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Analysis

A transdisciplinary approach to the economic analysis of the European Water Framework Directive

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ABSTRACT

The European Water Framework Directive (WFD) prescribes economic principles to achieve its ecological targets. The aim is to establish cost-effective measures to attain good ecological status and assess whether the costs of these measures are justifiable in view of the benefits they provide. The complex nature of water problems requires flexible decision-making embracing a diversity of 'knowledges'. Here, natural and social scientist worked together in an integrated approach 'ground-tested' through local stakeholders' knowledge and views. The aims were to: (1) develop a set of steps for implementing this transdisciplinary approach, and (2) critically reflect on the challenges of integrating different strands of knowledge to the specific context of the economics of the WFD. This was tested at a sub-catchment in Scotland. Hydro-chemical models were used to simulate effectiveness of phosphorous pollution mitigation measures, which was then incorporated into a cost-optimization model. Costs were compared with benefits resulting from water quality improvements. This analysis was accompanied by an iterative local stakeholder consultation process. The research further analysed whether selected measures are 'future-proof' in view of climate and land-use changes. Results are used to help set the research agenda for more practical specification of economically sound and socially acceptable ways to deliver the WFD.

1. Introduction

One of the most innovative aspects of the European Water Framework Directive (WFD) is the incorporation of economic principles and tools to support delivery of ecological targets. Amongst the various economic aspects of the WFD is the use of cost-effectiveness analysis (CEA) of mitigation measures needed to achieve the 'good ecological status' (GES) of waters. The aim is to establish the least-costly programme of measures to be included in basin management plans (Balana et al., 2011; Perni and Martinez-Paz, 2013; Skuras et al., 2014; Klauer et al., 2014a). Moreover, the WFD allows the derogation of environmental objectives if meeting them has disproportionately high costs, i.e. if the costs of the measures are higher than the resulting benefits (Martin-Ortega et al., 2014).

These principles add new challenges to the management of water resources, which is recognized to be a 'wicked problem' (von Korff et al., 2012; Patterson et al., 2013), that is: a problem for which it is impossible to define optimal solutions because of both uncertainty about present and future environmental conditions and intractable differences in social values (Shindler and Cramer, 1999). For example, addressing diffuse pollution requires implementation of actions involving multiple actors operating at multiple scales and influenced by a range of factors (Cash et al., 2006; Blackstock et al., 2012). Water management also commonly involves tensions and mismatches between spatial and temporal scales relating to environmental change, human behaviour and institutional processes (Cumming et al., 2006). The economic efficiency of the WFD's programmes of measures needs to be assessed at the river basin scale by regulatory agencies, while each specific intervention requires action at the source of the problem by those responsible (e.g. field level by farmers, household level for septic tanks, local authorities for sewage plants, etc.). In addition, there are heterogeneous perceptions between different stakeholders of what constitutes proper land-management and how it affects water quality (Christen et al., 2015). Moreover, effectiveness of measures varies over small spatial scales according to soil type, slope, management, etc., while modelling tends to take place at a catchment scale, aggregating responses throughout the catchment to an average response. Also, it is often not possible to define simple links between chemical water quality and ecological outcome, which is the key to WFD's pursuit of GES (Hering et al.,

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2010). All these elements add to the 'wickedness' of water management problems and help to explain the failure to deliver more substantive progress in the achievement of the WFD's objectives.[1] Finally, mitigation programmes created for current conditions might not be 'future-proof' against climate and land-use change, potentially making GES only a temporary occurrence.

The literature covering the development of strategies to tackle 'wicked' environmental problems points clearly to the need for interdisciplinarity and transdisciplinarity (Carew and Wickson, 2010; Brandt et al., 2013). However, to date the economic literature on the WFD has only been able to provide partial solutions from a mono-disciplinary, predominantly neoclassical perspective (Martin-Ortega, 2012). Moreover, an in-depth review of the scientific literature and policy practice on the issue of disproportionality across several countries in Europe shows that very different approaches have been taken (see Martin-Ortega et al., (2014) for a cross-country review; see also Galioto et al. (2013) for an Italian case, Jacobsen (2009) for the case of Denmark; and Klauer et al. (2014b) for a German case). A transdisciplinary approach is based on the principle that the integration of other actors in the knowledge production process, in addition to specialist scientific knowledge, results in a 'final knowledge' that is anticipated to be greater than the sum of disciplinary components (Lawrence and Després, 2004; Tress et al., 2004; Mobjörk, 2010). The principle is that the complex and dynamic nature of such environmental problems requires flexible decision-making, embracing a diversity of 'knowledges' and values (Reed, 2008; Blackstock et al., 2012).

The present paper represents a practical example of how to operationalize this transdisciplinary approach to meeting WFD targets, integrating hydrological and economic modelling informed, 'ground-tested' and shaped by stakeholders' knowledge, views and perceptions. This approach was tested at the sub-catchment level in Scotland through analysis of measures to mitigate rural diffuse pollution (phosphorus) under current and future climate conditions and land use. The aims were to: (1) develop a set of steps for implementing this transdisciplinary approach to meeting WFD objectives, and (2) critically reflect on the opportunities and limitations of integrating different strands of knowledge to the specific context of the economic analysis of the WFD. This represents a new angle on the economic analysis of the WFD proposed so far (Martin-Ortega, 2012). Results are used to help set the research agenda for devising a more realistic, economically sound and socially acceptable specification of management options to deliver WFD compliance under current and future conditions.

2. Case Study

The transdisciplinary approach was tested in the Skene catchment, a sub-catchment of the River Dee in the north-east of Scotland. The sub-catchment lies 13 km west of the City of Aberdeen and covers an area of 48.3 km^2 (Fig. 1). It is a rural, predominantly agricultural area, dominated by a single large, privately-owned estate, a characteristic land-holding and management system in Scotland (cf. McKee et al., 2013). The catchment drains into the Loch of Skene, a shallow lake (known as a loch in Scotland) with an area of 1.1 km^2. The loch is an important site for overwintering wildfowl and, as a consequence, is designated as a Site of Special Scientific Interest (SSSI), a Special Protected Area (SPA) and a Ramsar Site. The loch is used for recreational sailing between April and June; thereafter poor water quality (eutrophication) prevents further use. The principal feeder stream is the Corskie Burn, which drains three quarters of the loch's catchment (34 km^2) and receives effluent from the two sewage treatment works present in the catchment. It is also the only tributary to the loch for which monitoring data (chemistry and discharge) are available.

The Skene sub-catchment is part of the area covered by the Dee Catchment Partnership,[2] a body that has been working since 2003 to protect, enhance and restore the waters of the River Dee catchment. This independent and voluntary partnership of local stakeholders and interested organisations has sought to develop a consensual and informed approach to water management. Around 20 organisations are involved, working towards the delivery of an agreed Catchment Management Plan (Cooksley, 2007).

3. Methodology

Hydro-chemical models were used to simulate sub-catchment scale effectiveness of a selection of measures for improving water quality. Results were then incorporated into a cost-optimization model, which allowed the ranking of measures according to their cost-effectiveness ratio to achieve pre-established targets of water quality improvement. These costs were then compared to the benefits resulting from the achievement of good ecological status, elicited in an existing stated preference survey. This analysis was accompanied and sustained from the outset by an iterative consultation process with local stakeholders, whose inputs fed into the design of the analysis and also offered a way of comparing scientific results with local perceptions. The aim of the stakeholder engagement was not to substitute scientific knowledge with lay knowledge, but to gather understanding on their perceptions and practices that are otherwise unknown or inaccessible and, further, to anticipate that reality may depart from conventional model predictions. In other words, stakeholder engagement aimed to increase the reliability of the models and make outputs more realistic. Each of the individual methodological steps (Section 3.1) has its own limitations, due to different factors such as lack of data, budget restrictions and modelling capacity. However, the contribution of this research is the focus on the integration process, rather than each of the individual steps, and the reflection on the challenges that need to be addressed if scientific results are to inform policy.

3.1. Methodological Sequence

Fig. 2 depicts the methodological steps followed in this research. The baseline year for the analysis was 2007 and three time horizons were used for the analysis of disproportionality, coinciding with the three planning cycles imposed by the WFD (2015, 2021 and 2027). The climate and land use change scenario analyses were based on projections to 2050.

3.2. Step 1: Identify Pressures, Mitigation Measures and Water Quality Targets

Pressures on water quality in the study sub-catchment were identified based on previous work in the area (Balana et al., 2010). These were then presented to local stakeholders in a workshop (see Section 3.2 for details on the stakeholders involved and on the stakeholder engagement process). A participatory discussion explored whether the pressures and sources were identified accurately according to local knowledge and whether stakeholders considered any important pressure or source to be missing from the proposed list. Workshop participants were then asked to suggest locally relevant potential measures that could be used to address those pressures.

Of the key pressures identified, phosphorus (P) is the only pressure for which the WFD sets standards for surface waters,[3] and hence the one

[1] The third implementation report (EC, 2012) found only a 10% predicted increase in surface water bodies likely to reach GES by 2015 — as required by the Directive — compared to 2009; leaving almost half the surface waters in Europe likely to be less than good status in 2015.

[2] www.theriverdee.org.

[3] Nitrogen is another key pollutant, but the WFD only sets standard for groundwater, which is not relevant in this case.