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Contribution of Simulation and Gaming to Natural Resource Management Issues: an Introduction

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Nowadays, both computer-based simulations and gaming are widely used in the field of natural resource management (NRM). They have proved to be useful for various purposes such as supporting decision-making processes and training. Firstly, the specificities of the NRM research field are highlighted. Then, based on the analysis of the papers presented in this special issue of Simulation and Gaming, some key features related to the implementation of gaming in such a context are introduced. Finally, after reviewing the benefits of using simulation games in NRM, the authors stress the ethical issue of changing social relationships among stakeholders by playing a game with some of them.

KEYWORDS: *natural resource management; simulation games, social empowerment*

Many natural ecosystems are currently characterized by multiple and often conflicting uses that increasingly threaten their existence. The international community has recently called for a shift towards more sustainable development respectful of diversity and the rights of future generations to also enjoy these natural resources. Traditional Natural Resource Management (NRM) approaches based on centralized optimal allocation of resources between potential users, have failed to deliver so far due to the complex and adaptive nature of these socio-ecological systems (Holling, 2001). Users need to be taken as essential actors within the allocation process itself in order for them to acknowledge the inherently fragile nature of NRM issues (Agrawal et al., 2003). Thus, collective learning processes become keystone features of these adaptive and participatory designs for sustainable natural resource management.

Natural resources are often used by multiple users who have differing viewpoints and specific objectives. The overall observed patterns emerge from interactions between social and ecological processes taking place at different levels (Stepp et al., 2003). Simplified representations of such complex systems are useful to better understand them (Simonovic & Fahmy, 1999). From initial static representations (such as maps) to current dynamic simulation tools, there is a current trend to associate the different stakeholders with the design and the use of these models (Mermet 1992, Meadows, 2001). An extreme, yet effective, way to embed stakeholders in the modelling process is to invite them to become participants in simulation and gaming experiments. It is expected that by taking part in the simulation experience from within, participants will enhance their understanding of the underlying model

and improve their knowledge through collective interaction. This situation may nurture critical discussion about modelling assumptions, simulated outputs, and alternate scenarios. Depending on local circumstances, the objectives of these experiments might range between: (i) helping those who would like to know; (ii) teaching those who need to learn; (iii) opening new perspectives for those who already know (or think they know); (iv) facilitating collective decision-making processes. The latter is becoming increasingly important with respect to the decentralization processes that are often linked with NRM policies.

In most cases, natural resources face multiple, interacting users. These situations create self-referential conditions where by each user's decision modifies the other users' environment, and influences his own expected outcomes. A classic example of such potentially negative interdependencies is given by the 'tragedy of the commons'. Based on empirical evidence, Ostrom claims that only polycentric institutions – networks of nested centres of decision and management – can overcome the usual fate of overexploited natural resources and secure an overall sustainable management regime (Ostrom, 1990). More recent works on the complex dynamics of socio-ecological systems have confirmed the necessity to reconcile top-down and bottom-up approaches to achieve consistent decisions (Driessen et al., 2001; Walker et al., 2002). It is our assumption that simulation games might be powerful tools to support collective policy design and resource management among these institutions (Steins & Edwards, 1999).

Natural resource management involves numerous and diverse interactions between actors and their environment. These interactions need to be realistically simulated; they can be direct or indirect, social or biophysical, synchronic or diachronic. Direct interactions are those that occur among actors through direct communication. Other interactions among actors might happen either through the resource (task-based interaction) or through other levels of organisation (institution-driven interaction). In their pioneering simulation work, Lansing & Kremer (1994) demonstrate how task-based interactions have probably shaped the current complex organization of traditional irrigations systems in Bali (*Subak*) by synchronizing water and pest management practices among farmers.

Natural resource managers and users also have differing viewpoints and objectives regarding the state, dynamics, and value of the resource. Hence, simulated actors need to carry specific sets of indicators which assess the state of the resource, such as 'river's streamflow', 'forest density', or 'abundance of species'. These indicators are all situated: one user will observe the flow at point A, another will observe the flow at point B, while a third will observe the trout population at point C. As simulated actors are intentional, each viewpoint is associated with expected values. These expectations may differ in nature (qualitative or quantitative) regularity, or intensity. Thus, dedicated simulation and gaming platforms need to take into account the diversity of viewpoints and goals displayed by the simulated population of actors (Peck, 2004).

Beyond the necessity to encapsulate the diversity of viewpoints and expectations among actors, there is a need for simulation tools to become more interactive in order to help users learn collectively about resource dynamics and share a consensual vision about resource management. Simulation games present a way forward as the gaming component allows the legitimate and direct expression of various viewpoints.

Specific features of NRM games

First, a game is considered as a specific instance of a conceptual model, representing the socio-ecological system surrounding the resource at stake. Then, a game needs to be able to respond to the influence of the players – the Openness concept – in order to trigger

imagination and exploration from the participants (Meadows, 2001). Like all distributed simulation tools, games rapidly generate complex interactions and dynamics between decision centres that must reflect the actual reality of these systems (Schelling, 1961). Another important feature of NRM games is their communication abilities. Games need not only to trigger communication among players during sessions, they also need to enhance exchanges between users and managers beyond the gaming context (Ryan, 2000). Players need to experience some sort of catharsis that will have long-term influence on their behaviour.

Usually, games constitute very specific settings out of time and out of context. In this case, players and games are supposed to be disconnected from current contingencies (Huizinga, 1951). Hence, after a session participants have the opportunity to disqualify their behavioural patterns exhibited during the game: "*it was just a game*". But NRM games, as we've seen, are based on simplified representation of a reality and involve, to some extent, simulated versions of real characters or institutions. Thus NRM games temporarily create a space for 'potential realities'. Though simplified, these contextual settings tend to provide specific sets of indicators to the players upon which they attach values derived from actual reality. Finally, one of the most important stages of a gaming session is the debriefing (Lederman, 1992). This is the stage when the relation to the real world might be debated. This is also the stage when collective learning might be explicitly acknowledged (Ryan, 2000).

Papers included in this special issue of *Simulation and Gaming* provide a large range of applications and describe specific features of the different simulation games implemented. These features are often context-dependent and there is a need for overall evaluations of these various attempts in order to answer pending questions: how can we assess, *a priori*, the benefit of simulation games compared with less demanding approaches? How can we assess, *a posteriori*, the direct influence of simulation games on the evolution of the environmental context?

Implementing simulation games

The case studies presented in this special issue have developed specific tools and methods in order to engage more closely with participants, being stakeholders or students. The authors have selected diverse options for designing and implementing their games: type of medium, level of abstraction, openness of the storyboard and definition of roles. These considerations are based upon the NRM local context, the physical and temporal constraints, and the research team's skills and orientation.

Witteveen & Enserink are using video films to trigger reactions of students and lead them to simulate a consulting activity. **Lankford & Watson** are using a physical model with marbles to simulate water flow and management. In addition to these innovative media, other papers report the use of more classical tools in the context of simulation and gaming: card games, board games, and computer simulations. SHRUB BATTLE, designed by **Depigny & Michelin**, uses board-based interactions to generate natural events in the simulation. Following Meadows' FISHBANK, **Mathevet et al**. among others in this special issue, use a computer model to simulate vegetation dynamics and wildlife dynamics over a virtual landscape. **Barreteau et al.** along with **Dray et al.** head for hybrid approaches mixing computer simulation and board-based RPGs. One advantage is to be able to mix real players with computer avatars in order to simulate larger populations of actors while keeping the conviviality of board games. Computer simulations also allow for the exploration of larger time scales and a greater number of scenarios.

In most cases, simulation games presented in this special issue tend to immerse players in simplified metaphors of reality. **Lankford & Watson** point out this concept of metaphor as a

key feature between model and reality, considering for example their glass marbles as a metaphor for water flow. They propose organisational factors to increase the quality of a gaming metaphor. In the same trend, **Barnaud et al**. describe games which provide realistic features of a rural landscape where farmers influence natural dynamics through their practices. **Martin et al** bring farmers to discuss the organisation of a local production chain based on the analysis of computer simulation outcomes. Often, participants of simulation games provide scenarios for the simulation, rather than a consistent set of behavioural rules. In a case of conflict resolution, **Krolikowska et al** focus on the negotiation process itself rather than the underlying social and biophysical dynamics. Students assume viewpoints expressed by various stakeholders involved in the real conflict. **Qdrat-ullah** proceeds from an abstract mode of interaction, based on experimental economics assumptions, in order to evaluate the influence of collective debriefing on individual strategies.

The storyboards supporting gaming sessions fall into two broad categories: those offering bounded scenarios to the players and those offering the opportunity to the players to create their own rules at given stages of the game. BUTORSTAR, created by **Mathevet et al**, relies on rather sophisticated models and requires an initial learning sequence from the participants. In such a context, it seems difficult to leave the storyboard open and the authors opted for a closed one. When the underlying models are simpler or when the gaming sessions are longer, it becomes possible for the designers to leave the storyboard open. In ATOLLGAME, created by Dray et al., the players might agree on new features to be incorporated into the game. On the second day of the game, they have to create their own storyboard when faced with the appearance of a new character in the game.

Another issue concerns the definition and attribution of individual roles. These roles are defined by a few items and rules which are supposed to give enough guidance to the players. As these roles tend to simulate key categories of actors in the real world, they are defined through various features like: accessibility to resource, individual assets, personal objectives, perceived environmental indicators, behavioural rules and attitudes. Depending on the context, these simulated roles are then attributed to players having an equivalent role in reality, or to players having contrasted roles in reality. A third case concerns players who are supposed to learn from the simulation, typically students. Sometimes, these roles may also represent non-human entities such as a ‘shrub’ in SHRUB BATTLE (**Depigny & Michelin**). Overall, the different case studies selected present a continuous range of freedom for players: from open simulation games where players express their own understanding of the NRM issues (PIEPLUE, from **Barreteau & Abrami**) to more deterministic games where players are meant to select among predefined strategies (MAESALAEP, from **Barnaud et al.**). The latter allows designers to validate hypothesis about individual behaviours, while the former case obliges the designers to formally elicit the displayed behaviours and attitudes.

Some of the following papers challenge the concept of ‘role’ itself. Roles for participants in a VPA experiment as described by **Witteveen & Enserink** are very loosely constraining. They are communicated via an invitation which sets the context, defines the objective, and provides a list of available artefacts. There are no more specific rules attached to the notion of role, instead, the VPA experiment focuses on situated events that shape the learning experience.

Benefits of simulation games for NRM issues

Experiments reported in this special issue show strong benefits for using simulation games for NRM issues. These benefits deal with the strengthening of communication, learning, and constructive dialogue. According to **Lankford and Watson**, simulation games definitely

reinforce the interactions among actors who share a common resource. As such, simulation games have to be considered as deliberative tools. They are also providing participants with a joint experience they can refer to during their future interactions. This reinforcement of communication is often intimately embedded in the design process itself. For example, **Dray et al** trigger local communication through initial ethnographic surveys and local workshops tailored to design ATOLLGAME. **Barnaud et al** push further the communication aspects with a later version of MAE SALAEP that targets dialogue among farmers with contrasted viewpoints concerning cropping patterns. Researchers are not excluded from this process and they participate to the common recognition of legitimate, though contrasted, viewpoints.

Use of artefacts as models to represent complex systems as those at stake for NRM issues is frequent. However due to plurality of views and diversity of interests, stakeholders are sensitive to the representations hold by these artefacts. Gaming exercises are providing rather adaptable tools with possibilities for fine tuning of representations. **Mathevet et al** underline a crucial balance between simplification and realism that needs to be achieved in order to enhance dialogue: (i) simplification to facilitate the player's understanding of the processes, and (ii) realism to allow them to project this new understanding back into reality. Taking also into account playability of the game and conviviality of the sessions, one must admit that simulation game design is much like a skilled craftwork. **Krolikwoska et al** insist upon the necessity of focusing the design on specific points to be learned from the game. This is a way to keep track of the multiple interactions and to stay in control in highly conflictual contexts like the one they've experienced. During the VPA-Kerala experience, **Witteveen & Enserink** report that some stakeholders even discovered the existence of other stakeholders through their participation in one session.

A specific tuning of RPG when used for NRM issues is the balance between the futility of a game and the seriousness of NRM issues. Being beside real world dynamics is essential for a game to be a game (Huizinga, 1951), and not a simple workshop. However games used in papers presented in this issue provide all features to allow for recognizing issues of the real world tackled by the game. This balance provides security to players and feeling of freedom, along with shared facts to think over the serious problems of NRM. Most of the presented papers emphasize the capacity of well designed simulation games to destabilize players through suitable distance from the real world and even distribution of information. In the absence of direct reference to actual situations and a better symmetry of information, individualistic behaviours tend to give way to collective questioning about NRM issues. **Lankford & Watson** assume that the reason for the success of their experiments partly relies on their choice to represent water by marbles instead of water itself in their physical model.

Learning is a key objective of simulation games dedicated to NRM issues. A trivial form of learning is education, and several papers in this special issue deal with students (**Camargo et al**., **Krolikowska et al**., **Martin et al**). They propose a diversity of relations between students, games and the systems they learn about. But social learning is a much more complex issue where normative and formative processes interact to not only elicit and share knowledge, but to also create new knowledge through interaction itself. **Barnaud et al** report how social learning during MAE SALAEP sessions is then evaluated during debriefing discussions with farmers. Such a self-evaluation of learning leads **Mathevet et al** to claim that nearly 96% of participants to BUTORSTAR sessions think they have learned something about the NRM they are confronted with. This learning concerns ecosystem dynamics and the existence of feedback loops, including those supported by social interactions.

Learning also concerns researchers. Some of these experiments explain how the game sessions allow the expression of tacit knowledge. In the MAE SALAEP sessions, researchers were able to elicit elements of the local and traditional credit system. **Barnaud et al** explain how simulation games offer new dimensions in terms of knowledge elicitation through

observation of body language, attitudes, and direct actions during the game. **Dray et al.** reach the same conclusions after the ATOLLGAME sessions during which tacit beliefs about land tenure and groundwater management are made explicit through prompts included in the storyboard. **Camargo et al** describe benefits in terms of social learning which occurs among players as well as between players and researchers.

Raising awareness and social empowerment

Besides all these benefits, the experiments gathered in this special issue highlight a few concerns. In several examples, raising awareness is central to the participatory process. NRM issues are usually considered 'complex', increasing the need for stakeholders to improve their understanding of interactions they are involved in. There is a general view that confronting contrasted standpoints and enhancing participation will benefit decision-making processes in the end. RPG provide a mirror to systems they represent or to the thinking of researchers who work on them. They enhance reflexivity at individual and system level. This leads for example to a better understanding of the system stakeholders are part of: their involvement in feedback loops, the diversity of interests on the resources at stake, the consequences of their actions on others' interests.

However, the ambiguous concept of 'raising awareness' requires some clarification. Behind a genuine will to involve stakeholders, local communities, or social bodies in a constructive and democratic process – side-stepping the usual ways of making policies - researchers give themselves a superseding position and a framing power. The legitimacy and consequences of such a stand needs to be explored and made explicit. Most papers presented in this special issue address cautiously these ethical issues. This ethical concern is a condition for the quality of an approach using such sensitive tools as games within action research works which are rather intrusive in the societies they deal with. Several papers in this issue refer to a charter such as the Companion Modelling one. They also try to clarify the role and relative position of the designer/facilitator/researcher in the whole process. **Dray et al**. in particular provide striking evidence on the unexpected consequences of simulation game sessions and the ambiguous benefits of empowerment.

Conclusions

We hope that readers will enjoy reading about these experiments that don't fall into the usual topics covered by *Simulation & Gaming*. Compared with other simulation and gaming fields of application, Natural Resource Management offers two deceptive characteristics for the designer: (i) the legitimacy of the approach doesn't rely on the ordering of one client who controls the simulated environment (unlike business or corporate organization games, for example), and (ii) the internal consistency and gaming abilities of the designed platform often rely on assumptions that can be easily challenged by some participants (unlike simulation games for entertainment).

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