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Measuring Social Learning in Participatory Approaches to Natural Resource Management

Merel van der Wal,[1]* Joop De Kraker,[1] Astrid Offermans,[2] Carolien Kroeze,[1,3]
Paul A. Kirschner[4] and Martin van Ittersum[5]
[1]*Open Universiteit, School of Science, Heerlen, The Netherlands*
[2]*Maastricht University, International Centre for Integrated Assessment and Sustainable Development, Maastricht, The Netherlands*
[3]*Wageningen University, Environmental Systems Analysis, Wageningen, The Netherlands*
[4]*Open Universiteit, Centre for Learning Sciences and Technologies, Heerlen, The Netherlands*
[5]*Wageningen University, Plant Production Systems, Wageningen, The Netherlands*

ABSTRACT
The role of social learning as a governance mechanism in natural resource management has been frequently highlighted, but progress in finding evidence for this role and gaining insight into the conditions that promote it are hampered by the lack of operational definitions of social learning and practical methods to measure it. In this article, we present a simple and flexible method to measure social learning, whether it has occurred and to what extent, among stakeholders in natural resource management. The method yields measurements of social learning that are visual, quantitative and qualitative. First, we elaborate our definition of social learning as a convergence of perspectives and outline how stakeholder perspectives in natural resource management can be described with Cultural Theory. Next, we provide a generic description of the method, followed by two examples illustrating its application to the domains of water and land management. Finally, we discuss relative strengths and weaknesses of the method and how it could be applied to improve our understanding of factors that contribute to social learning. Copyright © 2013 John Wiley & Sons, Ltd and ERP Environment

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Introduction

Many of the current issues in the management of natural resources can be qualified as 'wicked' or 'unstructured' problems (Hisschemöller and Hoppe, 1995; Rittel and Webber, 1973). These are complex and dynamic multi-actor problems, characterized by structural uncertainties in knowledge and a diversity of perspectives on what the problem actually is and how it should be solved. A typical example concerns adaptation of natural resource management to climate change (Adger *et al.*, 2007). To cope with such problems, participatory approaches that involve stakeholders in the development of integrated solutions have become popular (Reed, 2008). The expected benefits of such a participatory approach can be summarized as (1)

*Correspondence to: Merel van der Wal, Open Universiteit, School of Science, Heerlen, The Netherlands. E-mail: merel.vanderwal@ou.nl

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improving the quality of the solutions by including relevant non-scientific sources of knowledge and experience, (2) enhancing the relevance, legitimacy and credibility of the solutions by accounting for the diversity of perspectives among the stakeholders and (3) widening the basis of support for the implementation of the solutions. In this context, social learning of stakeholders is increasingly seen as a key component (Muro and Jeffrey, 2008; Reed *et al.*, 2010). Social learning, as we define it, concerns a convergence of stakeholder perspectives on the problem and possible solutions (De Kraker *et al.*, 2011). It supposedly creates the basis for integrated solutions that require collective support and/or concerted action of multiple stakeholders (Röling, 2002), and its potential role as a governance mechanism in natural resource management and climate adaptation has been frequently highlighted over the past decade (see, e.g., Blackmore, 2007; Bouwen and Taillieu, 2004; Collins and Ison, 2009a; Pahl-Wostl *et al.*, 2007). However, so far there is only limited empirical evidence of the actual contribution of social learning to participatory management of natural resources, and better understanding is needed of how social learning can be facilitated to achieve the desired outcomes (Muro and Jeffrey, 2008). Progress in finding evidence for the occurrence and contribution of social learning and gaining insight into the conditions that promote it are hampered by the lack of clear, operational definitions of social learning and practical and reliable methods to measure it in the context of participatory approaches (Reed *et al.*, 2010).

In this article, we present a simple and flexible method to measure social learning, whether it has occurred and to what extent, among stakeholders in natural resource management. First, we elaborate our definition of social learning as a convergence of perspectives and outline how stakeholder perspectives in natural resource management can be described with Cultural Theory (Buck, 1989). Next, we provide a generic description of the method, followed by two examples illustrating its application to the domains of water and land management. Finally, we discuss the relative strengths and weaknesses of the presented method and how it could be applied in combination with in-depth analysis of the communicative interactions between stakeholders, to improve our understanding of the process features and context factors that contribute to social learning.

A Method to Measure Social Learning

Social Learning as a Convergence of Perspectives

We define social learning – in the context of a participatory approach to a complex problem with multiple stakeholders – as a convergent change in the stakeholders' perspectives on the problem and its possible solutions and risks, as well as on their own and the other stakeholders' position and responsibility with regard to solving the problem (De Kraker *et al.*, 2011). Our definition implies a focus on the social-cognitive dimension of social learning, which is common in the environmental and natural resource management literature (Muro and Jeffrey, 2008; Reed *et al.*, 2010; Schusler *et al.*, 2003; Van Bommel *et al.*, 2009). Changes in the social-relational dimension such as development of trust, improved communication and better working relations (Mostert *et al.*, 2007; Pahl-Wostl and Hare, 2004), and changes in stakeholders' behaviour and actions (Collins and Ison, 2009b), are outside the scope of our definition and measurement approach.

As Reed *et al.* (2010) observed, in the natural resource management literature, clear and distinctive definitions of social learning are often lacking. As a consequence, substantive evidence of social learning is rarely provided, which hinders progress in understanding of the factors that promote social learning. We defined social learning with the explicit aim to make it measurable, and our definition is in line with the proposal of Reed *et al.* (2010) to define social learning as (1) a change in understanding in individuals that (2) goes beyond the individual and (3) occurs through social interactions between actors in a social network. Reed *et al.* (2010) use the term 'understanding', whereas we chose 'perspective', but in both cases the term refers to the cognitive dimension of learning and encompasses not just knowledge but also goals, values, norms and beliefs. More precisely, in operational terms, we understand an individual's perspective to be a set of concrete beliefs about a complex problem, based on his or her knowledge, goals, values, norms and causal beliefs. These concrete beliefs pertain to the nature of the problem, the risks involved, the feasibility of possible solutions and the distribution of responsibilities to solve the problem.

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Changes in these concrete beliefs are understood to originate from changes in the underlying convictions. In the learning literature this is commonly known as 'double loop learning', in contrast to 'single loop learning' which concerns only changes in 'technical' knowledge and beliefs, e.g. about the effectiveness of certain actions. The concepts of single- and double-loop learning were coined Argyris and Schön (1978) and refer to the feedback loops in a learning process. In single-loop learning there is only one loop of error correction, i.e. between actions and their outcomes. Actions are changed when they do not have the desired outcomes, without questioning or altering the existing framework of goals and causal beliefs underlying the actions. In double-loop learning, a second feedback loop is added when the perceived range of options does not result in desired outcomes. In this feedback loop, the underlying frame of goals, values, norms and beliefs is included in the learning process. Social learning, as defined above, can thus be seen as double-loop learning in the context of a group and as a consequence of the social interactions within that group. It refers specifically to convergent and not to divergent changes in perspective, in line with the original conception of social learning as learning by observing and imitating others (Bandura, 1974).

Concerning the interactive processes that bring about social learning, the literature often points out the importance of collectively going through the loops in a learning process. For example, McCrum *et al.* (2009) refer to this as collective action and reflection, and Jiggins *et al.* (2007) as shared, experiential learning, amplified by facilitated communication and dialogue. In other words, individual perspectives may change when expectations are not met by observations, and this change may be convergent at group level, when the members of the group make their expectations explicit and exchange their views, and reflect jointly on new information and possible discrepancies with initial expectations ('surprises'). Whether such interactions between stakeholders do result in social learning depends on a broad range of conditions, including case-related factors, such as urgency, convergence of interests, mutually felt positive interdependence and trust, limited risk and balance of power among the stakeholders and a supportive institutional context, as well as a variety of process-related factors, such as balanced stakeholder selection, effective leadership or facilitation, space for reflection, safe and informal environment, and transparency (Aarts and Van Woerkum, 2002; Leeuwis, 2002; Mostert *et al.*, 2007; Van Bommel *et al.*, 2009; Wildemeersch, 2007).

Describing Perspectives with Cultural Theory

In the previous section we have elaborated our definition of social learning as a convergent change in perspectives. According to this definition, measurement of social learning requires a method to measure perspectives as well as change in perspectives and convergence. The method we present in this article is based on the work of Offermans and Valkering, who studied the dynamics of societal perspectives on water management (Offermans *et al.*, 2011; Valkering *et al.*, 2011), mainly drawing on Thompson *et al.* (1990). Thompson *et al.* (1990) developed an extended version of Mary Douglas' so-called Cultural Theory, which describes four archetypical active world views: the hierarchist, the individualist, the egalitarian, and the fatalist view. Key elements in these world views are the beliefs held regarding human nature and physical nature, and the relationship between human needs and natural resources. Van Asselt *et al.* (1995) made a further distinction between 'world view' (how the world is seen) and 'management style' (how the world should be managed), and defined a 'perspective' as the 'perceptual screen through which people interpret the world and which guides them in acting' (Van Asselt, 2000). Thus, in each of the archetypical perspectives, there is a consistent relationship between world view and management style (Table 1). In the hierarchist perspective, regulation of both humans and nature is essential to manage scarcity and risk. The rules should be set by governments, advised by scientific experts. The individualist perspective is characterized by optimism regarding the availability of natural resources and human ingenuity to deal with scarcity and risk. People should be given the freedom to pursue personal profit, and competition will result in innovative, efficient solutions. In the egalitarian perspective, nature is seen as vulnerable and the preferred management style is therefore preventive and risk averse. As everyone's interest and contribution count, cooperation and participatory management approaches are favoured. The fatalist, finally, sees humans as unreliable and nature as unpredictable. The fatalist perspective is therefore characterized by scepticism, indifference and acceptance of risks, and no particular management style is preferred. This classification of perspectives based on Cultural Theory ('CT perspectives') has been frequently and successfully applied to describe and analyse the diversity of societal views on environmental issues and natural resource management (Buck, 1989), including water management (Hoekstra, 1998; Middelkoop *et al.*, 2004) and climate change (O'Riordan and Jordan, 1999; Pendergraft, 1998; Verweij *et al.*, 2006). The elements of the CT perspectives (Table 1) correspond well

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	Hierarchist	Individualist	Egalitarian	Fatalist
World view				
Human nature	sinful	self-seeking	born good, malleable	unreliable
Physical nature	'tolerant': robust within limits	'benign': very robust	'ephemeral': delicate balance	'capricious': unpredictable
Human needs	given and unmanageable	individual and manageable	social and manageable	unmanageable
Natural resources	scarce but manageable	abundant and manageable	finite and unmanageable	erratic and unmanageable
Technology	moderate trust	large trust	low trust	scepticism
Management style				
Humans	regulation	competition	cooperation	coping
Physical nature	control within bounds	adaptive, laissez faire	preventive, treat with great care	passive, incident based
Needs and resources	increase resources to meet needs	match needs and resources with ingenuity	reduce needs	no strategy
Economic growth	desirable, with conditions	desirable, unconditionally	undesirable	matter of luck
Risk and safety	risk controlling; set standards and limits	risk seeking; take the opportunities	risk averse; reduce and avoid risks	risk acceptance; cannot be changed
Responsibility	government	individuals, private sector	civil society	no preference; apathy
Decision-making process	experts; scientific knowledge	markets; cost–benefit analyses	all stakeholders; participatory process	indifferent; 'they' decide for us
Technological solutions	high tech; expert assessment of consequences	cost-effective innovations; combine with making profits	small-scale technology; behavioural change preferred	no preference; positive/negative effects cannot be predicted
Incentives for problem-solving	governmental regulation based	competition and market based	communication and dialogue based	no preference

Table 1. Four archetypical perspectives according to Cultural Theory.[a]
[a]Based on Thompson *et al.* (1990), Van Asselt *et al.* (1995), Hoekstra (1998), Valkering *et al.* (2011).

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to those we distinguish in our definition, i.e. the stakeholder's perspective on the nature of the problem, the risks involved, the preferred strategies or measures to solve the problem and deal with risk, and the distribution of responsibility for the problem and its solution. The CT perspectives have been criticized for lacking an empirical basis, as people rarely appear to take a consistent and 'pure' CT perspective containing all the typical beliefs (see, e.g., Grendstad and Selle, 2000). However, Offermans (2012) has demonstrated that 'real world' stakeholder perspectives on water management can be adequately described as combinations of beliefs from the various CT perspectives, using these perspectives as reference points for an entire spectrum of 'real' perspectives. In the next section we will present a stepwise method to apply this approach to measure social learning as a convergent change in perspectives.

Measuring Social Learning

The method we present to measure social learning in participatory approaches to natural resource management is based on the premise that the individual perspectives of participants can be described with a set of beliefs based on the archetypical CT perspectives. The method consists of three steps: operationalization of the CT perspectives for a specific context in a 'perspective scoring table', applying the scoring table as a tool for repeated measurement of the perspectives of participants, and analysis of changes in perspectives.

Construction of a Perspective Scoring Table

To operationalize the four CT perspectives presented in Table 1 for a specific natural resource management problem and participatory process, we first need to determine the problem domain, the salient issues and the geographic or administrative scale at which the specific problem is addressed by the participants. Analysis of reports, sometimes supplemented by interviewing experts and/or stakeholders, usually suffices to provide this kind of information. With the information, we can select the most relevant elements of world view and management style from Table 1 and tailor the generic beliefs of each of the four perspectives to the specific problem context. This results in a table with a set of context-specific issues as rows and the four CT perspectives as columns, with the cells containing the perspective-specific beliefs. The next step is to 'translate' the rather abstractly worded beliefs into concrete statements that reflect the vocabulary of the domain and the participants. These statements can be obtained by interpretive analysis of problem-specific reports and/or transcriptions of stakeholder interviews or discussions, classifying and coding relevant statements into one of the four CT perspectives. In cases when no statement representing a perspective-specific belief is found, this belief can be translated into a concrete statement with the help of the statements found for the other perspectives. To reduce researcher bias, the translation of beliefs into concrete statements is best done by at least two researchers, for example with an inter-evaluator reliability test. In this test, a second researcher repeats part of the interpretive analysis. The degree to which the interpretations of statements of both researchers match is called the inter-evaluator reliability. The minimum acceptable reliability level is about 80%. A less time-consuming approach to reduce bias is to have the statements as interpretations of CT beliefs checked by two or three other researchers. The end result is a 'perspective scoring table': a table with statements on salient issues representing the CT perspectives with which participants can agree or disagree. Before use, the labels of the CT perspectives should be removed and the statements on each row must be randomized to reduce bias.

Measurement of Perspectives

The perspectives of participants can then be measured with the perspective scoring table as follows. Participants are asked to mark the statements in the table with which they agree, and are allowed to mark more than one statement per row. This results in a 'score' for each of the CT perspectives: the number of statements a participant agrees with that represent beliefs specific to a particular CT perspective. For example, using a perspective scoring table with 10 rows, a participant may exclusively agree with statements representing hierarchist beliefs, which results in a score of 10 for the hierarchist perspective and a score of 0 for the other CT perspectives. However, in most cases participants agree with statements that represent beliefs specific to two or more CT perspectives, resulting in a mixed score. The individual perspective of a participant can in any case be described with the scores for each of the CT perspectives, constituting a four-dimensional vector. By repeating the measurement with the perspective scoring table at several instances during the participatory process, changes in the perspectives of participants can be assessed, both in terms of the specific beliefs they endorse and in terms of their scores per CT perspective.

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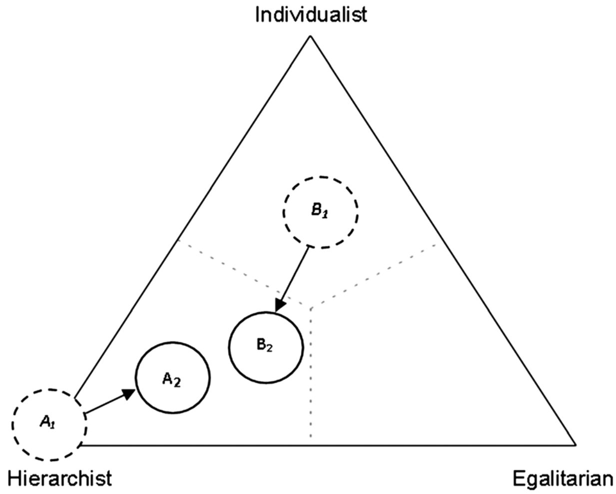

Figure 1. Visualisation of the position of two individual perspectives (of A and B), relative to three CT perspectives (corners) and each other, as measured at two points in time (A_1 and A_2, B_1 and B_2).

Analysis of Changes in Perspectives

The (individual) perspectives and changes therein can be visualized by positioning them in a space spanned by the CT perspectives. For example, Valkering *et al.* (2012) use a triangle spanned by the hierarchist, individualist and egalitarian perspectives at the corners (Figure 1). The position of a particular perspective is determined by its scores for these three CT perspectives, which are normalized and plotted in so-called barycentric coordinates as a point in the triangle. If the fatalist perspective is also included in the measurement, the triangle can be expanded into a three-dimensional tetrahedron with four corners (Offermans, 2012). The advantage of visualization is that it provides a quick and easy-to-grasp insight into the positions of the participants' perspectives relative to the various CT perspectives and relative to each other. Moreover, when repeated measures of perspectives are depicted in the same figure, the overall direction of change in perspective can be rapidly assessed and communicated. For example, in Figure 1, the perspectives of A and B have become less 'pure' hierarchist and individualist respectively, and, at the same time, the distance between the two perspectives has decreased. In other words, the perspectives of A and B have converged. The distance between two or more perspectives can also be expressed numerically, by calculating the percentage agreement. Agreement is calculated as the number of statements with which all participants agree, relative to the total number of statements with which one or more participants agree, expressed as a percentage. For example, in the case of a measurement with a perspective scoring table consisting of 40 statements (10 issues × 4 CT perspectives), there may be 30 statements with which one or more participants may agree. When, out of these 30 statements, there are six statements with which all participants agree, the percentage agreement is 20%. An increase in the percentage agreement between repeated measurements indicates a convergent change in perspectives. The next step in the analysis is then to assess the changes in perspectives in more detail by comparing the perspective scoring tables from the repeated measurements. This will reveal how exactly the beliefs of the participants have changed and on what specific issues they have reached more agreement. Graphical analysis of perspective change, calculation of percentage agreement and assessment of changes in beliefs will thus provide evidence whether social learning (as we defined it) has occurred or not, and to what extent.

Example 1: River Management in the Context of Climate Change

Case Description

The first example to illustrate our method to measure social learning is from the domain of water management. It concerns a Dutch project on river management in the context of climate change.[1] In this project, sessions with a

[1]http://www.deltares.nl/en/product/1518666/sustainable-delta-game.

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serious game were organized with a wide range of professionals from the water management sector (see for an extensive description Valkering *et al.*, 2012). The aim of the sessions was to explore possible climate adaptation pathways in river management and, ultimately, to identify sustainable strategies that are both flexible and robust to changing climatic and societal conditions. During these 3 hour game sessions, the participants had to manage a typical Dutch river basin over a period of 100 years under a transient scenario of climate change. The climate scenario determines the timing and frequency of discharge peaks and water levels in the river. A computer model calculates the combined consequences of water levels and river management strategy for risk of flooding and damage to houses and agriculture, shipping suitability and nature development in the river basin (Haasnoot *et al.*, 2012). In each session, the participants were distributed over two teams, which had to negotiate and choose a joint strategy, i.e. a set of river management measures to be implemented. In four steps of 25 years, the participants were confronted with the performance of the chosen strategy and had to decide on the strategy for the next 25 years. The game sessions were concluded with a debriefing discussion on the game itself, the dynamics of the session and the lessons learned.

Measurement of Social Learning

To measure the perspectives of the participants, a perspective scoring table was developed for the specific domain and scale of the problem, given the salient issues in the Dutch debate on river management (Table 2). Relevant issues were selected and perspective-specific beliefs were formulated and translated into concrete statements on the basis of workshops with water professionals and interpretive analysis of historical studies of river management. The inter-evaluator reliability in the development of the table with the statements was 92% (Offermans and Cörvers, 2012). Note that, in this perspective scoring table, the fatalist perspective was not included. For water managers, the fatalist perspective was considered irrelevant, given the 'passive' nature of this perspective and the lack of preference for a specific management style (Offermans and Cörvers, 2012).

Before the start of a game session, the participants were asked to fill out the (randomized) perspective scoring table. Based on their individual perspectives, the participants were distributed over two teams, each consisting of more or less like-minded members. The teams then again determined, as a group, their positions in the perspective scoring table. This yielded the first measurement of the team perspectives. After each round in the game, the teams were asked to review their positions in the perspective scoring table. Changes in position, if any, were recorded.

The results of a typical session are depicted in Figure 2. This session was organized at the Dutch Water Service, a governmental centre of expertise on water management, and the 10 participants came from a variety of positions and departments within the service. The locations of the team perspectives in the triangle show that initially the teams had quite distinct perspectives. One team perspective could be characterized as predominantly hierarchist, the other team as predominantly egalitarian. However, at the end of the game session, the distance between the two team perspectives had decreased and both teams had become predominantly hierarchist in perspective. The percentage agreement between the teams increased from 42 to 47%. Obviously, the perspectives of the team have converged during the game session, and thus, according to our definition, social learning has occurred. A comparison of the perspective scoring tables at the start and at the end of the game session revealed that the additional statements they agreed all on were mostly from the hierarchist perspective. This resulted in more agreement on the role and risks of technological measures in river management and on how to deal with safety and risk of flooding. In fact, both teams added rather than switched positions in the perspective scoring table, and thus 'expanded' their perspectives.

Example 2: Agricultural Land Use under Climate Change

Case Description

Our second example is from the domain of agriculture, and concerns a project on adaptation strategies for agricultural land use to climate change in the Dutch province of Flevoland (Wolf *et al.*, 2012). In this project, models were developed and applied to provide quantitative insights into the interactions between climate and market changes,

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	Hierarchist	Individualist	Egalitarian
Priority function of rivers	Discharge of water 'Discharge of water, ice and sedimentation.'	Source of prosperity 'A source of material prosperity and self-development; important for the Dutch's image.'	Nature and space 'A source of rest, space and nature.'
Trust in technology	Moderate trust 'I think it is important to thoroughly investigate potential consequences and to ensure that application is not too large-scale.'	Great trust 'I mainly see opportunities in the use of innovative technologies. Available technologies should be implemented rapidly and at a large scale.'	Low trust 'The risks are too high. We should deal very carefully with technologies. I prefer behavioural change over the use of technology.'
Climate change	Average 'I expect average trends, as predicted and forecasted by experts.'	Minimal 'I do not think that the climate will change significantly.'	Extreme 'I think the climate will change even more drastically than expected right now.'
Economic context	Average trend 'Business as usual. I do not expect deviations from current trends as extrapolated by experts.'	Strong growth 'I expect still a significant growth of the population in the Netherlands, as well as the demand for space and the economy.'	Weak growth or decline 'I think population growth, economic growth and pressure on space will stabilize and possibly even decline after a while.'
Safety	Flood prevention 'By flood prevention and control of discharge.'	Adaptation & innovation 'By adaptation to water: by utilizing opportunities and innovative options.'	Avoidance of flood prone areas 'By avoiding flood prone areas and accepting water as part of life.'
Principle of spatial planning	Water follows 'The river follows functions. Preservation of existing space.'	Water offers opportunities 'Functions utilize the river. Creation of space on and around the river.'	Water steers 'Functions follow the river. Give up space if necessary.'
Responsibility	Government 'National government.'	Private sector 'Market players and in risky areas (for example in flood plains) individual citizens.'	Society 'Regional governments, NGOs, in fact everyone should contribute one's mite.'
Decision making based on	Norms and expert knowledge 'Norms and standards set by expert knowledge and research.'	Markets 'Functioning of the free market and privatization. Cost–benefit analyses determine best choices.'	Participatory processes 'Participatory processes with input from all stakeholders.'

Table 2. Perspective scoring table with CT perspectives on river management in the context of climate change. Cells contain perspective-specific beliefs and corresponding statements. After Offermans and Cörvers (2012) and Valkering *et al.* (2012). These authors call this a perspective map.

crop responses and adaptation options. Stakeholders were involved in the project to assess the potential adaptation measures, the support for these measures among the stakeholders, and the likelihood that the measures would be implemented. These stakeholders included individual farmers and representatives of the regional farmers' organization, regional water board and provincial government. In a series of five workshops, scientists and stakeholders discussed the specific conditions and developments in the region and possible climate change impacts, as well as

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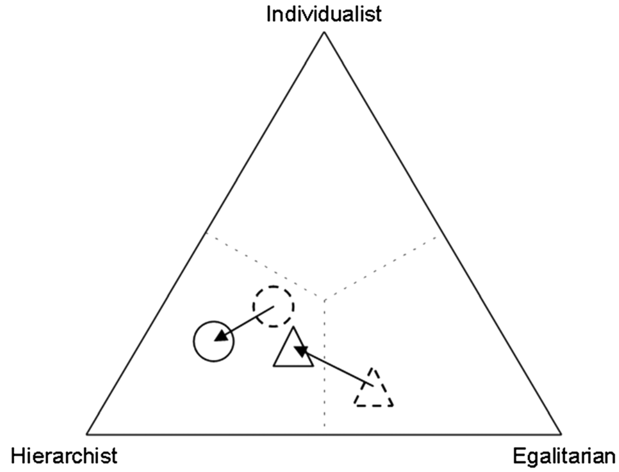

Figure 2. Visualisation of the position of the perspectives of two teams playing the river management game, as measured at the start (symbols with dotted lines) and at the end of the game (symbols with drawn lines)

potential adaptation strategies (see for details Schaap *et al.*, 2011a). During the final workshop, the perspectives of the stakeholders were measured, the results of which are presented below.

Measurement of Social Learning

To measure the perspectives of the stakeholders, a scale- and domain-specific perspective scoring table was constructed (Table 3). Relevant issues, e.g. water scarcity, were selected and perspective-specific beliefs were formulated on the basis of information from project meetings, reports and studies (see, e.g., Schaap *et al.*, 2011b; Mandryk *et al.*, 2012), and interviews with five individual farmers. The generic beliefs in the table were translated by the first author into concrete statements using transcripts of the farmer interviews and the discussions during a previous stakeholder workshop. These statements were independently checked by three other researchers, which resulted only in minor alterations.

At the start of the final workshop, the stakeholders were asked to fill out the perspective scoring table. As two out of the five attending stakeholders were late, they were excluded from the measurements. The remaining three stakeholders were two farmers who were also board members of the regional farmers' organization or the regional water board, and an employee of the regional farmers' organization. At the 3 hour workshop, researchers presented modelling results of possible climate change impacts and adaptation measures at crop and farm level. During and after each presentation many questions were asked by the stakeholders and their concerns were extensively discussed. The discussion focussed on which steps to take for a climate-proof agriculture in the region and the usefulness of the presented results for that purpose. At the end of the meeting, the stakeholders were asked to review their initial positions in the perspective scoring table.

The results, which were also presented and discussed at the very end of the stakeholder meeting, are shown in Figure 3. The initial perspectives of the three stakeholders were not very distinct: stakeholder A had a slightly more hierarchist perspective, stakeholder B's perspective was a perfect balance of hierarchist, egalitarian and individualist beliefs and stakeholder C was even more balanced, with equal scores for all four CT perspectives. After the session, stakeholder A had become a bit more egalitarian and B slightly more individualistic in beliefs, whereas C's position remained unchanged. Overall, the distance between the perspectives had not markedly changed. However, the percentage of statements on which all three stakeholders agreed increased from 29 to 34%, indicating, according to our definition, that social learning had occurred. A comparison of the perspective scoring tables at the start and at the end of the meeting revealed that the additional statements on which they all agreed concerned egalitarian beliefs regarding the issue of responsibility and the preferred type of incentive for problem-solving. As in the previous example, the stakeholders added rather than switched positions in the perspective scoring table, and their perspectives became (even) more balanced.

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	Hierarchist	Individualist	Egalitarian	Fatalist
Function of agriculture	Meeting societal needs	Source of profit and prosperity	Preserving the regional landscape and identity	Determined by external factors
	'Agriculture should fulfil the needs of society, regionally as well as (inter)-nationally.'	'Making profit is the only way to stay in business as a farmer.'	'To maintain and preserve the landscape, that's an important reason to be a farmer.'	'A farmer is what you are, it runs in the family. Whether you can stay a farmer depends nowadays on all kinds of rules and regulations.'
Climate change in next 50 years	Average	Minimal	Extreme	Unpredictable
	'The climate may change a bit, but with good anticipatory policies we can deal with it.'	'The climate won't change that much. Changes are not that fast that we should already consider these now.'	'The weather conditions will probably change a lot. If we already take that into account right now, we can prevent nasty consequences.'	'Climate change is unpredictable. You don't know what's coming, so you can't anticipate.'
Economic context	Average trend	Strong growth	Weak growth or stability	Unpredictable
	'The prices of products and inputs may fluctuate a bit, but not that much that we need to change our policies.'	'A farmer should invest to increase farm-size to stay competitive in a growing market.'	'We can provide well for the regional demands by taking the carrying capacity of the soil into account.'	'The economy is unpredictable. Past years have shown that we really cannot predict its development.'
Water scarcity	Regulate water management to meet needs	Resolve water scarcity individually with ingenuity	Reduce needs to match water resources	Water scarcity is a matter of bad luck
	'By regulating drainage and storage of water at a regional scale, we can prevent scarcity.'	'If water becomes scarce, it is everyone's own responsibility to deal with that. Scarcity can lead to innovative solutions!'	'Water scarcity forces us to look critically at our water needs. Probably there are alternatives to sprinkler irrigation.'	'Water scarcity is nothing new: sometimes it is too wet, sometimes it is too dry. That's how it goes.'
Risk and safety	Risk controlling	Risk seeking	Risk avoiding	Risk accepting
	'We can reduce risks with proper rules and regulations. By damage funds and collective insurance we can protect all against risks.'	'Risks are part of the game, and can best be handled by using the right technology and by individual insurance against possible disaster.'	'We can best avoid risks by taking them into account in our planning. If we need good drainage, we should avoid the lowest-lying areas.'	'Bad things happen, you can't do much about that. It is therefore impossible to anticipate risks.'
Trust intechnology	Moderate trust	Great trust	Low trust	Scepticism
	'I'd rather not rely completely on these new technologies. Good regulations, matching the local situation, are more important.'	'The ultimate solution would be new technologies that enable a closed system, without the need for soil to grow crops. Then you could fully optimise your production.'	'We can't predict all that may go wrong with technology. Therefore it's better not to rely on technological solutions. It is better to restore the balance of nature.'	'We can't rely on future innovations. Many new technologies have been introduced that didn't make it. We never heard of them again.'
Responsibility for problem-solving	Government, experts	Private sector, individuals	Stakeholders	No preference, apathy
	'It's important that all possible measures are first well-	'Everyone is responsible for his own business. You know	'Stakeholders should discuss among themselves about	

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	tested by experts before applying them at a larger scale.'	yourself what's best for your crops and how you can make most profit.'	possible measures and how these should be implemented.'	'In the end, everyone is in it for himself. Cooperation usually ends in dissatisfaction.'
Incentives for problem-solving	Governmental regulations based on expert knowledge	Markets and competition	Participatory planning and dialogue	No preference
	'Subsidies for nature in field margins or solar panels determine the farmer's choice. This is the way to ensure that agriculture meets the demands from society.'	'Those who pay, make the decisions. The government should not interfere with that, the market will provide the right party with the right solution.'	'The regional community, the stakeholders, and the natural conditions together determine what happens. By cooperating, the right knowledge becomes available for everyone.'	'Cooperation is only useful when it turns out well. If there is no clear benefit for the main party, it only slows things down.'
Scope of problem-solving	Long term; strategic policy-making	Medium term; technological progress	Long term; behavioural change	Short term; incident-based response
	'We should already start looking for policy-based, long-term solutions for future problems.'	'Problems should be solved when and where they occur. We do have to plan ahead, but 50 years is almost impossible.'	'Solutions to problems are to be found in our own behaviour and adapting to changing natural conditions. It is best to do this at the local scale.'	'Whatever will be will be, whatever we try to change now. We will look for solutions when the problem manifests itself.'

Table 3. Perspective scoring table with CT perspectives on agricultural land use under climate change. Cells contain perspective-specific beliefs and corresponding statements.

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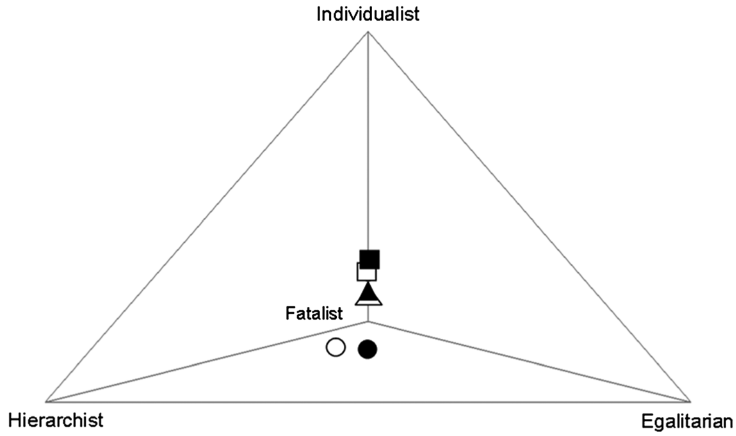

Figure 3. Visualisation of the position of the perspectives of three stakeholders, as measured at the beginning (white symbols) and at the end (black symbols) of the workshop on agriculture and climate change

Discussion and Conclusions

The role of social learning as a governance mechanism in natural resource management has been frequently highlighted over the past decade. However, progress in finding evidence for this role and gaining insight into the conditions that promote it are hampered by the lack of clear, operational definitions of social learning and practical and reliable methods to measure it in the context of participatory approaches (Reed *et al.*, 2010). With the presented method, the occurrence and extent of social learning can be assessed by measuring the perspectives of individual stakeholders, the diversity as well as the agreement in perspectives at group level and the changes therein over time. The method yields measurements of social learning that are visual (positions in graph), as well as quantitative (change in percentage agreement) and qualitative (changes in beliefs). As illustrated by the two examples, the method is flexible in that it can be applied to diverse problems and domains of natural resource management and context-specific perspective scoring tables can be developed with high reliability. As a method to measure stakeholder perspectives and perspective change, its reliability was supported in the reflective discussions at the end of the participatory sessions: in the presented examples as well as in about 20 other sessions with the river management game, the participants recognized and confirmed their initial positions and the changes therein.

The method has several advantages over self-reporting of learning, which is often used to assess social learning in natural resource management (e.g. Blackstock *et al.*, 2007; Schusler *et al.*, 2003). First of all, it is quantitative and much less subjective. A problem with self-reporting is that people are often not aware of (all) changes in their knowledge and views, and a more evidence-based evaluation of learning is required (Tuinstra *et al.*, 2008; Van de Kerkhof and Wierczorek, 2005). Second, the method allows for rapid assessment of and feedback on social learning within participatory sessions. Valkering *et al.* (2011) developed a simple computer tool to process perspective scoring tables, enabling rapid visualization of perspective diversity and change, calculation of percentage agreement and comparison of scoring tables. In both the presented examples, visualization was used as input for a reflective discussion on (change in) perspectives at the end of the session. As indicated earlier, such a collective reflection on explicated perspectives can be expected to stimulate social learning. In this way, the method is useful not only for researchers as an analytical tool to study social learning, but also as a facilitation tool for practitioners to promote social learning. By thus stimulating the convergence of perspectives among stakeholders in natural resource management issues, practitioners can enhance the effectiveness and efficiency of participatory decision-making on problems that require a collectively supported strategy. In using the method as a facilitation tool, one should be aware that convergence of perspectives in terms of scores for the CT perspectives may differ from convergence in terms of percentage agreement on specific statements. In the two examples, the percentage agreement increased in both cases by 5%, whereas the convergence in terms of CT perspectives was markedly higher in the first example (compare Figures 2 and 3). Both should therefore be taken into account in the analysis and, when the results are fed back to the stakeholders in a reflective discussion on perspective change, changes in agreement on specific statements should preferably be included in the discussion.

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An alternative to measuring stakeholder perspectives with perspective scoring tables is the use of Q methodology (see, e.g., Cuppen *et al.*, 2010; Cuppen, 2012). Q methodology differs from our method in two major ways: (1) domain- and problem-specific statements are derived from written or verbal sources without making use of predefined categories; (2) participants are asked to rank-order all statements (up to 60) on a scale of agreement, according to a forced normal distribution. A rather complicated statistical analysis then yields sets of statements that represent different perspectives among the stakeholders. Q methodology could be characterized as a 'bottom-up' approach to describing stakeholder perspectives, whereas our method is a combination of 'top down' (Cultural Theory categories) and 'bottom up' (participants may endorse statements from all four categories). The advantage of our method as compared to Q methodology is that it is less time consuming for the participants, and can be conveniently combined with stakeholder meetings that are more content oriented. Moreover, the results can be produced (and fed back) much faster and are easier to understand for non-specialists.

The relative simplicity of our method makes it very practical in use, but brings along several limitations as well. The focus is on the social-cognitive dimension of social learning (beliefs), and the social-relational and behavioural dimensions are not considered. This can be justified when the participatory process has a social-cognitive focus as well, e.g. in participatory integrated assessments (De Kraker *et al.*, 2011). Another limitation is that the statements in the perspective scoring table represent 'only' the archetypical CT perspectives, whereas for example in Q methodology the statements may reveal more subtle existing differences in perspectives among the stakeholders.

The presented method can be applied to measure social learning as an outcome of a participatory process. To determine which process features and context factors foster or inhibit social learning, the method must be combined with in-depth analysis of the communicative interactions between those involved in the process (Muro and Jeffrey, 2008; Reed *et al.*, 2010). For example, in our own investigation of the role of computer models in supporting social learning (De Kraker *et al.*, 2011), we combine this method with content analysis of recorded participatory sessions, direct behavioural observations during these sessions and follow-up interviews of stakeholders after the sessions.

In conclusion, the presented method offers a practical and reliable way to measure social learning, whether it has occurred and to what extent, among stakeholders in participatory approaches to natural resource management. When used in combination with analysis of the communicative interactions between stakeholders, it provides a much-needed analytical tool to increase our understanding of the factors contributing to social learning and how social learning can be facilitated.

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