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Community Information Systems Based on Unified Modelling Language to Create a Participatory Monitoring Tool on the Environmental Impact of Agriculture

Marco S. Barzman ^a and Cyrille Cornu ^b

^a INRA, Sophia-Antipolis, marco.barzman@sophia.inra.fr

^b CIRAD Department Environments and Societies, Montpellier, cyrille.cornu@cirad.fr

Abstract

Community Information Systems (CIS or *observatoires du territoire* in French) were designed to monitor environmental change in given agriculture-dominated areas. They serve both as information resource centres and as fora for exchange and coordination among local stakeholders. In 2004, the French Agriculture and Fishing Ministry asked CIRAD (Agricultural Research Center for Developing Countries) to assist in the set-up of CISs that would serve as pilot studies. CISs are co-constructed by local stakeholders using Unified Modelling Language to define and structure the information needed to better understand a specific problem associated with agriculture. Two years of experience of setting up CISs has allowed us to develop methods and recommendations for the set-up of such community information systems. We identify the factors that favour local and collective ownership of a social device based on data management, an area traditionally perceived as the domain of experts, i.e., “off-limits” to non-expert local stakeholders. We discuss the extent to which CISs allow a diversity of stakeholder groups to collectively address the multiple perceptions and interests and to tackle the complexities inherent in the agriculture-environment relationship.

Key words: Community Information Systems, Unified Modelling Language, Co-construction, Agriculture-environment relationship, Stakeholder perceptions.

Introduction

What are Community Information Systems?

There is increasing interest in creating participatory fora where scientifically-validated knowledge can play a new role in local environmental debates (Steyaert et al., 2007). Facilitating community-based debates via the participatory creation of an information system is one such novel and promising approach.

Community Information Systems (*observatoires du territoire*, in French) are long-term participatory observation and analysis arrangements that produce knowledge on a given locally-circumscribed problem (i.e., within a *territoire*) to support community action. The CISs involved in this paper all focus on the perceived negative and positive impact of agricultural activity on natural resources. The knowledge produced is the result of interactions between an information system (i.e., a technical device) and a multiple stakeholder process (i.e., a social construction).

In 2004, the French Agriculture Ministry asked CIRAD (Agricultural Research Center for Developing Countries) in partnership with the Chambre d'Agriculture of Rhône-Alpes Region to assist in the set-up of CISs in three sites around distinct issues involving an agricultural activity and its relationship to a resource of local significance. The three sites were to serve as pilot studies for the implementation of CISs on a wider geographical scales and a greater diversity of agri-environmental issues.

Three experimental sites

The pilot sites were deliberately selected in contrasting agricultural contexts and around different natural resource issues so that the study could offer recommendations regarding the range of application of this novel approach:

- Hiên Valley in the French Alp foothills (Rhône-Alpes Region): Dairy and forage production in the valley have been blamed for its impact on water quality, a debate largely fuelled by the detection of Atrazine—a persistent and currently banned herbicide—in subterranean water.
- Millevache Plateau in West-Central France (Limousin Region): Two endangered local landmark natural ecosystems—*tourbières* (bogs) and *landes* (heather brushland)—are thought to require sheep grazing for their maintenance against the encroaching forest.
- Aume-Couture watershed in Western France (Poitou-Charentes Region): Irrigation of maize is blamed for drying out small river beds during recurring summer droughts.

Methods

The approach used to both develop guidelines for setting up CISs and draw conclusions from the three experiences is participation-observation. We, the authors of this paper, actively participated in the creation of the three CISs. We helped local Chambre d'Agriculture coordinators set-up and formalise the various CIS stakeholder groups and we provided them with technical support to create an information system linking agricultural and natural resources databases. Our participation involved convening and participating in both small organisational or technical meetings as well as more open meetings with a diversity of local stakeholders. On the technical level, our main contribution was to adapt particular components of Unified Modelling Language (UML)—use-case and class diagrams—to local circumstances.

These activities started in January 2005 and continue to this date. All along, we have recorded this process, analysed it and reported it via internal reports (Barzman et al., 2005). Analysis and discussion took place at meetings convened by three research and development projects involved in the CISs: the *Observatoire Agriculture et Territoire* led by the Ministry of Agriculture, the *Observatoire Territorial des Pratiques Agricoles* led by the Rhône-Alpes Chambre d'Agriculture, and the *Conception d'Observatoires des Pratiques Territorialisées* led by INRA (the French national institute for agricultural research). The present paper is largely based on the conclusions arrived at with our colleagues in these various fora.

CIS: How to do it

Two years of experience of setting up CISs has allowed us to develop methods and recommendations for the set-up of such community information systems. We identify the factors that favour local and collective ownership of a social device based on data management, an area traditionally perceived as the domain of experts, i.e., “off-limits” to local non-expert stakeholders. We discuss the extent to which CISs allow a diversity of stakeholder groups to collectively address the multiple perceptions and interests and to tackle the complexities and uncertainties inherent in the agriculture-environment relationship.

This initiative, halfway between agro-environmental information management and participatory community development, wavers between two approaches associated with two different sorts of application. On favours information technology for the sake of generating information while the other favours interactions between local stakeholders for the sake of community development. In our experience, the trick is to balance the two. Through our trial-and-error process of setting up the three CISs, we have devised a set of steps that combine both dimensions and provide a roadmap.

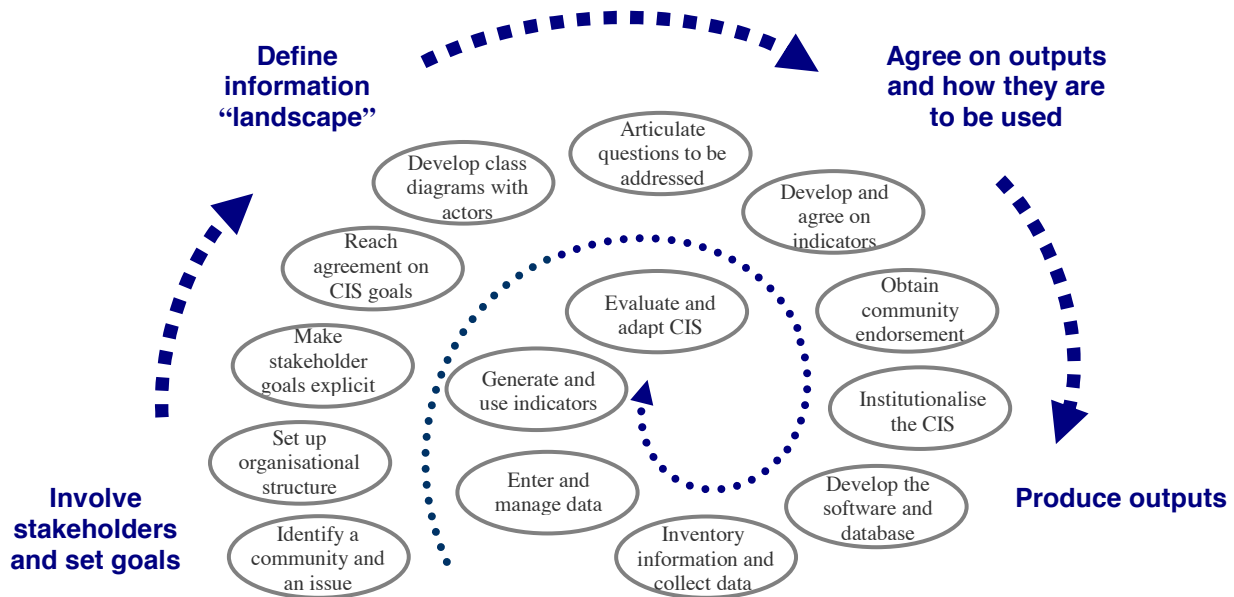


Figure 1. The steps involved in setting up a CIS (from Barzman et al. 2005)

A roadmap that includes the use of UML in participatory workshops

In the process leading to an operational CIS, UML is used as a tool for both data management and communication within a group of stakeholders that include participants such as farmers and local politicians unfamiliar with such information technology tools. To ensure that the information in the CIS is in fact used by stakeholders, their expectations as future users and the way they intend to make use of the information needs to be analysed and made explicit. Requirement engineering is therefore a mandatory preliminary step. It ensures a good match between stakeholder needs and what finally emerges. To “make stakeholder goals explicit”—the third step in Figure 1—a workshop attended by stakeholders pertinent to the issue was convened. Each stakeholder was asked to explain their goal in regards to the issue. A goal is defined as “something that a stakeholder hopes to achieve in the future” (Plihon et al., 1998). UML offers one type of diagram, “use case diagrams”, which represent in a simplified manner the roles and expectations of stakeholders with respect to the issue in general, and, more specifically, vis-à-vis the information system. Use cases were added to the UML toolbox by Jacobson (1992) to illustrate system functions from the point of view of users. For this project, use case diagrams were modified into “goal diagrams” to show the diversity of goals of each participant and to link them through a hierarchy going from most specific to most generic (Figure 2). The most generic goals that then emerge from this exercise form the basis of yet another use case diagram representing the “agreement on CIS goals”—the fourth step. Both diagrams are projected during workshops and participants are prompted to react and modify them.

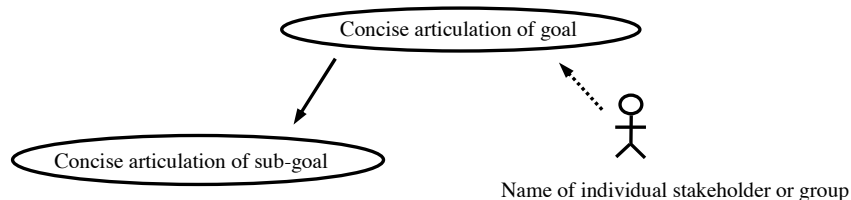


Figure 2. Graphic presentation used for the goal diagrams

After reaching agreement on a common goal, the next challenge is to arrive at a shared vision of the “information landscape”. The questions that need to be answered to contribute toward the established CIS goals and the type of information that will be required to answer these questions then help to identify the information-rich objects that are represented in the class diagram, which is also shown via computer projector during a workshop.

Class diagrams express the static structure of a system, in terms of classes and associations linking these classes. Classes describe a set of objects while associations describe a set of links (Muller & Gaertner, 2005). Class diagrams make it possible for us to model the issue—i.e., the relationship between agricultural practices and natural resources—and to describe it in terms of sets of information-carrying objects and sets of information-carrying links between objects. UML is increasingly used to design data-bases and to model data. Class diagrams provide both a visual representation of sets of objects, the way they are inter-related, the data they carry, and the means to build a conceptual model for a data-base.

However, class diagrams are often perceived as complicated by non-experts. In order to co-construct a class diagram for a CIS, the approach adopted is to allow stakeholders to define a series of simplified diagrams that may not be immediately operative. These preliminary diagrams allow stakeholders to express their perceptions and knowledge and to share their concepts and terminology associated with the objects defined as pertinent to the CIS. They are then modified to make them more compatible with UML and match the data format with the software application selected (relational database management system, GIS or other). In the end, they are assembled into a single diagram. This approach allows stakeholders to become intimately involved in the design of the information component of the CIS by working on models whose complexity increases as they become operational (Figure 3).

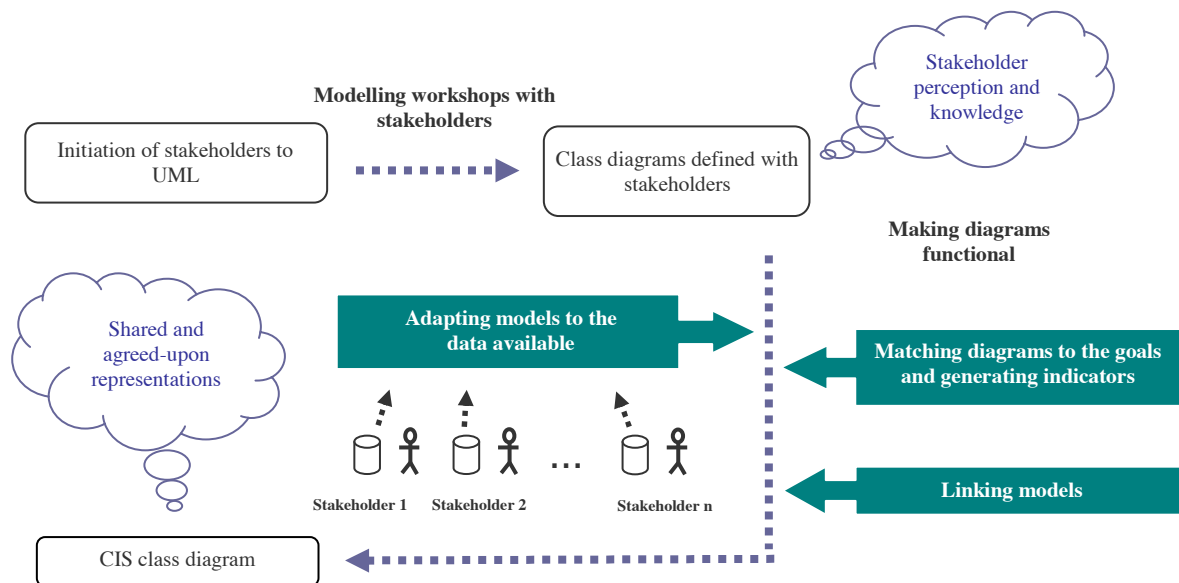


Figure 3. Participatory design and fine-tuning of class diagrams

An organisational structure also needs to be set up

In parallel to setting up the information-centred component of the CIS, an organisational structure—i.e., the people-centred component—must also be built up. Our experience in the three pilot sites has led us to create in each site several levels of organisation:

- An Advisory Board, made up of local elected authorities and representatives of the various sectors identified as relevant to the issue (agricultural production, State agriculture and environment services, non-profit environmental protection, local water management, fishing, etc.). It sets general guidelines, arbitrage, and can serve as a source of institutional legitimacy and publicity for the CIS.

- An Executive Committee, made up of those more directly involved in the routine implementation of the CIS—i.e., those dealing with CIS coordination, data on agricultural practices or environmental quality, or technical aspects of UML (ourselves). It evaluates progress, makes decisions on CIS implementation, and provides support to the coordinators.
- A coordinator or two co-coordinators belonging to the local agricultural extension service (*Chambre d'Agriculture*). These are the individuals that drive the process and take part in every aspect of the CIS.
- The stakeholder group, whose composition can be the subject of debate and which should in theory include individuals representing all the various interests at play around the issue at hand. This is the group that meets at the workshops—referred to above—to share their different points of view and reach agreement on defining the issue, the goals and the “information landscape” embodied in the class diagram.

Lessons learned

Building a CIS in a situation of conflict

Monitoring the environmental impact of agriculture is often a sensitive affair. In the Aume-Couture watershed site, the creation of a CIS took place in the context of a long history of conflict between maize producers dependent on irrigation on the one hand, and environmentalists and fishermen concerned about year-round flow of local rivers and brooks. The focus on information, its collective construction and the use of user-friendly communication tools such as the diagrams made it possible to some extent to engage a dialogue among the groups in conflict. In the end, however, the CIS was not able to maintain broad community buy-in. The result is a CIS that emphasises the IT dimension while minimising social interactions, and that has reduced the scope of information that it manages. For example, current discussions on the CIS revolve exclusively around the development of a website and no further workshops are planned. The information landscape has contracted: the data collected relates mainly to water volumes used by irrigation and efforts to include data on the status of water bodies were postponed.

Availability of data

An operational CIS is dependent upon the availability of data, obviously. Nevertheless, we have observed that lack of pre-existing data can have a beneficial effect on group dynamics. In the Millevache Plateau site, data on the relationship between sheep grazing and the maintenance of two ecosystems of interests was quasi-non-existent. The group of involved stakeholders was therefore faced with the need to generate the data, which they set out to do via a survey of farmers and their management practices. Developing the survey became an opportunity for the group to engage in joint work and conferred a certain degree of power to the group. In contrast, in the Hiên Valley site, a comprehensive survey of dairy farming practices had been conducted and indicators from that survey data had been developed prior to the CIS initiative. This sequence of events contributed to the maintenance of a certain distance between local stakeholders and the information system which by-and-large remained in the hands of those most intimate with the pertinent data.

Social organisation

The tendency of participating organisations is to improvise the creation of an organisational set-up, relying on existing structures and organisational habits. We have found however, that better results in terms of achieving wider buy-in can be obtained if the process is planned, facilitated and made more legitimate via the endorsement of locally-recognised institutions. That is why step 2 (Figure 1) is broken up into a number of steps to create an organisational structure that supports, feeds into and uses the CIS. The interactions that take place and the groups formed in the course of this process should not be seen as temporary means to achieve an end—i.e., the creation of an operational CIS—but rather, they should be seen as essential social components of the CIS to-be. Practical guidance on facilitating a social process that is more likely to generate quality interactions can be found in Hemmati (2002).

Conclusion

Our experience provides some evidence that information management need not be confined to the domain of IT specialists. Simplified versions of UML components can be adapted to the needs of non-experts and used in participatory community development initiatives. In all three sites, we observed that stakeholders appropriated the method, the tools and the participatory facilitation approach proposed. Overall, stakeholder expectations and knowledge were integrated into the various UML models developed. The formal endorsement of these models in workshops by stakeholders conferred them a degree of legitimacy. We observed, however that the level of participation, in terms of human and financial investment were unequal among stakeholders and across sites. This may not be due to the specific approach proposed but rather to external factors such as the different availability of participants and the different levels of interest for the CIS among them. To conclude, we observe that the particular value of this approach, compared to more traditional monitoring systems, resides in the improvement brought to the design phase by the way the models are developed and by a type of facilitation that favours interactions and strengthens the cohesion of a heterogeneous assemblage of stakeholders around a common understanding of the CIS to be implemented.

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