expertise, professions and from different
156 geographic locations in order to capture a wide range of perspectives and opinions on the process.
157 The testing of the NoK in the three case studies predominantly focused on different aspects of the
158 preparing and conducting phases of the NoK, with only the conservation case study examining a
159 policy driven issue with a specific requester from the policy community. A number of interviewees
160 were able to provide both a knowledge holder and user perspective, for example participants with a
161 background working in or with policy communities. Informed consent was obtained prior to data
162 collection and confidentiality was emphasized and maintained throughout data analysis to help
163 encourage participants to openly share their views with the interviewer. This included consent to
164 record interviews for transcription, keeping interviewer-related error to a minimum (Bryman 2004).
165 Focus groups were used during the later phases of the evaluation involving new and existing
166 participants in the evaluation from the marine and conservation case study expert groups to explore
167 in more depth some issues which had been raised earlier in the evaluation (Burnham et al. 2004) and
168 included a process of respondent validation on initial findings (Bryman 2004). This combination of
169 methods was complementary (Arksey and Knight 1999) and provided a depth of understanding
170 through contextual accounts from different people within the situation being evaluated (Rubin and
171 Ruben 2005).

172

173 **Table 1.** Number of interviews conducted in each phase of the evaluation

Evaluation phase	**Phase timing**	**Code**	**Number of evaluation participants**	**Perspective**	**Total**
Developing the NoK	15th March 2012 – 2nd July 2012	P1.1 – P1.24	2	Central European development workshop	24
			4	Northern European	

				workshop	
			1	Coordinator	
			2	Southern European workshop	
			10	Development conference	
			5	Client advisory group of potential knowledge users	
Testing the NoK	9th July 2012 – 13th March 2013	P2.1A - P2.9A (Agriculture case)	8	Case study expert group	36
			1	Coordinator	
		P2.1C – P2.13C (Conservation case)	12	Case study expert group (7 individually interviewed, 9 in focus group with 4 contributing to both)	
			1	Coordinator	
		P2.1M – P2.14M (Marine case)	12	Case study expert group (3 interviews and 9 in focus group)	
			2	Coordinators	
		P2.1N – P2.12N (Non-participants)	16	Invited to participate in expert groups but declined	16

Outputs and outcomes from the NoK	18th July 2013 – 23rd August 2013	P3.1 –P3.13	4	Conservation case study expert group	13
			1	Conservation case study requester	
			6	Coordinators	
			2	Client advisory group	
Number of participants interviewed					75*
Number of participants in focus groups					18**
Number participating in evaluation more than once					9
TOTAL NUMBER OF PARTICIPANTS IN EVALUATION					84

* 5 participated more than once (2 client advisory group members and 3 coordinators)

** 4 focus groups participants were also interviewed

Analysis of the interview transcripts was undertaken using categorical coding. This involves a uniform set of categories which are systematically and consistently used to organise the data (Mason 2002). Data were initially sorted into these categories which were based on the evaluation criteria and then further categorized into positive and negative statements based on participants' experiences (Saldana 2009) and suggestions for improvement to move beyond criticism of past efforts (Young et al. 2014). Thus, the first stage of analysis used a more deductive approach, using predefined categories to describe the data. The analytical process involved a continuous process of cross checking data with the category definitions to ensure consistency (Ritchie et al. 2003). During this analytical process it became clear that some aspects of the data related to more than one category, thus highlighting links between categories (Ritchie et al. 2003). Furthermore, some evaluation criteria were not perceived as the most important from the perspective of the interviewees and therefore some categories were not well represented in the data, for example cost effectiveness and conflict resolution. As a result criteria were grouped into themes to represent the data more accurately (Silverman 2005) and links between the themes identified to better understand connections between different components of the NoK. This more inductive approach helped move beyond descriptions of the data towards a more theoretical understanding of the data through the analytical process (Richards 2005).

Results

The themes identified in the analytical process, how they relate to the evaluation criteria (see Table 2), and the links between them are described in this section.

Table 2. Key themes grouping sets of criteria

Evaluation criteria		**Themes identified in analysis**
Representativeness	Including people from different perspectives, backgrounds and cultures	**Inclusiveness**
Conflict resolution	Addressing competing knowledge claims and factual controversies	
Openness	Discussing issues freely	**Communication**
Transparency	Understanding decision-making in the NoK	
Information flow	Providing information to participants	
Dialogue	Exchanging information between participants	
Cost effectiveness	Using resources effectively and efficiently	**Policy usability**
Quality assurance	Ensuring accuracy, validity and reliability	
Policy usability	Meeting the needs of the requester	
Influence	Contributing to decision-making in the NoK	
Self organisation	Allowing participants to decide how to contribute	**Capacity-building**
Capacity building	Facilitating learning, changes in attitudes, behaviours and actions	

Inclusiveness

The first theme highlighted in the evaluation was the degree to which different groups were included in the planning and implementation of the NoK. Interviewees acknowledged that biodiversity-related scientists were well represented in all aspects of the design and testing of the NoK. Social scientists and practitioners, particularly those working on science, policy and society interfaces were identified by interviewees as key for designing and implementing processes to organise and transfer knowledge through a NoK. Interviewees also considered the involvement of people working closely with or within policy communities as important in better understanding policy needs, highlighting a link between inclusiveness and policy usability themes. Skills such as effective communication, facilitation and negotiation were highlighted as vital to coordinate the interactions between groups of scientists, practitioners and policy makers in the process. Ensuring the inclusion of groups beyond the scientific community was seen by one interviewee as "quite [the] opposite of the usual 'ivory tower' of scientists" (P1.6). Although these different groups were perceived to bring with them different, but valuable, sources of knowledge interviewees sometimes felt unable to contribute their knowledge as one practitioner commented that he "could tell the moment I raised it [an issue in the question being asked] we were too far down the line [...] it was a waste of time [...] it was a frustration" (P2.1A). Furthermore interviewees perceived that peer reviewed knowledge was favoured over other forms of knowledge. This led one practitioner to comment that "one thing that perhaps slightly irritated me was [...] there is a huge amount of knowledge that is held by agencies and government departments, NGOs [...] but that side of it seemed to be largely ignored [...] and more emphasis was put on the value of academic papers as providing the ultimate reference point" (P2.3A). Interviewees criticised a lack of awareness in the NoK of methods and techniques to use different types of knowledge, such as local, traditional and indigenous knowledge, as well as scientific knowledge. This was perceived by interviewees as potentially resulting in a continuation of attitudes of a hierarchy between groups and knowledge types. However, when other groups, expertise, skills, knowledge sources and perspectives were included in the NoK this was seen by many interviewees as facilitating more holistic information flowing from the NoK to policy but also to feed into the NoK. Furthermore, interviewees highlighted that greater representation of views and opinions could reduce the likelihood of conflicts and knowledge disputes. Indeed, one researcher commented that discussions involving a range of perspectives really "made everybody rethink their point of view and [the outcome] really made sense" (P2.4A). Interviewees therefore recognised the added value of bringing together different knowledge holders and knowledge types, however some interviewees felt frustrated that the NoK did not always achieve this in practice.

To bring these groups together effectively, interviewees acknowledged the importance of understanding their motivations to be involved in the NoK. This understanding was particularly important as engagement in the NoK, as in many other such initiatives, relied on non-financial incentives. The evaluation revealed that motivations were not uniform between or within groups. For example, although increasing the number of publications was a strong motivation for some scientists, it was not the only motivation. Participants highlighted opportunities to contribute their knowledge and work with and build new relationships with others within an interdisciplinary process as contributing to their willingness to engage. This highlights how establishing the NoK as interdisciplinary could motivate others to engage, thus helping the NoK be more inclusive as it grows. Furthermore, opportunities for skills development, gaining new technical knowledge about techniques, methodologies, stimulating new ideas and collaborations as well as being involved in a policy driven process also contributed to participants' willingness to engage. This highlights a strong link between inclusiveness and capacity building by facilitating a process of knowledge exchange with those engaged in the NoK, providing benefit at both individual and organisational levels.

Effective communication

The second theme in the evaluation was communication, both within and outside the NoK. Interviewees held very different information needs and communication styles. For example, many scientists interviewed were satisfied with the way information was presented and discussed. Some individuals entering the process, as well as some practitioners, felt more information could have been provided to help them become better informed about the NoK procedures and goals whilst avoiding assumptions about understanding of scientific processes. Specifically on the perceived level of influence by participants in the Nok, some interviewees were unable to see if or how their ideas and discussions contributed to decisions and why some decisions had been taken which, in some instances, led to a feeling of frustration and even disengagement. As a practitioner participating in a design workshop explained "the group, it was not only me [...] felt like our things are not heard so we had a bit of a struggle to get our points through" (P1.11). Interviewees highlighted facilitation skills as being important to encourage the engagement of different groups in the process, but also that communication needed to be tailored to different audiences, highlighting a link between effective communication and inclusiveness. Furthermore, a close link between clear communication and transparency was identified by interviewees, which was perceived as a key aspect of building trust to help encourage individuals to contribute and promote the NoK more widely.

Policy usability

Interviewees stressed that the policy usability of outputs required better dialogue between knowledge holders and knowledge users broadly, and more specifically a NoK dialogue with the policy-maker requesting information throughout the knowledge organising process, in the early preparing phase, but also beyond. This was perceived by interviewees as helping to understand the requester's needs, including what information they needed and how they would use it. Interviewees suggested that dialogue from the start of the process could have helped identify and frame a question from the initial request for mutual benefit, for example by using policy language and, importantly, linking biodiversity to wider socio-economic policy objectives. As one practitioner commented "you can talk about biodiversity until you're blue in the face [...] it's important to talk about biodiversity but linking it to [other issues] is crucial [for policy makers]" (P2.1A). Furthermore, interviewees stressed that requesting policy-makers may need to communicate outputs from the NoK to different types of audiences outside the biodiversity or scientific community. For example, one interviewee (a policy requester) highlighted that while scientific papers add weight to policy-makers' argumentation, papers also needed to be translated by the NoK to influence policy audiences. The same policy requester identified the need for different targeted summaries to increase the likelihood of influencing different audiences. This highlighted a link between policy usability and effective communication.

In addition to including individuals with expertise in advising policy, shortening the time for knowledge to enter decision-making processes was suggested as a factor which could attract policy makers to engage with the NoK, however this may have trade-offs in terms of cost effectiveness and quality. For example, systematic reviews were perceived by some interviewees as comparatively resource intensive but ensuring a high level of credibility. This was highlighted as important for controversial issues, but may not be necessary for less contentious issues. A strong focus on policy relevance in the NoK may help balance the need to produce quality outputs in a timely way.

Capacity building

The fourth theme identified was the degree to which capacity building, self-organisation and learning were integrated in the NoK. Individual learning was identified by interviewees not only as a key motivation for engaging with the NoK but also as an outcome of the NoK. One interviewee with a background in policy commented that "having learned these techniques, I think we [when dealing

with controversial topics] could do that much better than we did it before" (P3.10). Another scientific participant stated that "I am so positive, I was really enthusiastic after this meeting [...] for me it was new and I really like it" (P2.4A) relating specifically to engaging with local knowledge holders following discussions about this with practitioners in the NoK process. Furthermore, other interviewees highlighted that they were already using new skills, understanding and knowledge gained in other aspects of their work. This highlighted the link between inclusiveness and capacity building through knowledge exchange.

To increase the influence of the NoK to achieve its objectives, interviewees suggested that learning needed to occur at both an individual and organisational level and that information should flow between the NoK and wider audiences, making stronger use of existing networks, projects and institutions as knowledge hubs and learning from other initiatives. For example one practitioner commented that using "local knowledge and engaging the public is [...] almost standard practice [outside Europe]" P2.1A.

Changing the way things are done was perceived as requiring not just new skills and technical knowledge from beyond the traditional boundaries of the biodiversity science community but also a more general change in attitudes and behaviours. As one practitioner commented this would help "involve stakeholders completely in the process, [otherwise] you have something which is essentially flawed and top down and doesn't function" (P2.3A). This highlights the benefit of a more focused approach to knowledge exchange within the NoK to increase its capacity to bring together and organise knowledge to inform decision making but also to feed into knowledge development processes more widely.

Discussion

The European Network of Knowledge evaluated in this study had the ambitious aim of building and integrating the different forms of knowledge of a broad biodiversity community. During the formative evaluation, which examined the development and operationalisation of processes to bring together and organise this knowledge using criteria from the public participation literature, four themes were identified as being important in achieving this. These themes are summarised here and implications of our evaluation for other initiatives, for example IPBES, are identified.

Inclusiveness was perceived by interviewees as closely related to credibility and legitimacy by providing skills and knowledge to better understand and examine an issue and allowing diverging knowledge claims to be explored, thereby reducing the potential for later disputes and

controversies. This may be particularly important in a complex policy setting such as biodiversity issues, where a range of different policy sectors may be involved, often with different priorities. The limitations of a narrow focus on what counts as 'valid' and therefore relevant knowledge is also being emphasised in the debates about the development of IPBES. This is also identified as a one of the lessons to learn from the IPCC in so far as this may overshadow the importance of including other knowledge holders and in turn undermine the potential for innovation and spurring action more widely (Turnhout et al 2012). As this evaluation highlights, achieving this in practice requires an understanding of the different motivations to engage different knowledge holders and users from the start to frame questions and establish a process of co-production which delivers mutual benefit. This would help develop practices which demonstrate equitable value of different forms of knowledge and facilitate knowledge sharing more widely (Fazey et al 2012).

Closely linked to inclusiveness was effective communication, ideally working with communication specialists, to build legitimacy not only by bringing in and retaining knowledge holders (Rowe and Frewer 2005) by being open and transparent but also communicating outputs of knowledge gathering processes to groups with different information needs and communication styles (Young et al. 2014). This requires an understanding of relevant knowledge holders' and users' information needs and communication styles, and a long-term, adaptive, communication strategy. The role of facilitators was recognised by interviewees as important to help the flow of knowledge into the NoK and is also recognised as a key component in participatory dialogue more widely (Fazey et al 2012). The need to focus on policy usability from the very start of and throughout the process also requires regular dialogue with the requesting policy maker. Policy usability therefore links with the need for effective, targeted two way communication and inclusiveness and together these were important factors identified by interviewees in ensuring the policy relevance of questions, methods used and subsequent response. The inclusion of participants with an understanding of policy needs may help avoid 'drift' from developing policy usable outputs, whilst avoiding the process becoming policy prescriptive, highlighted as a concern relating to IPBES (Vohland et al 2011). A key factor in achieving policy relevance is linking the issue to wider policy issues when scoping the questions to be addressed, and using language adapted to policy audiences. Meeting the needs of policy requests aligns closely with the general ideas of trans-disciplinary research with its continuous exchange between science and society/policy and joint framing of issues throughout the research process (Jahn et al. 2012, Young et al. 2014).

The need for capacity building as a central component of a NoK was identified by interviewees as contributing directly to the credibility and legitimacy of the NoK processes, but requires resources in

terms of time and effort (Neßhöver et al. 2013). Individual learning through a process of knowledge exchange with others involved in the process enabled some participants to better engage with wider knowledge holders and users in other aspects of their work. Furthermore, by exploring the different motivations of participants through the evaluation this close link between inclusiveness and capacity building was also highlighted, for example the motivation to contribute and gain knowledge and skills by engaging in the NoK. This highlights the potential benefit of developing a core focus on capacity building for the NoK to facilitate the incorporation of new ideas into future activities in the NoK and more widely. Furthermore, existing behaviours and attitudes were highlighted as potential challenges for the sharing and bringing together of different forms of knowledge. This highlights a need for capacity building within science communities to help overcome an ingrained bias towards certain types of knowledge over others that may also limit the inclusiveness of a process (Adams and Sandbrook 2013). Although highlighted as a core element of IPBES (UNEP 2010), capacity building as a process of improvement has received only limited discussion so far in the literature (Koetz et al 2012) and even less attention as a desirable outcome by participants engaging in science-policy interface activities.

The four themes identified as being important in building the NoK to better integrate different forms of knowledge were found to be closely interlinked, and were also closely linked to the credibility, relevance and legitimacy (CRELE) attributes identified by Cash et al (2003) and which have been used to examine science-policy interfaces more broadly (e.g. the IPBES, see Koetz et al 2012).

We identified many inter-linkages between our four themes and CRELE attributes. For example, improvements in one area communication is likely to have positive repercussions in terms of policy usability and inclusiveness and wider progress towards developing credible, relevant and legitimate processes, outputs and outcomes. These inter-linkages with CRELE also highlight potential trade-offs, as highlighted by Sarkki et al. (2013). For example, a policy request may need to be tackled quickly in order to ensure relevance and this may attract policy makers to engage with the NoK, but this may have trade-offs with quality and therefore jeopardise credibility. Within the NoK the level of detail required, time and amount of existing knowledge available (from anecdotal, expert-based knowledge to a large number of detailed data-based studies) will vary between requests. Thus, for example, focusing on policy usability may help achieve a balance with the degree of inclusiveness of knowledge and communication needed to meet the NoK's objectives. Flexibility and iterativity (Sarkki et al. 2013) should therefore be a key part of the NoK to improve the capacity of the NoK to adapt practices in a continuous process of improvement to manage these trade-offs. This would

also help develop a keen focus on processes to improve the credibility, relevance and legitimacy of a NoK and thus facilitate more effective outputs and outcomes.

We argue that merging and clustering the evaluation themes in this study with the CRELE attributes can contribute towards applying CRELE in practice to help strengthen science-policy initiatives more widely by highlighting the advantages of defining knowledge more broadly. As this evaluation highlights a focus on the public participation literature as a theoretical starting point was helpful to develop a better understanding of inclusive science-policy initiatives. Drawing on participation theory to select evaluation criteria enabled an in depth examination of key aspects (or themes) of the NoK linked to broader attributes for effective science policy initiatives, particularly legitimacy and credibility. Recent debates surrounding the development of IPBES are highlighting challenges for developing more inclusive processes, requiring coordinated action and flexibility to avoid undermining the credibility, relevance and legitimacy of this newly emerging institution (Hotes and Opgenoorth 2014, Turnhout et al. 2012). The key themes identified in this evaluation from public participation criteria further emphasise the interconnection between people and knowledge which is central for such science policy initiatives. Linking these themes with CRELE explicitly highlights how action to more broadly involve people and knowledge can contribute to strengthening these initiatives more widely.

Whilst we started from the public participation criteria to identify themes that could then be linked to CRELE attributes, we argue that in future evaluations it might be more helpful to develop a framework based on the four themes identified here (each of which are linked to CRELE attributes) and then breaking them up into criteria from the public participation literature. Firstly, inclusiveness, mainly linked to credibility and legitimacy, encompasses the two public participation criteria; representation, which relates to people, knowledge and skills; and conflict resolution, relating to how well discrepancies and controversies are addressed, for example from different knowledge sources. Secondly, communication, mainly linked to credibility, encompasses three public participation criteria; transparency; openness; and the multi-directional flow of information between all relevant actors, which merges information flow and dialogue from the original criteria. Thirdly, policy usability, mainly linked to relevance, encompasses three public participation criteria; effectiveness, including timeliness and cost; assuring and demonstrating quality; and policy specificity, which involves understanding the needs of policy makers and adapting the process and outputs for this purpose. As highlighted in both the introduction and methods, there was a greater focus in the NoK and the testing of the NoK on organising and collating knowledge rather than the subsequent use of knowledge – hence more of a focus on legitimacy and credibility than relevance.

However, whilst not tested in the NoK, and therefore impossible to evaluate in our study, we would argue that the criteria of conflict resolution, quality assurance, cost effectiveness and influence (all of which we found to be closely aligned with relevance) can and should help guide deeper examination relating to the exchange of knowledge with decision makers. Indeed, all but cost effectiveness were identified as contributing to the legitimacy of the NoK. Finally, capacity building, which is mainly linked to credibility and legitimacy, involves identifying and addressing gaps between aims and practice both structurally at the institutional level but also with actions and behaviours to facilitate better social interactions and flow of knowledge between relevant actors. Learning and self organisation to help harness the knowledge and skills of those involved in the NoK is an important part of this framework but a focus on institutional and individual learning and the interplay between these two levels is crucial. Policy influence also relates to capacity building, as knowledge flows into decision making processes and decision makers incorporate this knowledge into their activities, including engaging in future knowledge coproduction initiatives. However, decision making processes are dynamic and complex, involving knowledge coming together from different sources (Freeman 2011). Thus, arguably policy influence could potentially also be examined (as a theme/ criteria) in its own right as the flow of knowledge within and from decision making processes.

Evaluations such as the one described in this paper, and our new proposed framework for future evaluations can help develop a greater understanding of the implications of design options (Chilvers and Evans 2009) and highlight some tangible areas to focus resources to strengthen the credibility, legitimacy and relevance of science policy interface processes and outputs.

This formative evaluation has moved beyond the theoretical (Mascia et al. 2003, Fox et al. 2006) by examining some of the issues in practice which are also being raised in discussion surrounding the development of IPBES. By examining practice this evaluation highlights manageable entry points to develop the capacity of knowledge-policy interfaces for the benefit of both knowledge holders and knowledge users (Koetz et al. 2012). Specifically, this study provides evidence of the importance and practice of capacity-building not only within the decision-making processes but also within science communities (Vohland et al. 2011), as well as the need to acknowledge inter-linkages with other key elements, and the need for in-built flexibility and iterativity.

Conclusion

This evaluation has highlighted key elements, namely inclusiveness, communication, policy usability and capacity-building, needed to integrate the broad range of knowledge and values inherent in

complex issues linked to biodiversity and ecosystem services. Our evaluation highlights that developing processes to bring together and organise different knowledge types to meet the needs of decision makers is important but insufficient on its own for creating effective science-policy initiatives. Indeed, the most important finding of the formative evaluation was the acknowledgement and enthusiasm from participants of the importance of achieving this aim of bringing together different forms of knowledge and continuing to build the biodiversity community in the future. Bringing together knowledge and skills beyond the traditional boundaries of biodiversity science may be a valuable step to better reflect our existing knowledge on complex issues related to biodiversity and ecosystem services (Spierenburg 2012) and to address the wider needs of pluralist decision-making processes (Ehrlich and Pringle 2008). The plethora of scientific knowledge on Europe's biodiversity compared with many other regions of the world (Liu et al. 2011) may be a particularly challenging landscape in which to build a wider community of biodiversity knowledge, but also provides a range of opportunities, both of which may be addressed by a Network of Knowledge approach.

A continued and effective Network of Knowledge will need to be sustained by understanding and realising the motivations of knowledge users and holders within the biodiversity community, by providing tangible opportunities (or requests) for their engagement with the policy community and building in flexibility to develop their strengths and manage trade-offs. However, commitment by policy communities and resources, which are as yet undecided, will ultimately determine the ongoing success of a European Network of Knowledge.

Acknowledgements

This work was funded by the EU's Framework Programme 7, project KNEU: Developing a knowledge network for European expertise on biodiversity and ecosystem services to inform policy making economic sectors, contract number 265299. We thank two anonymous reviews for their insightful and constructive contributions and the interviewees and participants to the KNEU project for their willingness to share information and views on the project. More information on this project can be found at http://www.biodiversityknowledge.eu/documents.

References

Adams, W. M., C Sandbrook. 2013. Conservation, evidence and policy. Oryx 47/03: 329-335.

491 Arksey, H., P. Knight. 1999. Why Interview? Interviewing for social scientists: an introductory
492 resource with examples. London. Sage.

493 Beierle, T. C., D. M. Konisky. 2001. What are we gaining from stakeholder involvement? Observations
494 from environmental planning in the Great Lakes. *Environment and Planning* 19/4: 515-528.

495 Bryman, A. 2004. Social Research Methods. Oxford/ New York. Oxford University Press.

496 Burnham, P., K. Gilland, W. Grant, Z. Layton-Henry. 2004. Research Methods in Politics. New York.
497 Palgrave Macmillan.

498 Butchart, S. H. M. et al. 2010. Global Biodiversity: Indicators of Recent Declines. *Science* 328/5982:
499 1164-1168.

500 Cash, D. W. et al. 2003. Knowledge systems for sustainable development. *Proceedings of the*
501 *National Academy of Sciences of the United States of America* 100/14: 8086-8091.

502 Chilvers, J., J. Evans. 2009. Understanding networks at the science-policy interface. *Geoforum* 40/3:
503 355-362.

504 Clarke, A., Dawson, R. 1999. Evaluation Research: An introduction to principles, methods and
505 practice. London/ Thousand Oaks/ New Delhi. Sage Publications.

506 Ehrlich, P. R., R. M. Pringle. 2008. Where does biodiversity go from here? A grim business-as-usual
507 forecast and a hopeful portfolio of partial solutions. *Proceedings of the National Academy of*
508 *Sciences of the United States of America* 105: 11579-11586.

509 EPBRS. 2009. Concept note on a Network of Knowledge for biodiversity governance.- EPBRS
510 September 2009.
511 European Commission. 2014. General Union Environment Action Programme to 2020 - Living well,
512 within the limits of our planet. Luxembourg : Publications Office of the European Union. 87 pp.
513 doi:10.2779/66315

514 Fazey, I., et al. 2012. Knowledge exchange: a review of research agenda for environmental
515 management. *Environmental Conservation*. 40 (1): 19-36.

516 Fox, H. E., C. Christian, C. J. Nordby, O. R. W. Pergams, G. D. Peterson, C.R Pyke. 2006. Perceived
517 barriers to integrating social science and conservation. *Conservation Biology* 20/6: 1817-1820.

518 Freeman, R. 2007. Epistemological Bricolage: How Practitioners Make Sense of Learning.
519 Administration & Society. 39 (4): 476-496.

Hotes, S., L. Opgenoorth. 2014. Trust and Control at the Science-Policy-Interfaces in IPBES. *BioScience* 64/4: 277-278.

Jahn, T., M. Bergmann, F. Keil. 2012. Transdisciplinarity: Between mainstream and marginalization. *Ecological Economics* 79: 1-10.

Koetz, T., K. N. Farrell, P. Bridgewater. 2012. Building better science-policy interfaces for international environmental governance: assessing potential within the Intergovernmental Platform for Biodiversity and Ecosystem Services. *International Environmental Agreements-Politics Law and Economics* 12/1: 1-21.

KNEU consortium. 2014. A recommended design for "BiodiversityKnowledge", a Network of Knowledge to support decision making on biodiversity and ecosystem services in Europe.- accessed via www.biodiversityknowldge.eu (2014/04/24)

Laurance, W. F. et al. 2012. Averting biodiversity collapse in tropical forest protected areas. *Nature* 489: 290-294.

Liu, X. J., L. A. Zhang, S Hong. 2011. Global biodiversity research during 1900-2009: a bibliometric analysis. *Biodiversity and Conservation* 20/4: 807-826.

Mascia, M. B. et al. 2003. Editorial: Conservation and the social sciences. *Conservation Biology* 17/3: 649-650.

Mason, J. 2002. Qualitative Researching. London/ Thousand Oaks/ Singapore. Sage.

Neßhöver, C. et al. 2013. Improving the Science-Policy Interface of Biodiversity Research Projects. *GAIA* 22/2: 99-103.

Pielke, R., G Prins, S. Rayner, d. Sarewitz. 2007. Climate change 2007: lifting the taboo on adaptation. *Nature* 445/ 7128: 597-598.

Richards, L. 2005. Coding. In: *Handling qualitative data*. Edited by L. Richards. London. Sage.

Ritchie, J., L. Spencer, W. Connor. 2003. Carrying out qualitative analysis. In: *Qualitative research practice: a guide for social science students and researchers*. Edited by J. Ritchie and J. Lewis. London. Sage.

Rothman, D. S., C. Van Bers, J. Bakkes, C. Pahl-Wostl. 2009. How to make global assessments more effective: lessons from the assessment community. *Current Opinion in Environmental Sustainability* 2009/ 1: 214-218.

549 Rowe, G., L. J. Frewer. 2000. Public participation methods: A framework for evaluation. *Science,*
550 *technology and human values* 25/1: 3-29.

551 Rowe, G., L. J. Frewer. 2005. A typology of public engagement mechanisms. *Technology & Human*
552 *Values* 30/2: 251-290.

553 Saldana, J. 2009. The coding manual for qualitative researchers. London. Sage.

554 Sarkki, S., J. Niemela, R. Tinch, S. Van den Hove, A. Watt, J. Young. 2013. Balancing credibility,
555 relevance and legitimacy: A critical assessment of trade-offs in science-policy interfaces. *Science and*
556 *Public Policy* 2013: 1-13.

557 Secretariat of the Convention on Biological Diversity. 2010. Global Biodiversity Outlook 3.

558 Silverman, D. 2005. Doing qualitative Research. London/ Thousands Oaks/ New Delhi. Sage.

559 Spierenburg, M. 2012. Getting the Message Across Biodiversity Science and Policy Interfaces - A
560 Review. GAIA 21/2: 125-134.

561 Stirling, A. 2010. Keep it complex. *Nature* 468/7327: 1029-1031.

562 Turnhout, E., Bloomfield, B., Hulme, M., Vogel, J., Wynne, B. 2012. Listen to the Voices of
563 Experience. Nature. 488: 454-455.

564 UNEP. 2010. Report of the third ad hoc intergovernmental and multi-stakeholder meeting on an
565 intergovernmental science-policy platform on biodiversity and ecosystem services. UNEP/IPBES/3/3.

566 van den Hove, S. 2007. A rationale for science-policy interfaces. Futures 39/7: 807-826.

567 Vogel, C., Moser, S. C., Kasperson, R. C., Dabelko, G. D. 2007. Linking vulnerability, adaptation, and
568 resilience science to practice: Pathways, players, and partnerships. Global Environmental Change.
569 17/3: 349-364.

570 Vohland, K., M. C. Mlambo, L. D. Horta, B Jonsson, A. Paulsch, S. I. Martinez. 2011. How to ensure a
571 credible and efficient IPBES? *Environmental Science & Policy* 14/8: 1188-1194.

572 Young, J.C., et al. 2014. Improving science-policy dialogue to meet the challenges of biodiversity
573 conservation: having conversations rather than talking at one-another. *Biodiversity and Conservation*
574 23/2: 387-404.

575