Understanding and influencing behaviour change by farmers to improve water quality

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A B S T R A C T
Diffuse pollution from agriculture remains a significant challenge to many countries seeking to improve and protect their water environments. This paper reviews literature relating to the provision of information and advice as a mechanism to encourage farmers to mitigate diffuse pollution. The paper presents findings from a literature review on influencing farmer behaviour and synthesises three main areas of literature: psychological and institutional theories of behaviour; shifts in the approach to delivery of advice (from knowledge transfer to knowledge exchange); and the increased interest in heterogeneous farming cultures. These three areas interconnect in helping to understand how best to influence farmer behaviour in order to mitigate diffuse pollution. They are, however, literatures that are rarely cited in the water management arena. The paper highlights the contribution of the ‘cultural turn’ taken by rural social scientists in helping to understand collective and individual voluntary behaviour. The paper explores how these literatures can contribute to the existing understanding of water management in the agricultural context, particularly: when farmers question the scientific evidence; when there are increased calls for collaborative planning and management; and when there is increased value placed on information as a business commodity. The paper also highlights where there are still gaps in knowledge that need to be filled by future research — possibly in partnership with farmers themselves. Whilst information and advice has long been seen as an important part of diffuse pollution control, increasing climate variability that will require farmers to practice adaptive management is likely to make these mechanisms even more important.

1. Introduction

There has been increasing attention to how agricultural management affects both water quality and quantity in recent years, particularly as point-source pollution controls have failed to resolve all water quality problems (see Macleod et al., 2007). This paper makes a contribution to the broader literature on Integrated Water Resource Management, which emphasises stakeholder involvement, multiple forms of knowledge and sustainable practices (Mitchell, 2005), through the paper's focus on farmer behaviour. This paper takes the position that the farmer is an important decision maker to influence when managing agricultural diffuse pollution to the water environment. Understanding the reasons for their decisions and behaviour is therefore critical to an integrated approach to mitigating agriculture's impact on water quality. There is, however, little published on adaptive agricultural water management that takes a cultural and behavioural perspective and this paper seeks to fill this gap through bringing together disparate literatures.

Farmer behaviour can be influenced using various institutional mechanisms: legal instruments, economic rewards, provision of advice and voluntary collective actions (Wondolleck and Yaffee, 2000). Indeed, information and advice work in tandem with these other institutional mechanisms, as a cross cutting theme. This paper focuses on voluntary action, behavioural change and the provision of advice. Both the water management and agricultural extension literatures increasingly recognise the need for voluntary action by farmers to protect water resources due to the ever increasing burden of litigation, economic sanctions and government subsidies (Sabatier et al., 2005). Furthermore, it is argued that behaviour change leading to voluntary action will persist over time as it is more likely to become embedded in social norms (Ayer, 1997). Attempts to incite voluntary action require an understanding of existing behaviours, and how advice can help influence behavioural change. Managing common pool resources such as water generally requires action on a catchment or collective scale so this paper focuses attention both on individual and group behaviour.
Whilst there is a wealth of research that investigates voluntary action with regard to farmers in the context of natural resource protection and conservation, there has been little research that specifically examines the socio-cultural aspects of how stakeholders interpret, translate and respond to measures designed to mitigate diffuse pollution. This paper aims to explore these socio-cultural aspects in depth. Therefore, this paper places less emphasis on the influence of legal or economic instruments on changing behaviour with regard to diffuse pollution in order to explore these neglected aspects in more depth. However, this does not discount the interactions between economic, legal and advisory mechanisms and this will be returned to in the discussion.

This paper presents a review of current understanding of farmers’ behaviours in the context of water management protection, specifically examining how behaviour can be influenced by advice and persuasion. It draws on recent research carried out for DEFRA (Department of Environment, Food and Rural Affairs), which looked at influencing positive environmental behaviour across a number of forms of environmental management (water, soil and waste) (Dwyer et al., 2007). The research entailed a comprehensive literature review of references pertaining to behaviour, communication, policy (economic and legal) instruments, knowledge and advice to explore the complex connections between pro-environmental behaviour and advice; recognising, inter alia, social, cultural and economic barriers to change and the considerable heterogeneity of the land-based community. For the purposes of this paper, three themes from the literature will be examined in depth. These have been selected because they interlink, providing insights into socio-cultural aspects in more depth. However, this does not discount the content and quality of the message can be manipulated to make it more persuasive. For example, messages are more persuasive if they contain very specific recommendations for action rather than general recommendations (Greene et al., 1995); and if they present questions within arguments which encourage individuals to systematically analyse the information (Petty et al., 1992). Messages presenting both sides of an argument should ensure that opposing arguments are adequately refuted to be persuasive (O’Keefe, 2002). Appeals that contain ‘fear’ elements can be very effective in motivating behavioural change (Floyd et al., 2000). The UK’s ‘Voluntary Initiative’, whereby the agricultural sector sought to avoid statutory controls on pesticide application through collective voluntary action to mitigate diffuse pollution, is such an example, although the environmental outcomes have been mixed (House of Commons, 2005).

Roger’s (1983) protection motivation theory proposes that such messages will be effective when they convince recipients that (a) the problem is serious, (b) they are susceptible to the problem, (c) recommendations will alleviate the problem, and (d) they are capable of performing the recommended actions. Unfortunately, long residence times associated with recovery from nutrient enrichment (Neto et al., 2008) make arguing that farmer action will alleviate the problem — point (c) above — more difficult as there may be no recovery for some time after measures are implemented.

Finally, messages can be targeted to make them more effective. As receiver characteristics differ, any promotional strategy should use a variety of message approaches. Many personal factors can influence the persuasiveness of arguments, including ability to comprehend, need for cognition, locus of control and tendency towards self-monitoring (Pornpitakpan, 2004). O’Keefe (2002) suggests that levels

motivation and ability to process information (recipient characteristics), which combine to determine whether attitude change is induced. These theories are particularly relevant as firstly, they often underpin extension practices and, secondly, many evaluations of uptake of agri-environmental schemes illustrate that farmers have not been persuaded that they can or need to change their behaviour (Macgregor and Warren, 2006). For example, because diffuse pollution from agriculture is often ‘invisible’ and the impacts occur ‘off-farm’ (such as the eutrophication of estuaries from excessive nitrogen leaching); it has proved difficult to communicate the rationale for Nitrate Vulnerable Zones in the UK (ibid).

The literature stresses the importance of contact from a trusted source for achieving behavioural change. In general, the higher the source credibility the higher the persuasion factor will be. High credibility sources are particularly important when messages are complex, there is little available experience, and/or a message carries a high personal risk (O’Keefe, 2002). Two broad dimensions that contribute towards source credibility have emerged in the literature — namely, ‘expertise’ and ‘trustworthiness’. As experience and occupation are key factors that convince people of the reliability of the source; and people are more inclined to process in-group messages, the use of people from farming backgrounds or trusted networks is likely to enhance message uptake. For example, Lankford et al. (2004) illustrate the complex judgements made by farmers and other stakeholders about the messages from scientists regarding good practice for river basin management, resulting in some recommendations being ignored; whereas Robinson (2006) illustrates that having farmer facilitators improved uptake of the Environment Farm Project in Ontario.

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1 Another body of work debates whether attitude alone is a reliable indicator of behaviour but there is insufficient space here to explore this (see Burton, 2004a).

4 Extension refers to the theory and practice of advice provision. The term arose from the North American land grant university model and has come to refer to the communication of information to influence farmer’s decisions in the agricultural context.
of self-esteem and intelligence are important, whilst Wood and Kallgren (1988) found that respondents’ ability to recall relative beliefs and experiences influence message processing. Messages should be made as personally relevant as possible as people are more likely to respond where they recognise it is their behaviour being targeted (Petty et al., 1992). If, as suggested above, that some farmers are unaware that they are ‘part of the problem’ then they are unlikely to pay any attention to information about potential ‘solutions’.

Although it is important to understand how to influence individual behaviour, managing common pool resources such as water generally requires collective action on a catchment scale. As such understanding how to support and influence farmer group dynamics is crucial. Therefore, insights into how to support institutions for collective water management are of interest to those wishing to influence the mitigation of diffuse pollution. Indeed, Lubell et al. (2002) found from an exhaustive review of 958 watershed partnerships in the United States that such partnerships were most likely to be developed when facing severe pollution arising from diffuse agricultural and urban sources.

Institutions are required to overcome the problem that there are few incentives to provide public goods such as good water quality or to curtail the production of pollution, due to market externalities. Institutions can influence collective decision-making behaviour by structuring the range of incentives and disincentives involved, in a way that aligns individual and group objectives; enabling individuals to capture the benefits, or compelling them to confront the costs (polluter pays, regulation) of their actions (Ayer, 1997). The success of collective action can be related to the attributes of the resource and the user-group, for example: clearly-defined resource and user boundaries, conflict resolution mechanisms, and the effective implementation of monitoring, enforcement and sanctions (Ostrom, 1990). However, cooperation is not cost-free — the initiation and implementation of collective action incurs transaction costs. Lubell et al. (2002) note that successful watershed partnerships require that the benefits of working together to reduce diffuse pollution outweigh the transaction costs. Case studies illustrate that farmers are reluctant to engage in water management when they don’t feel they will benefit from their actions (Posthumus et al., 2008).

The will to overcome these transaction costs depends on whether the perceived benefits of collective action outweigh the perceived costs, which in turn is influenced by the circumstances and characteristics of stakeholders. Social networks and other aspects of social capital can lower the transaction costs of working together (Pretty, 2003). Advice and information can also assist with reducing transaction costs and increasing the benefits through: harmonising multiple objectives; sharing knowledge; sharing and mobilising resources; increasing the credibility of actions and objectives; allowing flexible, locally relevant responses; and, building capacity to cope with future changes (Wondolleck and Yaffee, 2000). For example, social capital and information sharing was central to the cohesion of the Pontbren group of Welsh farmers who have carried out voluntary water management activities in their catchment, delivering environmental improvements (Mills et al., 2008).

Mainstream ‘collective action’ scholarship has constructed generalised theories of the creation and maintenance of institutional arrangements using assumptions of individual decision making and rational choice (e.g. Ostrom, 1990). This approach has been criticised for implying that institutions are static and function according to universal rules, when empirical evidence suggests that institutions are context dependent and ever evolving. These critics (such as Johnson, 2004) also draw attention to the importance of understanding how informal and symbolic practices interact with formal rules and procedures; and to how individuals interpret and respond to institutional arrangements in different ways. These critiques resonate with the calls for more flexible responses to diffuse pollution measures that respond to farmers’ motivations and practices (Greiner et al., 2009). Such insights, along with the general recognition of the significance of collective behaviour, have contributed to a shift in approach to extension, which recognises that advice needs to be provided and used within a network of human relationships.

### 2.2. Knowledge exchange: understanding how to provide advice effectively

Theoretical understanding and practical implementation of the provision of advice have both seen a paradigm shift in response to a changing agricultural context. This shift has been from knowledge transfer approaches to human development or knowledge exchange approaches. Knowledge transfer approaches promote, through dissemination of information and technical solutions, the adoption of predetermined practices. Human development approaches emphasise the need for people to develop their own solutions to problems. In the former the role of extension is to persuade, in the latter to facilitate interaction, learning and innovation.

Traditional knowledge transfer extension approaches assume that innovations (and knowledge) originate in science and are transferred to farmers who adopt them (Black, 2000). This notion of a ‘one-way’, sequential path has been developed and adapted by a number of authors, the most pervasive being the diffusion of innovation theory articulated by Rogers (1983). Within this perspective, early empirical approaches sought to discover patterns or predictive factors in the way decisions are made on the basis of farmer socio-economic factors (e.g. Earle et al., 1979). Many model based approaches to diagnosing diffuse pollution risk take still take this approach, predicting pollution outcomes from land use types or farm size (e.g. Davison et al., 2008).

The knowledge transfer approach was the dominant paradigm for extension in the 1970s and 1980s, but has since been criticised (Buttel, 2001). Criticisms can be grouped under three main concerns: firstly, that the approach is no longer appropriate for modern multi-functional agriculture; secondly, that it does not reflect the empirical evidence of how farmers use information; and finally that it takes no account of other influences upon the uptake of information and advice. Critically the uni-linear approach also fails to represent the many different sources from which knowledge is generated, notably by the farmers themselves (Chambers et al., 1989). It also fails to explain or support collective behavioural change, as discussed above, which emphasises decision making within a social system, rather than persuasion of individuals.

These criticisms led to formulations of alternative ‘human development’ approaches which are based on the principles of participation, empowerment and ownership of the problem (Black, 2000). These approaches argue for validity to be given to non-expert forms of knowledge, including local farmer knowledge, and view the extension process as one of learning rather than passive knowledge utilisation (Morgan and Murdoch, 2000). This view has underpinned the development of ‘farmer-first’ ideology and participatory methods of extension championed by Chambers et al. (1989). A good example is Sturdy et al.’s (2008) ‘farmer driven experimentation’ to address water management practices in South Africa.

Human development approaches also recognise the significance of social interaction. Communication within a social system or a group is regarded as an important process in articulating, sharing and exchanging ideas amongst farmers. Theories drawn from knowledge networking (Engel, 1997); social networking. (Warriner and Moul, 1992); social capital, (Sobels et al., 2001) and social learning and systems research (Roling and Wagemaker, 2000) underpin much of the research undertaken, which seeks to understand the role of extension in facilitating collective processes. Considering groups or networks as

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5 Local knowledge is thought to be more ecosystem-sensitive and context-dependent and therefore more suited to sustainable agriculture (Roling and Wagemaker, 2000).
human activity systems' allows extension communities to discuss innovation and learning at specific levels of social aggregation. This approach permeates water initiatives such as SLIM (social learning for catchment management) (Ison et al., 2007) and HARMONICOP (Harmonising Collaborative Planning) (Mostert et al., 2007).

Although seen as an improvement on the failings of the knowledge transfer approach, there have been a number of criticisms of human development theories. There have been two explicit critiques leveled: firstly, the approach lacks a coherent theoretical foundation (Vancloey and Lawrence, 1994); and secondly, it fails to recognise the difficulties and dangers in working with multiple forms of knowledge (Morgan and Murdoch, 2000). Furthermore, we believe that the approach fails to recognize problems with issues of legitimacy, accountability and representation, issues that are at the heart of debates on how to implement Integrated Water Resource Management (Mitchell, 2005).

Consequently many consider that, whilst group-based approaches have advantages when well implemented, they should not be regarded as the only strategy (Black, 2000). The heterogeneity of modern agriculture suggests that no single approach to influencing behaviour is likely to be sufficient. Top-down knowledge transfer and bottom-up human development approaches are best characterised as two ends of a spectrum and the middle ground probably provides the most flexibility for future extension approaches (Black, 2000). These insights, that no one size fits all, illustrate the importance of recognising the heterogeneity of farmers; the importance of acknowledging the social embeddedness of agricultural production; and the role of culture in mediating change.

2.3. Understanding different audiences

The findings presented above need to be put in the context of a highly heterogeneous and constantly changing agricultural sector. Therefore, this section on understanding differences looks at the notion of (a) differences in farming enterprises and (b) differences in farming cultures. The literature concerned with defining and explaining differentiation between types of farm enterprises has noted significant shifts in the agricultural sector since the 1970's (Van der Ploeg, 1993). One outcome of this restructuring has been an increase in average farm size. However, since the 1980s, the number of small farms also began to increase in Western Europe, alongside the trend towards peri-urban 'amenity farms' in Australasia and Northern America. The so-called ‘disappearing middle’ (Buttell and Gillespie, 1984: 185) – the development of a dichotomy of large-scale corporate farms and relatively small-scale family farms or lifestyle units – was a result of two factors. Firstly, the cost-price squeeze in mainstream farming was particularly felt on medium-sized, mono-active family farms (Hill, 1989). Secondly, there has been a growth of hobby and part-time farming as a consequence of broader rural change (Gasson, 1988). As a result of the changing pattern of land ownership, there has been the tendency for an ever-growing proportion of agricultural output to come from a smaller proportion of farmers.

The ‘disappearing middle’ has important implications for the understanding of differences between farmers and the underlying reasons for their behaviour. The opposite ends of the spectrum are the intensive agri-businesses and the pluri-active family farm (Marsden and Sommio, 2008). Agri-businesses are motivated primarily by the profit motive and market share, often managing large holdings over several sites and investing heavily in human and technological capacity to maintain competitive advantage. Pluri-active family farms tend to rely on agri-environmental and off-farm income streams for financial viability. Where they rely on agri-environmental payments, they are required to manage to produce both food and environmental goods and services. These are important, if caricatured, differences in how farmers make decisions about land management.

There have been different responses to the pressures for restructuring that will shape behaviour. Marsden et al. (1993) identified four ‘ideal types’ of countryside within the UK, based on social, economic, political and cultural parameters:

- The preserved countryside where amenity values are protected and there are opportunities for rural diversification;
- The contested countryside where productivist agriculture often comes into conflict with the desire for landscape and environmental preservation;
- The paternalist countryside where large estates and big farms dominate and attempt to balance social obligation and financial imperative;
- The clientelist countryside where productivist agriculture dominates, often associated with low environmental protection.

There are also implicit spatial and environmental dimensions to these types – as the choices made are to some extent determined by the bio-physical attributes of the land, such as topography, soil type and meteorological conditions. Currently, modelling of diffuse pollution from agriculture tends to rely on these parameters, supplemented by economic or land use data; but without taking account of land manager objectives for their land.

These ideal types illustrate the interactions between the environmental and human dimension of the agricultural system, and draw attention to the decisions made by different farmer types. These types illustrate that whilst policies and economics are important, there is also a need to look at social and cultural issues in specific geographical or social contexts in order to better understand farmer behaviour. Individual decisions and actions do not take place in a social vacuum, but are shaped by ideas and practices negotiated by the social groups in which they are necessarily embedded. A greater acknowledgement of both the social embeddedness of agricultural production, and the role of culture in mediating key technical and economic drivers of change, has stemmed from the ‘cultural turn’ in social science (McCarthy, 2005). However, there has been little attention to cultural aspects of water management to date (Ison et al., 2007).

In other words, farmers attach symbolic meaning to the choices they make and the behaviours they exhibit. It has been argued that agriculture in Western Europe has been part of the modernisation project that encouraged ‘good farming’ to be associated with efficient production and high yields. Farmers allocate one another symbolic capital for visible demonstration of these values (Burton, 2004b). This finding has helped explain the variable take up of agri-environmental incentives, both in Western Europe and further afield. His work suggests that schemes that undermine the visible symbols of good farming, e.g. overgrown buffer strips etc may be less popular than those that contribute to signs of a successful productive enterprise (e.g. new fences). This reflects findings in other countries, such as a review of the Australian Land care programme (Sobels et al., 2001).

There is a growing body of work that argues that more attention should be given to the cultural constructions, interpretations and value systems of heterogeneous groups within agriculture (known as ‘agri-cultures’), and how these different cultures shape the choices made6. Members of the Wageningen school have developed Hofstee's (1946) notions of ‘farming styles’ to explain heterogeneity in agricultural practices. Van der Ploeg (1994) posits that styles are real, tangible and discretely identifiable, but others (e.g. Vanclay et al., 1998) suggest that styles are more usefully conceptualised as heuristic ‘ideal types’ that farmers draw on as part of a ‘cultural repertoire’ when constructing their farm practices.

Burton et al. (2008) contend that the “cultural capital” (status, peer esteem) generated by agricultural activities plays a key role in

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6 This also relates to knowledge exchange as there are different ‘knowledge-cultures’.
determining farmers’ engagement with voluntary agri-environmental measures. Morris and Evans (2004) recommend that any analysis of agriculture recognises how cultural differences constitute distinct social groups with their own meaning and value systems. Therefore, different sub-cultural groups in agriculture will differ in how they construct farming practices as ‘good’, ‘best’, and ‘proper’. Lowe et al. (1994) noted that different types of farmers had distinct views about, and representations of, water pollution resulting from agricultural activities. However, most of the water literature reviewed for this paper did not distinguish between different types of farmers or farming cultures.

These different agri-cultures affect both individual decisions and actions and also collective action. Within the family farm sector, research has focused on the single farmer as the decision maker (Ward and Lowe, 1994) but evidence suggests that all family members participate in the decision-making process, particularly on large farms (Burton, 2006). However, this type of collective decision-making process and its implications for policy and targeting messages are not well-understood. Furthermore, the literature on culture and being a ‘good farmer’ illustrates how farmer decision making is a complex multi-criteria process strongly influenced by the judgements of their peers. The social networks, trust and norms of reciprocity associated with social capital lower the transaction costs of working together by helping to harmonise group and individual interests and allowing actors to interact with each other with confidence in the predictability of their actions (Pretty, 2003). Therefore, any attempts to influence or understand behaviour needs to understand the potential impacts of, and on, both cultural and social capital.

This section has highlighted two key points. First that insights on linking advice to knowledge exchange and behavioural change are viewed in the context of understanding differences between farmers. Second, that farmers have multiple factors that influence their behaviour, some of which are related to their economic wellbeing and production objectives for their enterprise but others are related to their own identity and the influence of peer interactions. The implications, along with the remaining knowledge gaps, are discussed below.

3. Discussion

Whether considering River Basin Management Planning under the Water Framework Directive; the Australian Landcare Movement; or the international HELP basin initiatives; integrated water management solutions to diffuse pollution tend to consist of a blend of economic incentives; legal arrangements and voluntary behaviour. These institutional mixes are enabled and supported by advice and information – Dwyer et al. (2002) found that advice was central to all mechanisms aimed at changing behaviour concerning diffuse agricultural pollution. However, the influence of advice, particularly how it interacts with farmers’ identities and cultures, has yet to be adequately integrated into research on mitigation of diffuse pollution to water. Therefore, the discussion considers how the insights from the literature on advice and information could help to mitigate diffuse pollution more effectively. This section discusses the implications of our findings in five areas: raising awareness; recognising diversity; socially negotiated learning; new roles for scientists and targeting climate change to support the integrated management of diffuse agricultural pollution.

3.1. Raising awareness amongst farmers

The review suggests that providing well reasoned, data based and logical messages should be effective in persuading farmers to adopt certain preventative measures or ‘best management practice’, so long as farmers are convinced that there is a problem and that their actions can solve it. However, we have shown that there is not always agreement that a problem exists, or that farmers bear some responsibility for it. Recent studies in the UK, for example, illustrate how many farmers do not believe that agriculture makes a significant contribution to water pollution (Macgregor and Warren, 2006; ECSFDI Technical Services Team, 2008; Barnes et al., 2007; Posthumus et al., 2008) – a finding that echoes the review of the US Water Quality Program (Ribaudo, 1997). A recent paper by Oliver et al. (2009) on assessing risk of diffuse pollution from grassland in UK illustrates that raising awareness is an important first step in getting uptake of mitigation measures. Given the importance of mitigating diffuse pollution to protect aquatic ecosystems and human health, these examples suggest that more effective awareness raising is required. However, too many water management interventions proceed as if diffuse pollution from agriculture is an understood and accepted pressure, rather than taking the time to discuss this with their farming partners.

The failure to recognise culpability has been attributed to the fact that some farmers do not employ a systemic approach, focussing only on activities on their farm and ignoring linkages with the wider landscape where the consequences of current and historical practices are realised. Therefore, it seems that there are difficulties in ensuring that the message is seen as credible and salient to the farmers. Gaps remain in understanding when a farmer judges whether a message is credible or not, and in understanding the most effective way of increasing the credibility of the message content, including understanding how different sources of advice on diffuse pollution are evaluated by farmers. Until these challenges are addressed, debates regarding the source and severity of diffuse pollution; and who should clean it up – such as the conflict between the agricultural and second home communities in Ontario (Ferreya et al., 2008) – will continue.

3.2. Recognising diversity within farming stakeholders

The review of social psychology’s persuasion approaches has revealed how important it is to understand the individual and adapt target messages accordingly. Many of these elements have been recognised in extension practice for a long time and the insights into the diversity of agri-cultures also underpins recent interest in applying market segmentation approaches to agricultural extension (Garforth and Rehman, 2006). However, there is little evidence of this approach having permeated the water management policies and practices. Indeed, research on diffuse pollution tends to make assumptions about land use, rather than land management and the diversity of farming styles related to management decisions. Even when farmers are engaged, the literature tends to treat them as homogeneous within each farming sector (e.g. Oliver et al., 2009; Barnes et al., 2007). Therefore, just as water scientists appreciate that not all catchments are the same, it is important to recognise the heterogeneity of those managing land–water relationships and to tailor advice to these different farming contexts and cultures.

Changing behaviour involves targeting different cultures of farming and understanding how to generate social as well as economic rewards from behavioural change (see Burton et al., 2008). It is important, therefore, to identify who defines ‘good’ or ‘best’ agricultural practice and how there may be differences in how behaviours are judged. For example, measures to mitigate diffuse pollution that are visible and judged negatively by neighbouring farmers could be more difficult to promote, even if the science suggests that they are likely to be most effective. These insights help to better understand a farmer’s willingness to change their behaviour. Without understanding both capacity and willingness, applying good practice in advice provision will not be effective; and is less likely to result in the desired outcome of positive behaviour with respect to water management. Differences in how farmer sub-cultures construct farming practices as ‘good’ or ‘best’ also have implications for definitions of ‘good’ or ‘best’ agricultural practice in official publications aimed at persuading farmers to adopt anti-pollution measures.
Whilst a catchment wide approach might make sense spatially with regard to water management, farmers within that catchment will differ in terms of enterprise type and size, their farming style and cultural perspectives, as well as their ability to respond to advice due to economic, technological or labour constraints. Advice therefore needs to be tailored to understand these differences, which explains why one to one advice and the farm visit is popular, as these locate the advice in the farm specific context. This has influenced the England Catchment Sensitive Farming Delivery Initiative (ECSFDI) (Dwyer et al., 2007) whereby catchment officers have been employed to visit and advise individual farmers in priority ‘hot-spot’ catchments to mitigate diffuse pollution pressures. However, gaps remain in fully understanding how to target diverse farming audiences, in particular, how to engage with the collective decision-making unit, be this a family of farmers; a corporate board or a farmer and specialised contractors.

Judgements about the message and the source therefore need to understand the different social contexts of the receivers within farming communities. This finding also has implications for using farmer to farmer networks, as not all farmers will know, trust or even talk with one another. This is particularly true when ‘farming’ can cover activities from highly intensive horticulture through to ‘hobby farms’ in Western Europe, Australasia and North America. Research that explored how UK farmers responded to advice regarding the management of farm waste (manures and slurry) to avoid nutrient enrichment in local water courses has indicated how the dynamics of social networks can shape the circulation and negotiation of information and knowledge (Blackstock, 2007). To the best of our knowledge, there little other published research that recognises this heterogeneity when tackling diffuse pollution from agriculture. There should be more research undertaken on how different interpretations of ‘best practice’ are linked with farmer to farmer transmission of knowledge.

### 3.3. Socially negotiated learning

More generally, the results above illustrate how knowledge exchange is mediated through social relationships and local group learning. Evaluations of collective water management activities show that facilitating shared (or social) learning, as advocated by human development approaches to extension, can be relevant and effective. For example, the SLIM project achieved the transformation of individual and institutional behaviour, at a large social scale, with significant technical results for water quality across Europe (Ison et al., 2007). Both the HarmoniCOP and SLIM projects found that there was a need for capacity building if social learning is to be used for diffuse pollution mitigation. Building on the observations about recognising diversity, it will be important to find out which kinds of farmers need which kinds of capacity building to enable socially negotiated learning.

The paradigm shift towards knowledge exchange through social networks has been recognised and many water management activities are coordinated and facilitated at catchment and river basin scales. Increasingly, partnership or stakeholder approaches have become a part of most government policies to management of water at the catchment level (Sabatier et al., 2005), such as the requirement to have active involvement by stakeholders in the European Water Framework Directive. Indeed, much of the literature on collective action using social learning has focussed on these multi-stakeholder processes, where farmers have been part of a wider coalition of stakeholder interests involved (e.g. Ison et al., 2007; Mostert et al., 2007; Ferreyra et al., 2008). The particular needs and interests of diverse farming interests are rarely reflected in this literature. It would be useful to research which farmers engage in these multi-stakeholder processes in order to better understand how these processes can inform and influence day to day farming practices through peer networks.

Negotiating how to manage water collaboratively has proved challenging. The critiques of the mainstream institutional literature indicated that stakeholders inevitably hold different views on problems and on the desired outcomes of any partnership (Ison et al., 2007). For example, watershed partnerships in Ontario were described as arenas in which different types of knowledge, diverse values and divergent sectoral perspectives are confronted (Ferreyra et al., 2008; Robinson, 2006). In other words, catchments are situations of complexity, connectedness, uncertainty and controversy (Allan, 2008), requiring inter-organisational leadership to develop and sustain collaborative management. Whilst this is increasingly recognised in analyses of stakeholder process for water management, there is little explicit attention to controversy within farming communities rather than between farmers and other stakeholders.

#### 3.4. A new role for scientists

The importance of bringing in different knowledge and perspectives reflects not only the trend towards valuing farmers’ knowledge but also the new social contract for science (Lubchenco, 1998) whereby science becomes one of many perspectives involved in problem framing and problem resolution. This also echoes the discussion above about the credibility of the source of advice and understanding how different farmers evaluate scientific discoveries. Farmers will still need to draw on reliable scientific advice from experts. It is clear however, that for some farmers, demand-driven information systems are supplanting supply-driven extension (Garforth et al., 2003). Therefore, if the relationship between farmers and scientific experts is shifting from knowledge transfer to knowledge exchange, there are implications for how science underpinning land and water management is conceptualised, conducted and communicated (Carolan, 2006). Examples of these shifts from within the water science community include the debates on ‘minimum information required’ model of diffuse pollution pathways (Heathwaite, 2003) and the new generation of decision support tools for diffuse pollution (McIntosh et al., 2007). Both examples are responding to demands from stakeholders, including farmers, to exchange knowledge in ways more suited to the end user’s needs.

#### 3.5. Adapting to climate change

The discussion above needs to be considered in light of the implications of climate variability. To rehearse the assumptions, the predicted increase in climate variability is likely to have negative implications for water quality through increasing run off, changing thermal regimes and extreme flows (high and low) (Bates et al., 2008). Therefore, increased climate induced impacts will require farmers to mitigate climate change risks and adapt to its challenges. However, there is considerable uncertainty about how pressures will change, when they will change, where they will impact and how best to respond to them. The net result will be increased variability in conditions facing farmers. This highlights the need for farmers to manage adaptively and increase their resilience to a range of possible conditions.

Understanding how to influence farmers’ behaviour in the context of such adaptive management is crucial. We contend that given the uncertainty of how pressures and measures will respond to climate variability, farmers may well need to react to changing conditions and adapt behaviour in advance of changes in legislation or economic incentives (Matthews et al., 2008). Therefore, increased attention should be paid to the role of advice and information; and to the importance of voluntary individual and collective action. This recommendation echoes the climate change literature on the need for flexible institutions and a mix of measures, with increased emphasis on adaptive voluntary behavioural change (Gowdy, 2008).

Our findings relating to raising awareness highlight the need to engage farmers in the debate over the extent and impacts of climate change and persuade farmers that messages about climate change are
relevant to them. Unfortunately, the psychological literature on message sources recommends consistent and authoritative content, which is difficult to deliver when dealing with the contested and uncertain nature of adaptation and mitigation. Our findings on the heterogeneity of farming styles and cultures require attention to be paid to different mitigation and adaptation strategies. However, given that very little information exists on farmers’ responses to climate change and water management perverse (see Wilcock et al. 2008 for a rare example, albeit from a knowledge transfer not human development paradigm), it is not surprising to find that such differentiated literature does not yet exist.

Our findings on socially negotiated learning suggest that to achieve resilience and enable adaptive management, farmers will need to be knowledgeable, aware and pro-active, working with policy makers and scientists, rather than passively receiving knowledge transfers. Syme et al.’s (2006) deliberative methodology for catchment planning under climate change is a good example of such an approach. This human development approach has implications for scientists, asking us to exchange not just transfer information. In some cases this might be discussing precise scientific knowledge about specific natural processes, in other cases it might be advising farm groups about how to work with other farmers so that co-learning can be achieved, or in other cases again, joining a process of negotiation with policy makers about the implementation of adaptive water management in the context of uncertainty (Pahl-Wostl, 2007). What is clear is that multiple forms of scientific and other expert knowledge need to be delivered in combinations tailored to the specific context, in order to influence adaptation and mitigation most effectively.

4. Conclusion

Diffuse agricultural pollution, as well as abstraction and morphological pressures, has been identified as the main threats to the water environment in western Europe. Tackling these pressures will require the adoption of good management practices by farmers. This paper has synthesised these three areas of literature that have important implications for influencing voluntary behaviour by farmers to manage and protect the water environment under a changing climate. The paper has focussed on the area of cultural and social influences on farmer behaviour as this is an area that has been neglected in the water management literature. However, we recognise that these social and cultural influences co-exist with economic and legal instruments as part of the institutions governing the mitigation of diffuse pollution and climate change.

The main findings of the paper are that whether farmers become involved in catchment partnerships or respond as individuals to printed or verbal advice, they are interacting with a range of actors and multiple sources of information, often with advisors acting as mediators. Therefore, no single approach or strategy for influencing farmers’ behaviour to manage diffuse pollution in the context of climate change is likely to be sufficient. Attempts to influence farmer behaviour need to take account of good practice in developing and communicating consistent and salient messages that the farmer feels able and willing to respond to. The sense that the farmer can and should do something about water management can be heightened if the human development, rather than knowledge transfer, paradigm is adopted. The exchange of knowledge, and consequent behaviour change, are interpreted and influenced by individual and group identities within differentiated farming cultures. Therefore, understanding and influencing behaviour is a complex and multi-faceted issue, interwoven with issues of power and politics within farmer cultures and between these peer groups and the wider policy and political settings.

The paper has drawn attention to existing knowledge gaps with implications for managing diffuse pollution now, and under future climate variability. To summarise, the sources of diffuse pollution, and decisions regarding who should mitigate these, are still contested and further awareness raising is required. The farming community is heterogeneous, even within one catchment, and advice needs to be tailored to their different needs. Most integrated water management stakeholder processes tend to include ‘farming’ as a single category of interest, and it would be useful to further explore which kinds of farmers are represented, what capacity they have to participate and how their participation influences farmer to farmer transmission of information and advice. These research gaps also have implications for how scientists best participate in such processes — this is another under-researched area. Finally, further research is required on the role played by advice, information and voluntary behaviour in the context of existing or potential legal and economic mechanisms.

The paper has illustrated how these psychological, sociological and institutional literatures can help to guide policy makers and academics working with farmers in the future. It has demonstrated how improving water and agricultural management requires attention to choices made by farmers, to the mechanisms to promote behavioural change, and to what extent behaviour can be influenced through advice. These insights are particularly valuable as climate change conditions will increasingly require adaptive management and collective action. This paper makes a contribution to how researchers may help achieve these goals.

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