

## Integrated management of natural resources: dealing with ambiguous issues, multiple actors and diverging frames

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**Abstract** Uncertainty is an increasingly important concern when trying to manage complex systems of interrelated natural resources. Scientific knowledge or necessary information may be lacking or incomplete. Additionally, the multiple and interdependent users of those resources may diverge in defining what really is at stake. When they frame issues in very different ways, ambiguity results, i.e., the existence of two or more equally plausible interpretation possibilities. Environmental management in these conditions implies a shift in attention from solving clearly delineated problems to continuous negotiating and tuning between different actors and expertise domains. This requires dealing with the frame differences in a reciprocal way by mutually acknowledging frames and connecting them. Some or all parties will have to revise, enlarge or reframe the way they relate to the issues and to each other, in order to support mutual understanding and common action. The contribution of experts does not consist then in providing total predictability nor in predefining issues and solutions, but in supporting a joint learning and negotiation process among different actors and in feeding this process with relevant information. Behavioural simulations may play an important function to stimulate multi-actor learning and negotiation processes.

**Keywords** Ambiguity; behavioural simulations; framing; natural resources management; uncertainty

*"The problem is that there are too many meanings, not too few. The problem faced by the sensemaker is one of equivocality, not one of uncertainty. The problem is confusion, not ignorance." (Weick, 1995)*

### Uncertainty and ambiguity in natural resources management

Integrated management of natural resources has to cope with considerable uncertainties (Van Asselt and Rotmans, 2002; Walker *et al.*, 2003). The complex objectives of integrated management approaches have to be achieved in times where uncertainties resulting from climate change and the overall socio-economic conditions are increasing. Decisions often need to be made in conditions where scientific knowledge or necessary information is lacking or incomplete. Ecological systems are very complex and interrelated systems, where impact on one of the natural resources can have unpredictable implications throughout the system. Furthermore, natural resources do not exist in themselves but are closely interrelated with various social systems, in which different social actors make different uses of the available natural resources. These conditions resemble what Emery and Trist (1965) described already almost 40 years ago as "turbulent fields", which are characterized by unpredictable, interdependent and quick changes. In this kind of complex and interdependent multi-stakeholder context where unilateral interventions fail to produce effective solutions, participative decision-making, collaborative arrangements

and multiparty negotiations have been proposed as management strategies (Gray, 1989; Whyte, 1991; Huxham, 1996). Managing the interdependent uses and users of the available resources implies dealing with very different actors which all have a stake in the management of these resources. These different actors may diverge substantially in how they define what really is at stake (Salipante and Bouwen, 1995; Lewicki *et al.*, 2003). These differences in how they frame the issues results in ambiguity, i.e., the existence of two or more equally plausible interpretation possibilities.

We will elaborate and illustrate these issues below, starting with disentangling the concepts of indeterminacy, uncertainty and ambiguity. Uncertainty and ambiguity are often used interchangeably to refer to situations where things are unclear. Uncertainty is also often confused with indeterminacy. As we will argue, however, it seems more useful to understand these concepts as referring to different phenomena or states of affairs. In general terms, we will refer to *indeterminacy* as the inherent unpredictable and chaotic nature of certain phenomena in the outside world; to *uncertainty* as a lack of knowledge or information about a phenomenon; and to *ambiguity* as the simultaneous presence of multiple frames of reference to understand a certain phenomenon. Although for conceptual clarity these three qualities can be analytically distinguished, it may not always be possible to distinguish them in practice. It may for example be quite difficult to separate indeterminacy from uncertainty when confronted with a *de facto* unpredictable system. Another example can be found in Pahl-Wostl *et al.* (1998), who illustrate how the concept of ozone holes was elaborated only after NASA scientists stopped correcting strange measurement values they plausibly interpreted as measurement errors.

Indeterminacy, uncertainty and ambiguity can be located in Walker *et al.*'s (2003) comprehensive map of the various dimensions of uncertainty involved in modelling. *Variability uncertainty*, defined as uncertainty due to inherent variability in the phenomenon, corresponds to indeterminacy. *Context uncertainty* is clearly related to the way we conceive of ambiguity, in that it points the attention to “the choice of the boundaries of the system, and the framing of the issues and formulation of the problems to be addressed within the confines of those boundaries.” *Model structure uncertainty* and *inputs uncertainty* can play a role in ambiguity too, insofar as they concern the definition of relevant variables to be included or excluded in the problem framing. In the conception of Pahl-Wostl *et al.* (1988), which goes back on Funtowitz and Ravetz (1985), these elements of separating the phenomenon from its context and determining model structure and inputs would be called *conceptual uncertainty*, i.e., uncertainty about *which* conceptual frame to apply in order to understand the phenomenon. The remaining aspects of uncertainty in the Walker *et al.* (2003) model can be readily understood as different forms of incomplete knowledge about a phenomenon, including *epistemic uncertainty* as imperfection of our knowledge which may be reduced by more research and empirical efforts; *parameter uncertainty* related to calibration issues; *technical model uncertainty* related to computer implementation issues; *model outcome uncertainty* or prediction error; and the different *levels of uncertainty* ranging from statistical uncertainty to recognized ignorance. We distinguish indeterminacy, uncertainty and ambiguity in this way because these concepts are applicable to different phenomena. Indeterminacy is an inherent characteristic of some phenomena in the outside world, while uncertainty is a characteristic of our knowledge about that world, and ambiguity, as we will argue further, is a characteristic of social situations in which multiple actors bring in multiple frames.

Within organizational sciences, Karl Weick (1995) defined ambiguity as too many interpretation possibilities of a situation, while uncertainty is caused by a lack of information. Van Looy *et al.* (2002) make a similar distinction and define uncertainty as referring to situations in which the problem solvers consider the structure

of a problem – including the set of relevant variables – as given, but are dissatisfied with the present knowledge of the values of the parameters. In uncertain situations it may still be rather clear which aspects or parameters are unknown, and gathering more information of the same kind can often solve the uncertainty. In other words, it is clear which frame to apply, but not (yet) how it should be filled in. In ambiguous situations, however, what is at stake is not the value of certain parameters but the structure of a problem – i.e., what the relevant parameters are – or even which problems should be tackled. What is ambiguous is the meaning of a situation and which frame should be applied to make sense of it. While uncertainty can be located at the boundary between knowing and what is yet unknown within a certain frame, ambiguity can be located at the boundaries between different frames of knowledge or different kinds of knowing. This is why we feel that applying the levels of uncertainty (Walker *et al.*, 2003), conceived as a progression from “know” to “no-know,” to *conceptual uncertainty* leaves out an important aspect that is more adequately captured by the concept of ambiguity. Different stakeholders, including scientists and policy makers, can have different and equally valid conceptions about the boundaries of an issue and its core elements. The relevant dimension for ambiguity is not the one from complete knowledge to complete ignorance, but something ranging from unanimous clarity to total confusion caused by too many stakeholders voicing too many different but equally valid interpretations of the situation.

#### **Dealing with multiple actors and multiple frames**

There is a small but growing literature on the framing of environmental issues that reveals differences in how stakeholders form interpretations of what is at stake and what should be done. Aarts *et al.* (2003) have studied how stakeholders differentially respond to the uncertainty and ambiguity generated when planning future land use. Lewicki *et al.* (2003) have identified a repertoire of frames adopted by environmental stakeholders. These include views of nature frames, social control frames, conflict management frames, characterization frames, power frames, risk frames and identity frames. Other research has shown important substantive differences in the way government officials differ from lay citizens in their framing of risks (Hanke *et al.*, 2003).

Different ways of framing issues can find their origin at several levels. Frame differences can originate out of different scientific disciplines, like the social and natural sciences. Different levels of government act within different electoral, scale and responsibility frames. Natural resources may also mean very different things for actors like industries, farmers, tourist agencies or environmental NGOs. Apart from these more institutionalized stakeholders, loosely organized and sometimes transient stakeholders can emerge, for example a group of inhabitants of a frequently flooded region or a protest group against the construction of a dam. On a higher level, cultural traditions or beliefs can inform different ways of making sense of a situation, as can very personal experiences which are part of a personal subjective history. Wherever these differences in framing the issues come from, our focus is on what the relevant frame differences are in the specific situation of natural resources management at hand. As Pahl-Wostl *et al.* (1998) observe: “any theoretical framework ... is generally considered merely one possible scheme of classification. ... The value systems of people engaged in actual debates are generally agreed to be more hybrid than stereotypes can account for.” The framing concept draws the attention to the concrete interactions where actors bring in their conceptions of problems and possible solutions, and how they affect each other’s frames in and through a developing relationship. We adopt an interactive approach to framing (Putnam and Holmer, 1992; Drake and Donohue, 1996), understanding issue frames primarily as sensemaking devices used for interacting and communicating with others.

This differentiates our frame concept from an alternative concept of frames as mental schemata (Benford and Snow, 2000). As Dewulf *et al.* (2004) showed, the frames that stakeholders use to make sense of situations are both a reaction and an anticipation to a specific problem domain and to specific other stakeholders, and are thus dependent on the unique situation of natural resources management at hand.

Environmental management in conditions of uncertainty and ambiguity implies a shift from solving clearly delineated problems to continuous negotiating and tuning between different actors, expertise domains and decision centres. Herlau and Tetzschner (2001) relate the difference between uncertainty and ambiguity to different phases and tasks of the decision-making or problem-solving cycle. While ambiguity for this author has to do with problem definition and looking for adequate questions, which has to be resolved by mutual tuning and negotiation among actors (the “preject phase”), uncertainty refers for her to problem solving and looking for the right answers (the “project phase”) for which relevant information has to be gathered. The preject negotiations determine the relevance criteria of the project information. Putting the definition of the situation at issue, which is often ambiguous or interpretable in various ways that all seem valid simultaneously, constitutes a trigger for new sensemaking by negotiation of meaning. This has important managerial consequences, because in ambiguous situations information has to be dealt with differently. Since this ambiguity is the result of the different frames that different stakeholders bring with them, ambiguity cannot be reduced in a straightforward way. Adding more and more information is likely to increase ambiguity instead of reducing it. What is needed then is more and more varied cues and mechanisms that “enable debate, clarification, and enactment more than simply provide large amounts of data” (Daft & Lengel, 1986, cited in Weick, 1995), in order to create meaning through discussion and joint interpretation. Rich personal media of communication such as meetings and direct contact become more important than poorer impersonal media such as formal information systems and special reports (Weick 1995: 99).

Social learning, negotiation and conflict management strategies become more important when dealing with ambiguous situations, because the relation between different stakeholders and their frames is at stake. A process called reframing (Putnam and Holmer, 1992) has been identified as a possible way of tuning and connecting different frames. It involves a redefinition of the common problem domain and the frames of stakeholders that makes possible a compatibility or integration between them. Ambiguity is then not only to be considered as problematic and negative, it is also an opportunity for change. It may produce a shock among the involved actors that motivates them to engage in joint sensemaking. Paradoxically, research indicates that reframing may even need ambiguity (Baervoets, 2000; Van Looy *et al.*, 2002; Dewulf *et al.*, 2004). When the relevant differences are voiced and explored within a constructive relationship between stakeholders, the resulting confusion offers possibilities for re-structuring the issue on different sides and thus making connections between the different frames involved. In this sense also, transitions and innovations need ambiguity in order to happen but at the same time this ambiguity has to be kept manageable. This framing-reframing approach is in line with the pluralistic approach proposed by Pahl-Wostl *et al.* (1998) to deal with uncertainty.

### **Illustrations from a behavioural simulation of multi-stakeholder management**

We would like to illustrate some of our theoretical points with interaction moments from a multi-stakeholder simulation, developed by the first author on the basis of a real case, namely the management of the Podocarpus National Park located in Ecuador (South America). Our analysis and observations will concentrate on the conversations between the representatives of different social groups, who try to make sense and come to

decisions in indeterminate, uncertain and ambiguous conditions that characterize the natural resources management domain.

The Podocarpus National Park simulation condenses a multiple stakeholder negotiation process into a sequence of internal, bilateral and multilateral interaction moments, each phase taking 30 minutes. After a first round of internal meetings, the representatives of each of the involved stakeholders meet each other in multilateral meetings, where they discuss the future direction of a problem domain. Between the three multilateral meetings bilateral visits take place. In this simulation five groups of participants represent five stakeholders involved in the co-management of the Podocarpus National Park. The task for this collaborative task system is only minimally defined, namely to agree on which actions to take in order to guarantee the effective management of the park for the coming years. The following stakeholders are represented in the co-management committee: (1) Foundation: a non-governmental organization with an ecologist and social vision on the management of the park; (2) Municipality: the local authority for this sector of the park; (3) Miners: an association representing miners working in traditional small scale gold mining; (4) Farmers: an association representing farmers who live in the villages along the border of the park; and (5) Ministry of Environmental Affairs: the national legal authority in environmental issues. Through the general instructions and the specific instructions for each stakeholder group, the most important information, interests and perspectives for each group are given. Differences in issue framing are stimulated by presenting stakeholder-specific views on the situation of the park in the specific instructions, and by giving each stakeholder group a different A3-sized color map of the park area, with different layers of information highlighted for each specific stakeholder group. The participants are asked not to play a role but to represent their group's interests.

We will use excerpts from the first multilateral meeting of a simulation run with researchers from the HarmoniCOP (5FP) project to illustrate the ambiguities that can emerge when very different stakeholders encounter each other in an environmental management process. We will focus specifically on the negotiation of what will be the common problem domain to work on and the negotiation of who will take what role in the process. Of course, many more things are going on in a conversation like this, but we will limit our discourse analytically inspired analysis (Wood and Kroger, 2000) to what is most relevant in view of the concepts treated above. The subscript numbers in the excerpts refer to the lines of the original transcript in Atlas-ti ([www.atlasti.de](http://www.atlasti.de)), a software program for analysis of qualitative data. We will put these subscript numbers in parentheses to refer to specific parts of the reproduced transcripts.

Although the instructions do not specify who should preside the meeting, the Ministry opens the meeting in the following way.

<sup>5</sup> MINISTRY <sup>6</sup> I'm the representative of the Ministry of <sup>7</sup> Environment and I thank everybody for <sup>8</sup> attending this meeting to develop the issues <sup>9</sup> related to the Podocarpus National Park. We <sup>10</sup> have identified various issues that we feel <sup>11</sup> that we could develop, and would like to <sup>12</sup> develop them with the various actors sitting <sup>13</sup> at this meeting. <sup>14</sup> Policies that we have from our perspective <sup>15</sup> that need to be developed is one, I'm <sup>16</sup> getting straight to the point, the mine at <sup>17</sup> San Luis we are looking at the possibility <sup>18</sup> of closing that down, as it is located right <sup>19</sup> in the middle of the zone which we feel <sup>20</sup> should not have any exploitation of mining <sup>21</sup> and we'd be interesting in talking to the <sup>22</sup> mining organization or the representative of <sup>23</sup> the mining organization to develop the ideas <sup>24</sup> that we have of how we should go about doing <sup>25</sup> that.

The Ministry frames what has to be done as 'policy development' (14–15), explaining what he understands by this in what follows, for example closing down a mine in the

park. Note how this message is packaged in very soft formulations (“looking at the possibility”, 17; “which we feel should not have”, 19–20) and how this sentence defines the limits of the problem domain on which to work. The role of the other actors, in this case the miners, is defined as “talking... to develop the ideas that *we* have of *how* we should go about doing that” (21–25), where “that” clearly refers to closing down the mine. *That* the mine will be closed is implied as a given aspect of the situation, while “*how* we should go about that” is something that should be jointly addressed. In a very similar manner the ministry further states “we would <sup>29</sup> like to there again eh discuss with them as <sup>30</sup> feasible ways of moving them into different <sup>31</sup> areas”. This again implies the “moving” (30) as a given part of the situation and as such not at issue or something that has to be part of the common problem domain, instead only “feasible ways of” are at issue. After the miners, the Ministry addresses the farmers.

...the farmers who are involved with <sup>34</sup> illegal extraction from the particular areas <sup>35</sup> we would like to also look at the <sup>36</sup> possibilities and develop policies to <sup>37</sup> prevent policies to prevent or to stop such <sup>38</sup> activities from going on, so I think I put <sup>39</sup> some of the issues that we want to develop <sup>40</sup> at this meeting.

Up to this point everything is rather clear and unambiguous. By opening the meeting the Ministry provides a minimal structure and presents its ideas about the Park and what it views as issues that should be tackled. At this point, one could say, there’s only uncertainty. There’s only one frame present, namely the frame presented by the Ministry, focused on policies and enforcement of regulations. Thereby the contours of the problem domain are defined, a problem domain that contains also some pockets of uncertainty. The issues of how the mine should be closed, in what way the miners should be moved to other areas or what policies should be developed to stop illegal wood extraction, are examples of what the Ministry treats here as uncertainties or as parameters within his frame that have to be filled in through talking with the other stakeholders. At the end of his intervention, the Ministry representative gives the word to the Miners.

<sup>43</sup> MINERS <sup>44</sup> Yeah, thanks for the invitation to this <sup>45</sup> meeting and as the representative of the <sup>46</sup> miners we don’t have any interest to move <sup>47</sup> out of the zone because this is we have to <sup>48</sup> maintain our lives by mining we didn’t learn <sup>49</sup> anything else than mining plus we don’t see <sup>50</sup> the point why we should move out of this <sup>51</sup> place.

The Miners’ representative thanks the Ministry for inviting them, thereby confirming and strengthening the convening role that the Ministry took up. As to the content of the problem domain, the Miners use a very different frame to make sense of it, implying with the statement “we don’t see the point why we should move out of this place” (49–51) that moving out is not part of the common problem domain.

<sup>56</sup> the impact <sup>57</sup> to the tourist areas is very little, since <sup>58</sup> we don’t cut trees, we don’t burn wood, we <sup>59</sup> have hardly any infrastructure, we don’t <sup>60</sup> build roads, so we don’t see any reason to <sup>61</sup> move out of this area, this is our point.

In his entire intervention, the Miners’ representative puts no issues on the table that should be jointly dealt with or should be part of the common problem domain, basically implying that the situation should stay as it is and that they have nothing to do with any problems there might be. That this in itself is not a neutral frame becomes clear when looking more closely at how the status quo is defended: the “we” in the sentences “we don’t cut trees, we don’t burn wood” (58–59) is perhaps as significant as the “don’t,” given that in the general instructions it is stated that the Farmers do cut trees and burn

wood. As Putnam and Holmer (1992) argue, issues are not objective agenda items but discussion topics that are named, blamed and claimed through the way stakeholders argue about them. The Miners frame the situation in a very different way than the Ministry, through differently naming it, blaming different stakeholders and making very different claims with respect to the park. Through this second intervention ambiguity or equivocality enters into the interaction. For the ministry the park is an area that is in high need for intervention, while for the miners it is a place where they live and work and where they should not be disturbed.

After this intervention from the Miners, the Ministry gives the word to the farmers.

69 FARMERS 70 Yeah thanks a lot as a representative of the 71 farmers uhm thanks a lot to my colleague 72 representing the miners because I think we 73 are very we strongly support them, miners 74 and farmers, 2,400 farmers actually 75 having a very hard life in that area and all 76 of a sudden you come here and you draw lines 77 on a map and you say you're out of it now. 78 So we haven't been consulted before and we 79 just want to live our lives like we did 80 before and we're now already in this area 81 for 30 years and we don't want to move out 82 because we just don't know how to survive 83 somewhere else. So this is a very strong 84 point I think. We're talking about our 85 livelihood, and everything is actually 86 built by us, we were constructing the little 87 roads there, to go to our farms, we were 88 constructing the roads to bring our produce 89 out, there was no help from government all 90 the time and now government is coming and 91 telling us to go out so we are not going 92 out. 93 94

In a combative style, the Farmers' representative presents a still different picture of the situation, starting with suggesting a strong alliance between miners and farmers ("thanks a lot to my colleague", 71; "we strongly support them", 73). The Farmers put the blame on the Ministry, and thereby frame their own negative reaction as a legitimate defense against an attack from an untrustworthy and uncooperative government ("we haven't been consulted before", 78; "there was no help from the government all the time", 89). While the Miners framed the current situation as given, the representative of the Farmers goes further back in time and turns the establishment of the park and its borders into an issue: "all of a sudden you draw lines on a map" (76) and "we're already here for 30 years." Note how this is further supported by attaching a very different meaning to 'road construction', which is here framed as a contribution to the community ("everything is actually built by us", 85; "we were constructing the little roads there", 86), rather than as a negative "impact on the area", as the Miners did before (59–60), which creates ambiguity as to the evaluative meaning of building roads. While the Miners positioned themselves outside the common problem domain, the Farmers do put forward some issues for discussion, which could be summarized as consultation, help from the government and the borders of the park, which is a quite different framing of the problem domain when compared to the Ministry. The Municipality is the next to intervene.

95 MUNICIPALITY 96 Thank you for inviting me as well, I'm the 97 representative of the Municipality 98 and it's very good to hear that everybody 99 has some issues that they'd like to bring to 100 the table and we obviously want to 101 help as much as possible for negotiation to 102 happen here. Our main concern is two things, 103 our main concern is clean drinking water, 104 which affects the farmers, because you need 105 clean water to drink and 106 it also affects you as miners because you 107 also need clean drinking water. This is our 108 main issues. Our second main issue is to eh 109 maintain income generation for all groups so 110 we would like the miners to maintain an 111 income and we'd also like the farmers to 112 maintain an income. But we'd also like to 113 work with you in perhaps revising the 114 current activities that are taking place in 115 the park to take account of the issues 116 raised by the Ministry of Environment.

The representative of the Municipality expresses appreciation for the issues raised by the others and positions herself in what could be called a facilitating or mediating role (“we want to help for negotiation to happen here”, 101). She puts the issues on the table in a different way, namely by framing them as important for other actors also (“you need clean drinking water”) and by connecting different issues of different actors, namely “maintain income generation” (109) and “revising activities” (113). These formulations combine aspects of the status quo framing by the Farmers and the Miners (“maintain”) and the need for change framing of the Ministry (“revising current activities”). In this way, the Municipality proposes a broadening of the common problem domain, including issues from different stakeholders. Our interpretation of this intervention is that, while the previous interventions have mainly contributed to creating and increasing ambiguity, the municipality here addresses the issue of ambiguity, by pointing to the need for negotiation, and tries to do something with it in a constructive way, by trying to connect different issues of different actors into a common problem domain.

The representative of the Municipality can also be seen to use ambiguity in order to support this connection. In the light of the previous formulations by the Ministry (“moving out”) and the Farmers and the Miners (“we want to stay where we are”), the formulation “revising activities” is interpretable in multiple ways and is for that reason acceptable by the different stakeholders. This is in line with the findings of [Turcotte and Pasquero \(2001\)](#) who conclude that in multi-stakeholder platforms it is important to “preserve some amount of ambiguity in the definitions and the solutions so that consensus can emerge, even under various interpretations”. [Eisenberg and Witten \(1987: 422\)](#) similarly conclude that “ambiguous missions and goals allow divergent interpretations to coexist and are more effective in allowing diverse groups to work together.” As opposed to the intervention of the Ministry, neither the Farmers nor the Miners did attack this intervention of the Municipality, who could maintain a mediating role, while at the same time advancing its own interests, throughout the rest of the simulation. The initial clash between the Farmers and the Ministry created so much ambiguity with respect to what the problem domain was and how it should be tackled, that it continued much further into the simulation.

### **Discussion and conclusion**

With these small pieces of analysis, we have tried to illustrate a way of conceiving uncertainty and ambiguity as they function in an interaction and communication process between multiple stakeholders involved in natural resources management in which the meaning of a common problem domain is negotiated through the way the different stakeholders interactively frame the issues. As we have illustrated through our discourse analytically inspired approach to the interaction data ([Wood and Kroger, 2000](#)), different linguistic formulations produce very different versions of what is the case and what should be done. Inquiring into the different frames that stakeholders bring to the table thus requires attention to the specific formulations they use, because these seemingly subtle differences may have important implications for delineating the problem domain, defining the issues and the mutual relations. Dealing with these frame differences in a reciprocal way requires a mutual acknowledgement of frames and inputs and their connection into a reflective conversation where the different parties and their issues can feel included. Some or all parties will probably have to revise, enlarge or reframe the way they relate to the issues and to each other, in order to create a vocabulary that can support mutual understanding and common action, which is crucial for reaching an effective collaborative management of natural resources.

Scientific and technical expert actors, whose frames of knowledge have high status, tend to take their frames for granted. It is still a frequent practice in the natural and engineering sciences in resources management to analyze the problem entirely from the perspective of the researchers or experts and include stakeholders only at certain specific points to express their preferences about predefined parameters, e.g., in a multi-criteria analysis. This approach proceeds as if only uncertainty were to be dealt with, while excluding other ways of framing the issues. Experts sometimes assume that their frame will eliminate the ambiguity out of a complex situation. Therefore, in terms of preject and project phases, (Herlau and Tetzschner, 2001), they leap directly to the project phase and start reducing uncertainty. However, insurmountable problems may occur when passing over the preject phase, where ambiguity among different frames has to be dealt with, and new frames have to be created which are meaningful for all the actors. The ambiguity that was eliminated at the beginning can and often does resurface in later stages of the project, leading to resistance or unimplementable results. Connecting different frames cannot be achieved by some diagnostic or mathematical procedure. Rather confrontation, exploration and negotiation of frames in personal and emotionally laden interactions create possibilities for enlarging frames and reframing issues. Experience, insight and skills for dealing with ambiguity in multiparty negotiations are then to be considered an important requirement for scientific experts, policy makers, administrators and specific interest groups alike, if they want to reach integrated, adaptive and sustainable management of complex environments.

Behavioural simulations of multi-stakeholder situations offer possibilities for learning about ambiguity, for dealing with ambiguity and for researching ambiguity. For learning purposes, behavioural simulations can create ambiguous situations for the participants to experience. This is accomplished by assigning them different groups and diverging interests to represent and foreseeing moments of interaction between (representatives of) the different groups (Vansina and Taillieu, 1997). For intervention purposes, behavioural simulations can be used to engage different stakeholders to interact within fictitious or quasi-real contexts, where they can learn to deal with their mutual framing differences. For research purposes, behavioural simulations can be seen as simulated or miniature social systems that can be used for obtaining observational data on how ambiguity and differences in framing are dealt with, as was illustrated above.

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