Learning to change farming and water managing practices in response to challenges of climate change and sustainability

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Abstract: Extremes of wet and dry weather experienced in the UK in the past few years have raised many questions and issues about traditional water managing and farming practices. Farm infrastructure and traditional machinery have been found limiting in addressing some of the issues that have arisen, such as increases in flooding, diffuse pollution and inability to access land to carry out basic farming operations. This paper considers some reactions to these issues from those who are tasked with trying to address them both in the short and long term. These include those who suggest that it is not the weather that is at issue but how we deal with it, with our legacy systems of technologies and institutions. This paper is written from the viewpoint of considering what kinds of social infrastructure can support learning to make improvements in such situations at a range of different levels. It also reviews the nature of some of the learning that has taken place and discusses implications for future learning system design. Key examples are drawn from two research contexts (i) some long-term inquiries through case studies that concerns water managing, governance and climate adaptation and (ii) a community of researchers working on the development of a new generation of agricultural machines they claim to be more appropriate to extremes in weather. Theories of learning systems inform this contribution.

Keywords: learning systems, change, innovation, farming, water, thinking, practices

Introduction

A huge tractor is bogged down in mud as a farmer tries to go about usual cultivation practices. Fields are damaged and cereal yields reduced because of compaction due to heavy machinery being used in wet weather. Pollution incidents occur as slurry storage facilities are unable to cope with unusually intense rainfall (Environment Agency 2013). Residents in the Northumberland town of Morpeth in the UK face a major clean up as floods following unusually high rainfall sweep through their homes for the second time in four years (BBC, 2012). In contrast, fears that droughts have reduced yields of vegetable crops lead to an increase in imports from overseas (International Business Times, 2012). Such incidents have been a part of my experience and learning as an academic, researcher and UK resident over the past two years, since the last IFSA symposium. This paper reflects on these and similar incidents in the context of recent and relevant discourses concerning learning systems, sustainability and innovation. The aim of this reflection is to understand the significance of these incidents in what Ison (2010) refers to as a climate changing world.

Contexts of agriculture, climate change and sustainability

In relation to agriculture, climate change is often seen as an exacerbating factor rather than the driving force of change (DEFRA 2012). Key challenges for the UK agriculture sector include food security, rising demand for food due to population growth, changing consumer preferences, compliance with regulations, increasing energy prices and market competition (ibid). The increased occurrence of extreme weather events, generally accepted to be linked to longer term

climate change, has in recent years proved particularly challenging for many UK farmers. For instance in 2012 the UK Environment Agency reported a reversal of a general decline (from 2008-2011) in pollution incidents in agriculture. "The large majority of incidents came from dairy farms spreading or storing slurry. The prolonged wet weather in 2012 may have contributed to this increase by filling uncovered slurry stores more quickly than expected and causing structural damage or by washing slurry that had been spread on fields into rivers and streams" (Environment Agency 2013, p.13). The cold spring of 2013 frustrated livestock and arable farmers alike, with large scale losses of new born lambs and crops failing to grow in some areas. Later in the year intermittent but unusually severe hail storms destroyed some crops just about to be harvested. 2014 started with the wettest January since records began in parts of Southern England (Met Office 2014) and consequently with extensive and enduring flooding that has affected huge areas of farm land as well as towns and villages.

Farmers have always been challenged by the UK's changing weather so it could be argued that there is little that is new here. Yet there is growing evidence in the UK that the agricultural sector is beginning to respond in different ways to the challenges of extremes in weather than it has done in the past. Blackmore (2014) argues that being able to respond appropriately to changing weather conditions is partly a technological issue – i.e. it is not that the UK now experiences 'the wrong kind of weather' but that responses to the weather often include use of the 'wrong kind of machinery' because of a legacy of large and heavy agricultural machinery used for economies of scale. Blackmore and his colleagues are among those beginning to experience more open-ness to some radical changes in farming practices, partly in response to increasingly volatile weather. (This example is discussed later in this paper.)

Efforts to understand farmers' responses to changes they are both experiencing and making are evident in recent literature. One example comes from the UK's Demonstration Test Catchment project (DTC, 2013), in which context the UK's Agricultural Advisory Service (ADAS) recently surveyed farmers in sub-catchments in the River Avon area about their opinions on diffuse pollution. This survey was intended both to give a baseline for interpreting water quality and aquatic biology data and to find out about current and future use of on-farm mitigation measures. Although weather is just one of many factors in diffuse pollution the survey's findings did give some clues about attitudes to making changes from traditional water managing and farming practices. It was for instance found that (i) the most common soil management practices adopted were to cultivate compacted soils, cultivating and drilling across the slope and ditch management and (ii) that the measures farmers indicated they were least likely to adopt in the future fell into the land use change and farm infrastructure options. This suggests to me that these particular farmers are beginning to work differently than in the past, albeit in an incremental and perhaps experimental way.

Further insights into how farmers are thinking about change come from Geoghegan and Leyson (2012) who considered responses to climate change among farmers in Cornwall, UK, from a cultural geographical perspective. This perspective provided critical and interpretative methodologies and a lens concerned with the construction of knowledge, the workings of social relations in space and place-based identities. It focused on three ways in which lay climate knowledges were articulated by a group of farmers in a particular landscape: weather and seasons, embodied and experiential knowledges, and farming practices. Geoghegan and Leyson concluded that "For the majority it is the circumstantial, suggestive, remembered and observed changes to weather, seasons and climate that form the basis of an understanding of what is changing, if not why." They found that "…'placing' climate change in the context of the farm provided a way of imagining the past, present and future and enables a conversation about climate and the ways it may change that draws on local structures of feeling, lay knowledges and personal experiences." One outcome of this place-based approach was that it highlighted specific details of people's experience

of climate and place and enabled " a re-evaluation of lay knowledges, and a fresh understanding of the ways in which different actors and interest groups negotiate the future in terms of responsibility for and custodianship of local landscapes." (Ibid p.64)

How humans respond to change more generally is discussed by Wals and Corcoran (2012) who argue that rapid changes to people and planet – physical, social and cultural - impair our ability to respond to urgent sustainability challenges. They also note that "part of the difficulty in addressing unsustainability lies in the complexity, power dynamics and uncertainty that surrounds sustainability issues" (Ibid p.23). Ison (2010) also recognises issues of complexity and uncertainty when considering how we might respond to human-induced climate change through systems thinking and practice. He elaborates how we can take responsibility for the world we are creating, including the climate we are changing, by paying much more attention to how we think and act.

From the selection of examples and literature discussed so far, two emergent themes that in my view warrant closer scrutiny when considering what and how learning to change takes place and how to support it are: the nature of responses and the relationship between past, present and future practices. One kind of theoretical perspective with potential to illuminate these two themes is a learning systems perspective. It is particularly relevant to the kinds of dynamic situations of complexity, uncertainty and interconnectedness associated with farming practices. The concept of a learning system can have different meanings, some are in popular usage and others are applied more specifically and technically, as is the case here. A learning systems perspective that draws on systems theoretical and practice traditions, where a system of interest with the purpose of learning can be identified is most appropriate here. In the context of this IFSA workshop with its focus on innovation platforms, the purpose of a system of interest might also be innovation.

Learning systems perspectives

Traditions of learning systems that draw on systems theory and practice have become established through the work of Schön (1973), Vickers (1965, 1987), Bawden (1994, 1995, 2007), Wenger (2000), and others, who have all drawn on classic systemic works on learning (e.g. John Dewey (1933), Kurt Lewin (1946) and Gregory Bateson (1972), see Blackmore, 2009 for a fuller discussion).

In the context of the two themes that have emerged in this paper (i.e. the nature of responses and the relationship between past, present and future practices) those theories that explicate the dynamics of learning and the idea of responses and responsibility are particularly relevant. These include:

Vickers' work on appreciative systems which made explicit a temporal dimension and put forward the idea of changing our settings (or 'readinesses of the mind to see, value and respond') through appreciative inquiries, as a way of understanding the dynamics of learning (Vickers,1965 p.54, Blackmore, 2010a). Vickers' analysis brings into question what we can and cannot perceive at a particular time, suggesting a need to consider past, present and future learning as interrelated. His writing considers both individual and group processes of change.

Schön's work offers insights into how learning systems can be viewed as constructs for a range of different purposes, where opportunities for learning might lie and how inter-connected transformations relate to each other. Schön also identified a need to consider issues of design and institutions when supporting learning.

Wenger's primary focus is on communities of practice and his use of systems theories is more implicit than explicit. His development of the notion of a 'trajectory' is particularly relevant here– a past, present and future pathway. Wenger developed this concept to help people under-

stand their identities in relation to communities of practice. He claims that 'a sense of trajectory gives us ways of sorting out what matters and what does not, what contributes to our identity and what remains marginal' (Wenger 1998, p155). Groups as well as individuals can usefully review their trajectories.

Bawden (2000) develops the idea of *critical* learning systems, in order to draw out an ethical component in systemic inquiry and discourse. This aspect is particularly relevant when considering responsibility and not just what changes occur but what *should* change from an ethical viewpoint and how such change might be supported.

I have previously drawn on the work of all four of these authors in my research on environmental decision making and in synthesising perspectives on social learning systems for students studying for an Open University's postgraduate module on managing systemic change (Blackmore (2009, 2010a)). I have also repeatedly discussed the work of these authors in previous contributions to IFSA symposia (Blackmore 2002, 2004, 2006, 2010b, 2012). Therefore I will not go into further detail here but instead will next elaborate further two examples that help to illuminate the relationship between past, present and future practices and the nature of responses to change. Whereas the examples discussed at the start of this paper were about individual inquiries concerning changes farmers are making, each of the following examples has a research and practitioner community at its core, spans a longer time frame and could be conceptualised as a platform for learning and innovation. I discuss later in the paper how learning systems perspectives can help to understand and show how to support learning responses to change.

Past, present and future practices 1. The case of agricultural robots – an innovation and futures response to change

In presenting his vision of future farming systems underpinned by agricultural robotics, Blackmore (2014) urges farmers to respond to unforeseen changes in the weather (accompanied by other economic, environmental, social and institutional changes to the contexts of farming), by engaging in 'real-time' farming. This engagement means moving away from a calendar base and from doing what has worked in the past at particular times of year. For Blackmore, real-time farming involves increasing farmers' capacities to learn quickly so that they know and are able to respond to current conditions. A key implication of real-time farming is to make a change from past practices, which have often had unintended consequences such as soil compaction, overuse of fertilisers and pesticides and inefficient use of water. Changes in thinking as well as in practice are needed (Blackmore, 2014; BBC Radio 4, 2014).

Blackmore 2012 considered how agricultural and robotics communities were beginning to work together in order to improve the efficiency and sustainability of agricultural production, facilitated by a relatively small group of agricultural engineers who acted as 'boundary spanners'. (This community has close links with precision farming communities.) At that time a new community of practice was developing that embraced both agricultural and robotic opportunities. In this case change in farming practices and technology is often framed as innovation, in the sense of renewal of products, service or process with successful implementation (van Oost, 2014). This kind of activity deals with a full cycle of innovation, including conceptual development, design, build and trialling of commercial applications. It sits well with the European Union's innovation policy for enterprise and industry that is about helping companies to perform better and contributing to wider objectives such as growth, jobs and sustainability. This agricultural robotics community continues to thrive despite economic downturn across Europe. It is distinctive in its dynamic relationships among academic researchers, farmers, business and industry. As more stakeholders engage with this technology-focused kind of response to changing circumstances and conditions,

this community has moved away from a culture of technology transfer (from researchers to users) to a more collaborative way of working.

Past, present and future practices 2 – designing learning for systemic innovation in water managing and governance through long term case studies

Colvin et al (in press) report on three case studies that have been at the core of a decade of inquiry into changing water managing and governance practices. All three cases, which originated from SLIM, an EU Fifth Framework Research Project (2001-2004), are concerned with social learning. One of the case studies came from England & Wales where developments in the application of social learning approaches to river basin planning in the context of the Water Framework Directive at first appeared to be promising but were subsequently marginalised. However the approaches resurfaced towards the end of the 10-year period of study. A second case study from Italy considered the trajectory of a series of research projects. A part of this trajectory was a five year project to support the development of climate change adaptation policy for Italian agriculture that began in 2008. The third long-term case focused on the implementation of the National Water Resources Strategy in South Africa with three cycles of inquiry. Critical incidents in these cases were recorded and analysed.

Colvin et al (in press) discuss their overall design praxis related to the SLIM design framework, comparing starting conditions for each inquiry and pathway dependencies which support and constrain social learning locally. They conclude that these long term case-based inquiries opened up spaces for learning and systemic innovation - where innovation refers to new processes, institutions or ways of working that meet a set of needs or tackle a set of problems (World Bank, 2006; Bacon et al, 2008). Colvin et al also discuss contexts in which the framework appears to have been most and least effective. Limitations are noted at the level of orchestrating regime level innovation. One response to this limitation from some of those involved has been an increasing focus on water governance rather than on managing and use of water resources. For example, the research project CADWAGO (Climate adaptation and water governance - reconciling food security, renewable energy and the provision of multiple ecosystem services) has continued to build on the UK and Italian cases along with others, to create a forum and dialogue between researchers and stakeholders at different scales. CADWAGO is an ongoing research project that aims to improve water governance by developing a more robust knowledge base and enhancing capacity to adapt to climate change (see http://www.cadwago.net/).

Through this longer-term perspective it can be seen that changes in practices are not always a progression in one direction of change (e.g. towards more social learning approaches) but an iterative process.

My own role in this succession of case studies has been as one of a small group of researchers involved at different times in the UK inquiries. I also conducted an inquiry into what supports learning for environmental decision making (EDM), partly among European researchers involved in this ‘decade of inquiry’ (Blackmore, 2009). An example of the types of inter-related change involved in these changing water managing practices is given in Table 1 where changes in individuals experiences are nested in attributes, engagements and mediators (such as institutions) with environmental change situations. These changes are interdependent.

Table 1: Examples of changes as learning, in the context of managing water resources

EDM situation	Environmental change	Changes in mediators	Changes in Engagements	Changes in Attributes	Experiences of change at individual level
Managing water resources	Climate change – increased flooding or drought	New principle for multi-stakeholder decision making. Water Framework Directive. New government policies.	Increased constructive interactions with other stakeholders. Increased monitoring of effects of actions on each other. Developing proposals for improvement.	Facilitation skills. Understanding cumulative effects of stakeholder actions. Conceptual changes regarding what constitutes expertise.	Improved communications about flooding and drought. Stakeholders observed to be acting purposefully together. Improvements experienced in planning.

Source: I1, I4, I5, I7, I8, I11 – I14, project-based inquiry (Blackmore, 2009)

My perspective on CADWAGO is currently one of taking part in two of its work packages, one on systemic governance practices and one on governance learning. This continuing activity has enabled me to observe a variety of responses - ranging from removing flood defences and making more space for water, to improved measures across a catchment and a catchment–based approach. I have also taken an active part in designing workshops for governance learning.

Discussion

There are many who see learning and innovation with key roles to play in responding to the challenges of climate change and sustainability (Wals and Corcoran, 2012; Ison, 2010; Leeuwis and Pyburn, 2002; Snyder & Wenger, 2004). But the dynamic nature of learning is notoriously difficult to capture in order to understand how past, present and future thinking and action are connected. To be able to understand which changes are feasible as well as desirable it is also necessary to consider dynamics aspects of how such thinking and action *should* be connected, in the critical sense of which past practices should or should not continue in the interests of sustainability. Vickers' deliberations about appreciative systems offer many insights into the dynamics of learning. In particular he refers to the need for individuals, groups and societies to re-set their 'appreciative settings' (readinesses of the mind to see, value and respond) when they are in the process of appreciating situations. Colvin et al (in press) and Blackmore (2014) both describe processes of changing readinesses to see, value and respond recognising the need to change thinking as well as practice.

As the rate of physical, social and cultural change in many parts of the world accelerates (Wals and Corcoran 2012), is it inevitable that our ability to respond is impaired? How quickly can our appreciative settings change? This is clearly an issue for Blackmore's real-time farming activity. It appears that new technologies can help but changing thinking and practice also requires space for reflection-in-action (a distinction made by Schön). The changes in thinking and practices that Colvin et al (in press) describe, that developed over time among researchers and other practitioners, could also be described as re-setting appreciative settings over time. In this case one apparent change in settings included readiness to value social learning approaches,

While becoming aware of the need to change how we see, value and respond might help in speeding up our ability to respond, it does not necessarily mean that any changes made will improve situations from a sustainability point of view. Models of somewhat unsustainable economic

growth and competitiveness rather than sustainability still underpin many innovations, such as those associated with new technology, so it is important to recognise underpinning values and ethics and what needs to change. Adding a critical dimension to inquiries that concern change, where ethical considerations are made explicit in this process is likely to make more evident what kind of improvements are likely to result. Including this ethical dimension is consistent with Bawden and his colleagues' view of learning systems.

The interconnected nature of changes that need to come into effect at different levels is also a challenge for learning and innovation, reinforcing the need to understand learning and innovation as systems. Schön (1973, p. 161) recognised that 'transformations of local systems influence one another and may be supported in doing so' and that 'the gradual transformation of the system as a whole influences the context in which each local system experiences its own transformations'. The related changes in water managing detailed by Blackmore (2009) give an example of such inter-related transformations.

Sterling (2012 p514) contrasts anticipative learning or 'learning by design' with reactive learning "Default learning happens when events impress themselves on the learners' consciousness, by surprise, shock or crisis. Learning by design, by contrast, implies a prior awareness, a willingness, openness and intention to learn in response to a perceived innovation, threat or opportunity. The former is a reactive response, the latter an anticipative response."

Further inquiries would be needed concerning the nature of the responses to change described in this paper in order to understand whether they are reactive or anticipative but design has clearly had a role to play in learning to change. Some of the examples discussed show that inquiries of various kinds in different cases and communities can open up space for learning and innovation. A key part of these inquiries is their design. Wenger (1998, p.225) argued that learning cannot be designed but is something that happens, whether designed or not. He focused instead on designing social infrastructure that fosters learning, claiming that there are few more urgent tasks. Colvin et al do not frame their work in terms of social infrastructure. But their focus on design praxis including processes and spaces for social learning and systemic innovation does appear to exemplify some kinds of social infrastructure that can support change. By way of example, table 2 lists some of the elements Colvin et al. mention as important in opening up spaces for learning that included elements of design. These elements are all structures of one sort or another that have the potential to enable interaction so could easily be considered as elements of social infrastructure.

Table 2: Elements of social infrastructure in Colvin et al's 'decade of inquiry' into water managing and governance using long term case studies?

• Policy instrument - Water Framework Directive
• Partnership agreement between two overlapping communities of practice to investigate social learning approaches
• Pilot and stakeholder engagement studies
• Policies set out in the South African National Water Act (NWA)
• Pathfinder inquiries
• Meta-level cycles of inquiries
• Two-year conversation processes of project design
• Workshops for project steering committee
• Workshop designed to open a new space of conversation between local stakeholders, researchers and national policy makers.

Source: Elements cited from Colvin et al (in press)

Geoghegan and Leyson design of a place-based approach also appeared to support a learning process, to new understanding and possibilities for the future. Their concern with the workings of social relations in space and place-based identities also exemplies elements of social infrastructure that might be designed. The design of ways to increase farmers capacities for real-time farming and innovation is at the core of Blackmore and his colleagues futures response to change, with technology playing a mediating role. In their case, elements of social infrastructure have included digital media, information and communication technologies and a succession of conferences, calls for funding, workshops and projects that have provided opportunities for learning. The robots and precision farming technologies could also be considered a part of the social infrastructure as they have taken the role of mediating objects in developing new understandings among a range of stakeholders.

Conclusion

Learning to change farming and water managing practices is essential if we are to respond appropriately to challenges of sustainability and climate change. Several examples of changing thinking and practice have been described and discussed in this paper. Learning systems theories have helped to draw out some of the elements, processes and connections that characterise responses to changes that farmers, researchers and other practitioners have been experiencing in the past few years, such as extreme weather events. Further inquiries are needed in order to understand the relationship between past, present and future practices and the nature of the social infrastructure that might best support learning in all the situations discussed. My hope is that this paper does at least show that a start has been made in understanding these interconnections and what can support learning to change some aspects of farming and water managing practices in response to challenges of climate change and sustainability.

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