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Research article

Eyes wide shut: Exploring practices of negotiated ignorance in water resources modelling and management

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ABSTRACT

Formalised methods to address uncertainty are becoming the norm in hydrological modelling, yet they remain fragmented and highly academic, thus limiting their utility for practitioners. Using a qualitative, empirical study of the PIREN-Seine program in France, this paper explores the processes behind this trend in an effort to elucidate its prevalence despite inherent limitations when applied to a decision-making context. We identify: 1/ displacement of 'uncomfortable knowledge', 2/ fragmented responsibility, 3/ confidence, and 4/ relational framing as interconnected factors, which concurrently support the production of scientific knowledge and the social construction of ignorance, whether it be wilful or intentional. We posit that ignorance is implicitly negotiated among researchers and practitioners in order to reconcile cognitive dissonance and maintain confidence, thereby allowing water managers to take action in the face of uncertainty. Finally, we put forth the notion that having our 'eyes wide shut' can be interpreted in two ways: one facilitates the normalisation of ignorance, leaving us vulnerable to unexpected surprises; the other promotes transparent and explicit communication in support of more adaptive and robust decisions.

1. Introduction

Environmental problems are rife with uncertainties, differing not only in type and source, but also their impact on subsequent decisions. In the context of model-based decision support, formalised methods exist to identify, quantify and minimise uncertainties. Yet, they remain fragmented and highly academic, leaving practitioners to discern how this information can be incorporated into sound decision-making. Researchers produce valuable knowledge that supports management and policy decisions, but tend to only focus on uncertainties associated with the model (e.g. its inputs, parameters or outputs). In the context of decision-making, however, uncertainty is also influenced by the values, interpretations and framing of individual actors (Brugnach et al., 2008; Dewulf et al., 2005) as well as the institutions they serve.

Modelling tools have the double advantage of helping scientists gain a deeper understanding of environmental processes, while at the same time, supporting management, policy and planning decisions (Argent et al., 2009; Brugnach et al., 2007; Brugnach and Pahl-Wostl, 2008; Chong et al., 2017; Liu et al., 2008); the idea being that enhanced knowledge leads to more informed decisions. In reality, the production of knowledge is not always straightforward and linear. First, scientific knowledge is not the only type of knowledge that is used in decision-making (Brugnach, 2017) and second, it often requires translation in order to be integrated into policy (Brugnach et al., 2007; Isendahl et al., 2009; Vezzaro et al., 2013). Third, new knowledge can sometimes uncover new unknowns (Walker et al., 2003) which may cast doubt on what was previously known or lead to 'uncomfortable knowledge' (Rayner, 2012). 'Uncomfortable knowledge' is what has been excluded from and/or is in tension or outright contradiction with the simplified narratives developed by individuals and institutions in order to act in a complex, dynamic world (Rayner, 2012).

Fourth, while knowledge and ignorance are often seen as polar opposites, where increasing one effectively minimises the other, many authors (e.g. McGoey, 2012; Ravetz, 1987; Rayner, 2012; Smithson, 1989) contend that ignorance is socially constructed. Acknowledging and/or disregarding certain information – whether explicitly or implicitly – to advance strategic objectives can be a way of constructing ignorance. For example, in their study of insecticides causing Colony Collapse Disorder for bees in the United States, Kleinman and Suryanarayanan (2013) illustrated how the Environmental Protection Agency used ignorance to justify not implementing regulatory measures; a decision which worked in favour of large agrochemical corporations.

In another example, Dedieu and Jouzel (2015) demonstrated how

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actors can rationalize 'uncomfortable knowledge' learned through an investigation into the direct and indirect sources of pesticide poisoning of French farmers by finding 'good reasons' to ignore it. While the flaws and limitations of their policy tools were acknowledged, the fault was ultimately attributed to victims failing to follow proper procedure, rather than questioning the adequacy of the assessment tools themselves. Similar studies (e.g. Heimer, 2012; Lohmann, 2008; Marris et al., 2014; McGoey, 2012, 2007; Stankiewicz, 2009) have highlighted factors that contribute to the social production of ignorance, but few focus attention to the unintentional production of ignorance, which may prove to be more hazardous if knowledge (and ignorance) is taken for granted.

In recent years, the relationship between science and practice has become increasingly collaborative, but significant gaps still remain. Characterised by ambiguity and complexity, these gaps create the necessary conditions for the social construction of ignorance, whether it be wilful or unintentional. This paper explores the driving forces behind the social construction of ignorance, using the empirical example of the PIREN-Seine program (Programme Interdisciplinaire de Recherche sur l'eau et l'environnement du bassin de la Seine) in France. Drawing primarily from documentary analysis and interview material, we look at the ways in which researchers and practitioners reconcile uncertainty in the context of model-based decision support. In doing so, we identify four interconnected factors, which support the social construction of ignorance. Then, we illustrate how knowledge and ignorance are produced and 'negotiated' between various actors. Negotiation occurs when shared facts and narratives are explicitly and/or more often implicitly agreed upon by mutually establishing what is *known* from what is *unknown*, as well as what is considered to be *knowable* and *unknowable*. The outcome of this negotiation is ultimately reflected by the uncertainties that are addressed (and which are not), as well as the methods used to address them, which provides insight into the prevalence of an academic-oriented approach to addressing uncertainty, despite its limitations in a decision-making context.

2. Methods and materials

A qualitative, empirical study was conducted based on Grounded Theory (GT) (Glaser et al., 1968; Strauss and Corbin, 1997). GT is a novel, iterative research methodology, characterised by the systematic collection and analysis of data led by raising generative questions to identify core theoretical concepts and develop tentative linkages. As one of the longest research programs of its kind, the PIREN-Seine (PIREN) serves as an exemplary case to explore the diversity of interactions and exchanges between researchers and practitioners, while internal interest for critical reflection of the program and its nearly 30 years of work allowed for accessibility and transparency. Documentary analysis, exploratory interviews and observations served as the basis for this study.

2.1. Documentary analysis

To provide a foundational background, we analysed relevant documents produced by the PIREN-Seine dating back to its formation in 1989. This body of literature includes hundreds of peer-reviewed journal articles and a handful of books, in addition to a wealth of grey literature (including 700+ reports, booklets, and synthesis documents), reflecting a variety of studies from different disciplines. As the borders of the PIREN are permeable, we also extended our analysis to scientific literature produced by these actors that involved modelling and included some reference to uncertainty in the context of the Seine River basin, without specifically mentioning the PIREN-Seine.

2.2. Exploratory interviews and observation

To provide further insight into how uncertainty is reconciled in practice, exploratory interviews and observation were necessary. A total of 40 semi-structured interviews lasting from 1 to 4 hours were conducted from 2015 to 2017. Interview participants included PIREN researchers from different academic disciplines and operational partners (modellers, public institutions, regulating authorities) with varying modelling expertise. A general guide (*see* Appendix A) was used to structure interviews around specific themes and questions were adapted according to the role of the participant and their relation to modelling activities. Interviews were recorded, transcribed and coded according to emergent themes, perspectives and ideas. Data gleaned from interviews were supported by observation from 2015 to 2017. This included official PIREN-Seine meetings, seminars, workshops and conferences, as well as unofficial interactions and exchanges. Notable events include three general assembly and annual planning meetings organised for researchers and operational partners to collectively reflect upon the previous years work in order to co-define future research objectives.

2.3. Modelling tools

Modelling tools underpin a large part of the work conducted by the PIREN. As water quality is its primary focus, hydrological models are the most common, though other types of models can also be found (e.g. agronomic, economic). The majority of models used and developed within this context are primarily considered to be research tools that provide indirect decision support. Therefore, only a small number were appropriated and used directly by operational partners (*see* Chong et al., 2017 for a detailed description of the different types of use and utility). Two commonly used and cited models are found in the table below (Table 1).

3. Results

Empirical data obtained from the PIREN-Seine highlights a number of key underlying processes that are involved in reconciling uncertainty in order to act or take a decision (*see* Fig. 1). The primary process is knowledge production, where facts are constructed using scientific and empirical data and shared among researchers and practitioners. This knowledge is subject to uncertainties of different types and sources, with varying impacts on subsequent decisions. When decisions or actions are based on uncertain knowledge, a secondary process of ignorance construction may occur in order to reconcile uncertainty. Embedded in this secondary process is the explicit and/or implicit negotiation of facts to build shared narratives, which simplify complex problems into ones that can be adequately managed.

The treatment of uncertainty among PIREN actors may vary depending on the individual or the institutions they serve. The most commonly used methods focus primarily on statistical uncertainty in the model inputs, parameters and outputs, while other uncertainties are rationalised as inevitable. These methods tend to be fragmented and highly academic, making it difficult to translate into information that is considered useful for practitioners. That is to say, they are typically part of scientific studies and may not be easily applicable to practice, may be too detailed or focused on uncertainties that are not directly relevant to management or planning decisions, and are not treated in a comprehensive manner that incorporates other uncertainties that practitioners must take into account. Despite the inherent limitations of an academic-oriented approach, its application to the decision-making context is

Table 1
Commonly used models within the PIREN-Seine.

Model	Type	Key References
ProSe	River quality	(Even et al., 1998; Garnier and Mouchel, 1999)
Riverstrahler/Seneque	Catchment quality	(Billen et al., 1998; Garnier and Mouchel, 1999)