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Can fuzzy cognitive mapping help in agricultural policy design and communication?

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ABSTRACT

Agricultural environmental regulation often fails to deliver the desired effects because of farmers adopting the related measures incorrectly or not at all. This is due to several barriers to the uptake of the prescribed environmentally beneficial farm management practices, most of which have been well established by social science research. Yet it is unclear why these barriers remain so difficult to overcome despite numerous and persistent attempts at the design, communication and enforcement of related agricultural policies. This paper examines the potential of fuzzy cognitive mapping (FCM) as a tool to disentangle the underlying reasons of this persistent problem. We present the FCM methodology as adapted to the application in a Scottish case study on how environmental regulation affects farmers and farming practice and what factors are important for compliance or non-compliance with this regulation. The study compares the views of two different stakeholder groups on this matter using FCM network visualizations that were validated by interviews and a workshop session. There was a farmers group representing a typical mix of Scottish farming systems and a non-farmers group, the latter comprising professionals from the fields of design, implementation, administration, consulting on and enforcement of agricultural policies. Between the two groups, the FCM process reveals a very different perception of importance and interaction of factors and strongly suggests that the problem lies in an institutional failure rather than in a simple unwillingness of farmers to obey the rules. FCM allows for a structured process of identifying areas of conflicting perceptions, but also areas where strongly differing groups of stakeholders might be able to gain common ground. In this way, FCM can help to identify anchoring points for targeted policy development and has the potential of becoming a useful tool in agricultural policy design and communication. Our results show the utility of FCM by pointing out how Scottish environmental regulation could be altered to increase compliance with the rules and where the reasons for the identified institutional failure might be sought.

Introduction

During an inspection of Scottish watercourses as a first step in a national strategy to mitigate diffuse pollution, a significant number of breaches of formal regulations to prevent diffuse pollution were identified (SEPA, 2014a). Specifically for the case of keeping livestock from creating bank erosion (General Binding Rule (GBR) 19 in Scottish regulation (SEARS, 2009b)), breaches were found to occur on average once per kilometre of the examined waterways. These findings constituted a challenge to the regulatory framework of Scotland, including the obligatory GBR related cross compliance to receive European Common Agricultural Policy related subsidies (Scotland. et al., 2013; SEPA, 2011) and the achievement of the good ecological status prescribed by the Water Framework Directive (WFD) (SEPA, 2013). The number of breaches of GBR 19 indicated that there might have been other breaches to the remaining GBRs taking place, such as regulation on use of fertilizer (SEARS, 2009a) and land cultivation (SEARS, 2009c). The problem could be framed as an issue of failure with regards to communicating landscape stewardship issues among Scottish farmers who either are not aware of regulations or actually choose to ignore them. But it might also be interpreted as a case of institutional failure on behalf of the government. Instead of trying to point out responsibility to each of the two actors, government or farmers, it might be more fruitful to frame the issue as a matter of (not) reaching an alignment on what constitutes proper agricultural and landscape management between the perspectives of farmers and other relevant stakeholders involved in policy design and communication. Dissonance in

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terms of perspectives or perception among heterogeneous stakeholders has been identified in many other contexts apart from Scotland. Examples include water management issues in Australia (Marshall, 2013), issues of multifunctional agriculture in the EU and Australia (Burton and Wilson, 2006; Elands and Præstholm, 2008; Wilson, 2004) as well as numerous studies within the field of social learning in relation to natural resource management across different EU member countries, as well as North America (Blackmore et al., 2007; Evely et al., 2008; Holling, 2001).

The context for the present paper is a case study on perceptions of the environmental regulatory framework and farm and landscape ecology among farmers and relevant stakeholders in rural Scotland. In this research, we refer to the later as non-farmers, which include those involved in the design, implementation, administration, consultancy/communication/advice on or enforcement of the regulation. In sum, non-farmers are not involved in the farm practices themselves, but that can influence, on a way or another, the way that regulation is designed or communicated to farmers. Starting from the hypothesis that there is a lack of alignment between farmers and non-farmer's perceptions on environmental regulation and factors determining compliance, the present study addresses the following research questions:

(1) Can fuzzy cognitive mapping (FCM) help to diagnose and disentangle the (lack of) alignment of perceptions between the different groups (i.e. and therefore help corroborating or rejecting the hypothesis)?
(2) Can the insights gained from the use of FCM be used to provide input to how improving policy design and communication?

It is our ambition that this inquiry can lead to a better understanding of what may promote complicance and non-compliance of GBRs, and thereby to derive recommendations for how to successfully adapt the agro-environmental regulation both in Scotland, and in general in all contexts in which diffuse pollution from agriculture remains a critical challenge. For this purpose, groups of Scottish farmers and non-farmers participated in a series of workshops, where they were asked to produce fuzzy cognitive maps based on the question "*How do environmental regulation affect farmers and farming practices and what is important for compliance or non-compliance with GBR (General Binding Rules)?*"

Firstly, the paper presents a brief introduction to FCM and its implementation in land use policy and planning. Secondly, a further development and adaptation of the FCM methodology is described in the form of a step by step procedure of its application in this research. Consequently, results from the Scottish case study are synthesized graphically in the form of Fuzzy Cognitive Maps over the central concepts identified as important to affect farmers and farming practices. Finally, the mapped differences between farmers and non-farmer's perceptions, and the relations between the different central concepts are discussed, and used to suggest recommendations for future policy development.

A brief history of fuzzy cognitive mapping (FCM)

Fuzzy cognitive mapping originates in the work of Robert Axelrod (Axelrod, 1976) within the field of political science and the work of Bart Kosko (Kosko, 1986, 1988) within the field of information science. Axelrod introduced cognitive mapping as a distinct form of representing social scientific knowledge on causal relations. In his seminal work, Bart Kosko focused on cognitive maps as an approach to deal with uncertainty of causal knowledge, hence the term *fuzzy* cognitive mapping. More recent applications of Kosko's ideas have expanded the range of contexts within which FCM have been applied. One particularly relevant field of inquiry in relation to our case is sustainable development (Dodouras and James, 2007). Dodouras and James have suggested FCM as an appropriate approach to address issues of sustainable development, where the aim is to "*reduce multidisciplinary conflicts, explain complex phenomena and lead to more informed decisions*" (Dodouras and James, 2007: 827). Other important objectives include the involvement of "*all interested parties in defining their current and future needs and priorities, and in identifying their own proposed solutions*" (Dodouras and James, 2007: 827). Other approaches within the field of landscape ecology have expressed similar considerations. Özesmi and Özesmi states, in relation to a case study in Turkey, that "*. . .for successful conservation and sustainable development to occur, many stakeholder groups need to be involved in the process. Within this process, a rigorous scientific approach that can quantify the subjective perceptions of the different stakeholder groups can be useful. Such a method can be helpful both to obtain the support of the participants and to compare the similarities and differences among groups of stakeholders. Such a method may also make it easier for the groups to make decisions together and accept the results. Fuzzy Cognitive Mapping (FCM) offers such an analysis*" (Özesmi and Özesmi, 2003: 518). These authors suggest four types of problems where FCM is particularly useful (Özesmi and Özesmi, 2004). These problems include (1) where human actions affect ecosystems, and (2) where detailed scientific data are lacking but local knowledge or indigenous knowledge does exist. The third type of problems are (3) where problems are "wicked", meaning that there are many diverging perspectives on what constitutes the problem and that there are no optimal solutions to be found (Bouma et al., 2011; Norton, 2012; Rittel and Webber, 1972; Whyte and Thompson, 2012). The fourth type of problem is (4) where public involvement or intervention is desired or even mandated by law.

Our case in Scotland exhibits three of these attributes. First, it is a case of human action affecting the environment. Second, it is a case where there is a lack of knowledge, or to put it more precisely, a lack of integrated knowledge on the interaction between agricultural management and landscape development (in this case the ecological state of waterways). Third, our case also exhibits some attributes of being a "wicked" problem, as there is obviously heterogenous perceptions of what constitutes proper land management between farmers and non-farmers (Martin-Ortega, 2012). The fourth type characteristic suggested by Özesmi and Özesmi, matches the WFD's public participation principle. Although the expression "public participation" does not appear in the Directive, three forms of public participation with an increasing level of involvement are mentioned: (i) information supply; (ii) consultation; (iii) active involvement. According to the Directive, the first two are to be ensured, the latter should be encouraged (Martin-Ortega et al., 2014). The specific type of involvement on behalf of the government is up to national discretion (EC, 2003). The present study may serve as inspiration for governmental authorities (e.g. The Scottish Environmental Protection Agency SEPA or The Scottish Natural Heritage SNH) and policy makers (e.g. the Scottish Government or the European Commission) on how to improve the effect of agro-environmental policy measures, and avoid the failures described above. In either case, FCM offers an approach which allows different actors to map their own perception of causal relations between entities which are part of their life world.

Applications and adaptions of FCM

Among the various applications of FCM which can be found, different modalities of using FCM can be identified. In a study by Fairweather (2010), the FCM was adapted to reflect different perceptions of socio-ecological systems across different locations. A distinct feature of the study was that FCM was applied in a semi-structured manner, meaning that at least half of the factors which