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Effects of awareness on farmers' compliance with diffuse pollution mitigation measures: A conditional process modelling

Murat Okumah[a,*], Julia Martin-Ortega[a], Paula Novo[b,c]

[a] Sustainability Research Institute, University of Leeds, Leeds, LS2 9JT, England, UK
[b] Land Economy, Environment and Society Group, Scotland's Rural College (SRUC), Edinburgh, EH9 3JG, Scotland, UK
[c] Social, Economic and Geographical Sciences Group, The James Hutton Institute, Aberdeen, AB15 8QH, Scotland, UK

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ABSTRACT

Despite several decades of research and financial commitment, diffuse water pollution remains a major problem threatening the health and resilience of social-ecological systems. New approaches to tackle diffuse pollution emphasise awareness raising and provision of advice with the aim of triggering behavioural change. However, empirical evidence on the effectiveness of this approach remains scarce and mixed, with most studies relying on smaller datasets and case studies. Using one of the largest datasets (N = 1,995) with this information, this study seeks to establish quantitatively the relationship between farmers' stated awareness of diffuse pollution mitigation measures and their compliance with them, through the analysis of Scotland's pioneer advice-driven approach. Results from a conditional process modelling suggest awareness might not directly determine compliance but influences it indirectly through the mediating effect of other environmental management practices (in this study reflected in participation in agri-environmental schemes). This mediated relationship appears to be contingent on farm type and location. This would indicate that while public efforts in awareness creation is important, awareness alone is not sufficient to improve compliance; farmers may need to consistently engage in environmental management practices to develop a deeper understanding of the problem and action strategies. In this context, agri-environmental schemes appear to provide an opportunity for the creation of tacit knowledge and understanding of diffuse pollution mitigation measures through experiential learning which may also lead to the creation of new values.

1. Introduction

Diffuse pollution remains a major threat to ecosystems' health at the global level (UNEP, 2016; Novotny, 2013) with agriculture being one of the largest sources (United Nations, 2016; OECD, 2012; Boesch et al., 2001; Skinner et al., 1997). It is estimated that the environmental and social cost of diffuse water pollution (DWP) from agricultural sources exceeds billions of dollars annually in OECD countries (OECD, 2017, 2012). In England alone, the UK Government spent around £8 million to tackle diffuse pollution in 2008–2009 with over £140 million spent on water quality more broadly (OECD, 2017; NAO, 2010).

The pronounced impacts of diffuse pollution have led to the development of policy actions to mitigate the problem. Worldwide, strategies to address diffuse pollution have either concentrated on the implementation of single mechanisms or the integration of two or more policy options such as economic incentives, environmental regulations or advice provision (OECD, 2012; Deasy et al., 2010; Kay et al., 2009). Both single and integrative approaches have so far failed to make significant improvement in reducing diffuse pollution and other water quality problems (e.g. Kay et al., 2012). It is argued that the poor performance of attempts so far in mitigating diffuse pollution is related to the complex or 'wicked' nature of the problem (Duckett et al., 2016; Patterson et al., 2013); i.e. it is a problem with several causal factors, with multiple pathways that change overtime and are surrounded with uncertainty and ambiguity (Duckett et al., 2016; Patterson et al., 2013; Novotny, 2003).

The persistent nature of diffuse pollution particularly in rural agricultural areas has also been attributed to a number of specific barriers. These include financial issues such as complexities and bureaucracies involved in accessing funds, cultural aspects, inconsistent messages sent to land managers, uncertainty surrounding scientific evidence and lack of stakeholder awareness (Vrain and Lovett, 2016; Novo et al., 2015; Barnes et al., 2009). Some land managers do not perceive themselves as being responsible for diffuse pollution, whilst others are unaware of existing mitigation measures (Novo et al., 2015; Macgregor and Warren, 2006). Many of these barriers have an effect on land managers'

* Corresponding author.
E-mail address: ee15sa@leeds.ac.uk (M. Okumah).

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behaviour (e.g. if land mangers do not ascribe to themselves the responsibility to reduce DWP, they will not act upon it, or if they are exposed to contradictory messages from scientists or regulating bodies, they may not adopt recommended mitigation measures). Therefore, there is now consensus on the fact that understanding and influencing land manager behaviour is key to enhancing uptake of mitigation measures to reducing diffuse pollution (Novo et al., 2015; Vrain et al., 2014; Martin-Ortega and Holstead, 2013; Blackstock et al., 2010; Pike, 2008; Dwyer et al., 2007).

Understanding and influencing land manager behaviour is challenging due to the complexities associated with pro-environmental behaviour (Christen et al., 2015; Blackstock et al., 2010; Dwyer et al., 2007). Nonetheless, the literature has identified a number of ways in which behaviour can be influenced (Novo et al., 2015; Martin-Ortega and Holstead, 2013; Pike, 2008; Macgregor and Warren, 2006). These can be synthesised into key areas: specifying and ensuring consistency in regulations, providing economic rewards, providing scientific evidence and raising awareness. Indeed information provision and awareness raising is a cross-cutting theme that accompanies the other suggested factors (Blackstock et al., 2010). It has been argued that information provision and awareness raising has the ability to influence land manager behaviour particularly when the approach adopted is evidence-based and one-to-one (Blackstock et al., 2010; Dwyer et al., 2007). Working directly with land managers and providing them with the required advice is expected to make them part of the process, enhance their understanding, create trust, allow for knowledge exchange and co-construction, and hence likely to be more effective than top-down regulations and/or provision of general recommendations (Martin-Ortega and Holstead, 2013; Pike, 2008).

However, empirical evidence from the wider field of behavioural studies suggests that, while provision of information and advice might be important, they do not necessarily result in pro-environmental behaviours. For instance, after a critical review of factors influencing pro-environmental behaviours, Kollmuss and Agyeman (2002) concluded that there appeared to be many more intervening or situational factors (e.g. economic) that influence pro-environmental behaviour. Bamberg and Moser (2007) reaffirmed these findings using a meta-analytical structural equation modelling. Others have highlighted how message framing and delivery can influence the role of knowledge on behavioural change (e.g. Baek and Yoon, 2017; Hovland et al., 1953) as well as the role of tacit knowledge and experiential learning (Science for Environment Policy, 2017; Kolb and Kolb, 2012; Boiral, 2002). This demonstrates the complex nature of the knowledge-behaviour nexus and raises new questions regarding the effects of awareness and how it translates into pro-environmental behaviours. Such questions need to be clarified if policies targeting behaviour regarding diffuse pollution mitigation measures are to be successful (Martin-Ortega and Holstead, 2013; Blackstock et al., 2010). Further evidence on the effectiveness of awareness-focused approaches may redirect the focus and strategies of policies that aim at influencing behaviours related to diffuse pollution mitigation and provide insights into new directions and areas to target (Kay et al., 2012).

This paper adds to the scarce body of literature that empirically examines whether and how awareness of measures to mitigate diffuse pollution influences farmer behaviour regarding their uptake (e.g. Vrain et al., 2014; Macgregor and Warren, 2006). Using what is to our knowledge one of the largest existing databases on this topic (N = 1995), this study seeks to establish quantitatively the relationship between farmers' stated awareness of diffuse pollution mitigation measures, specifically in this case Scotland's General Binding Rules (GBRs), and their compliance with them. This is done through the analysis of Scotland's Priority Catchment Approach, a pioneer advice-driven approach (Novo et al., 2015). Specifically, this study aims to establish whether there is a statistically significant relationship between farmers' awareness of and compliance with the GBRs, as well as understanding the interplay between these relationships with other factors at the farm level, using conditional process modelling.

2. Case study: Scotland's priority catchment approach

Diffuse pollution is one of the major causes of poor water quality in Scotland (SEPA, 2014, 2013). Eighteen percent of water bodies in the Scotland River Basin district have been classified as having less than good quality attributable to diffuse pollution (DPMAG, 2015). To address this problem, a Diffuse Pollution Management Strategy (DPMS) was developed as part of the River Basin Management Plan (RBMP) (2009–2015). RBMP are produced as part of the implementation of the European Union Water Framework Directive, which is the regulatory framework for water management in the European Union. SEPA is the agency in charge of the regulation of environmental management activities in Scotland and are directly responsible for the implementation these frameworks. The RBMP[1] was produced by SEPA on behalf of Scottish Government; it covers a summary of the state of the water environment, pressures impacting on the ecological conditions of the water environment where it is in less than good condition, activities to safeguard and improve the water environment and a summary of results after implementation. As part of the DPM strategy, SEPA has established a Diffuse Pollution Management Advisory Group (DPMAG) that focuses on protecting and improving Scotland's water environment by reducing rural diffuse pollution. DPMAG has a two tiered strategy to reduce diffuse pollution. First, it includes a national campaign to improve the status of water bodies and prevent further deterioration, with specific focus on promoting awareness and ensuring compliance with diffuse pollution GBRs, which provides a statutory baseline of good practice. GBRs represent essentially a set of compulsory guidelines which cover specific low risk activities, such as storage and application of fertilizer and pesticide, cultivation of land and the discharge of water run-off, mining, groundwater abstraction, etc. This study focuses on those GBRs that apply to agricultural activities.

Second, SEPA has established a so-called Priority Catchment Approach, covering fourteen catchments in the first cycle (2012–2015) and up to 32 in the second cycle (2015–2021). These are the catchments that are deemed to have poor ecological status within Scotland. In the Priority Catchment Approach, catchment coordinators have been appointed to investigate the sources of pollution and to liaise with land managers to implement mitigation measures. The idea is to enable catchment coordinators to tap into farmers' extensive local knowledge and allow for the co-construction of solutions and deeper understanding of diffuse pollution in the catchment. The catchment coordinators focus on the priority catchments through a range of catchment walks, workshops and one-to-one farm visits to provide information to land managers about the required steps to improve water quality. Land managers are also advised on diffuse pollution GBRs and the voluntary measures contained in the Scottish Rural Development Plan (SRDP), the EU Common Agricultural Policy (EU CAP) agri-environmental schemes prevailing in Scotland.

The Priority Catchment Approach represents a transition from a purely 'punitive' approach to a pioneer 'advice-centred' and targeted approach with emphasis on raising awareness and working with the land manager on a one-to-one basis (Novo et al., 2015). This is in line with trends that seek to raise awareness to foster behavioural change through dialogical learning and co-construction of solutions as opposed to the traditional approaches which are 'one-way', top-down and emphasise punitive measures (DPMAG, 2015; Environment Agency, 2011).

[1] https://www.sepa.org.uk/environment/water/river-basin-management-planning.