Companion modelling approach for participatory land management: the case of erosive runoff in Upper Normandy

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***Abstract**: Erosive runoff is a recurring problem, and a source of sometimes lethal muddy floods in the Pays de Caux. This risk results from the combination of natural and human factors. Efficient actions against the runoff in agricultural watersheds are well known. However their implementation is still difficult. The objective of this study using the Companion Modelling approach was to create a Role Playing Game (RPG) designed to facilitate collective learning and thinking. This RPG named "CauxOpération" and created by a scientific team working closely with the local stakeholders gathers farmers, a municipality mayor and a watershed advisor. During a game session, the players were confronted with a disastrous runoff in a fictive agricultural watershed. They are supposed to meet and to negotiate in order to find solutions to reduce runoff and damage. The RPG was used twice times. The results throw light on the collective learning process and the emergence of collective thinking using the ideas and the mental-representation of each player.*

***Keywords:** companion modelling, role-playing game, erosive runoff, watershed scale, Upper Normandy*

Context and challenge of the study

The Pays de Caux in Upper Normandy includes a large number of sites with erosive phenomena. From a socio-economic point of view, the erosive damage affects both agricultural and non agricultural lands, off-site damage being the most dramatic with muddy floods and sometime human casualties. Following the curative processing of the problem via implementation of mitigation measures (storm basins), it appeared necessary to combine curative processing with preventive processing to reduce runoff issueing from the agricultural territory. Since runoff flowing on a slope is unaware of field and farm boundaries, the actions to be undertaken require co-operation between the stakeholders. But designing a collective management of agricultural land is all the more difficult as the economic context leads the farmers to follow a productive and individual logic. The productive logic means that damages are taken into account only insfar as they affect production. The individual logic results in space management that is limited to the farm territory and consquently does not take into account the continuity of the physical phenomena concerned. Devising a collective form of watershed management is therefore a real challenge especially since such environmental management, commanded in a way by the natural process to be controlled, does not leave the actors free to choose their cooperation. The challenge is therefore to provide the local actors with the tools that will help them to envision the collective consequences of their individual decisions and to initiate a process of negotiation among them, the end-objective being the collective management of the watershed.

Method

At the beginning of 2006, we proposed to the local stakeholders to set up a companion modelling approach (ComMod) to reflect upon a collective management of erosive runoff. This consists in a participatory modelling approach alternating field and laboratory activities in an iterative and continuous way. It is a useful method to facilitate a shared representation of the system, dialogue, shared learning, negotiation, and collective decision-making among multiple stakeholders (Collectif Commod, 2006). The project which involved researchers, farmers, municipality mayors and agents from different extension services allowed the identification of the main issues to be addressed and the

development in close cooperation with the stakeholders of a conceptual model based on the ARDI method (Etienne, 2006) and the associated role-playing game. Nine 3-hour meetings were organized between January 2006 and July 2007. Participants were invited to share their knowledge of the main practices of local stakeholders, to develop and validate a virtual spatial representation of a watershed made up of fields, a village and a road likely to suffer erosive damage. Over a hundred proposals were submitted for discussion. The RPG was built step by step on the points of agreement that made sense to all the stakeholders. At the end of these workshops, we were in possession of the elements constituting the framework of the RPG: the stakeholders to be included, a set of relationships between them, a time and space frame as well as a range of possible actions. Then, a multi-agent system (MAS) was built with the Cormas platform (Bousquet et al. 1998) as a support for the RPG named "CauxOpération". In the MAS, runoff is estimated by means of a cellular automaton according to the crop choice, the farmers' agricultural pratices and the implementation of grass strips or storage ponds. This cellular automaton is based on the STREAM model (Cerdan et al. 2002).

Result

The RPG was used twice with farmers, mayors and watershed advisors. These sessions provided an opportunity for the players to visualize the collective consequences of their individual decisions, to participate in meetings organized in the virtual town hall for sharing their knowledge, their ideas and their vision of the problem in order to test different strategies to reduce runoff and associated damages. During these two RPG sessions, participants improved their capacity to understand their role and to act in a complex situation. They understood that erosive runoff does not only concern the inhabitants of downstream towns, but also their own upstream farms. To measure more easily the impact of the players' strategies with regard to runoff, we imagined theoretical game sessions with extreme values for comparison. A first theoretical game corresponded to a simulation with no runoff management while the second corresponded to a simulation with an optimal runoff management by all the players. Comparison with the first theoretical game showed that by engaging in a dialogue about grass strips and storage ponds, they managed to reduce runoff by 20 to 50%. Progress is still needed to achieve the runoff levels of the second theoretical game by introducing better agricultural practices because during the RPG sessions, the watershed advisors did not encourage farmers to do this.

Conclusion

The interest of this study is not to build a model to predict the future state of the environment, but to use a continuously evolving one to support discussions among stakeholders about the system to be managed and exploration of possible future scenarios. Because of the complexity of the management problems, results of co-conception and game sessions showed modelling and simulation can prove very useful to accompany the collective learning process. This new way of working was very well accepted by the participants who expressed their interest for organizing new sessions of the role-playing game.

Acknowledgements

This work was carried out with the financial support of the «ANR- Agence Nationale de la Recherche - The French National Research Agency» under the «Programme Agriculture et Développement Durable», project «ANR-05-PADD-007, Commod». The authors also want to extend their thanks to the stakeholders who participated in the co-construction of the conceptual model and the RPG and in the RPG sessions.

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