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Some Novel Information Systems for the Empowerment of a Decision-Making Process on a Territory: Outcomes from a Four Years Participatory Modeling in Senegal

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Abstract: The Maps, the Geographical Information Systems (GIS), the Role-Playing Games (RPG) and the other participatory supports, the Multi-agent Systems (MAS): all are modeling supports designed through their conceivers' perception. Even in participatory approaches, these designing and modeling can take off towards technocratic, but often unconscious, drifts. Yet, a true empowerment of local governance means to let stakeholders and their principals totally handle their information and modeling systems. The mere access to information is certainly a first step but it is far from a true power over it, so long as this local people are not able to select, process and manage their information systems. Actually, the present fast developing use of these tools could be a threat as much as a progress for the democratization of information. These new information technologies are still often a way to reinforce technical point of view into the decision-making process. This analysis brought us to methodological experiments between 1997 and 2001 in the Senegal river area, to support a land use management local process based on a *Information Systems Self-Governance*. We conceived and tested novel forms of maps, Geographical Information Systems, Role-Playing Games, other participatory supports and Multi-agent Systems in a designing approach truly reversed. For all these supports, stakeholders or their local principals guided all steps of designing and modeling process. This method rests on two principles: the *endogenou*s nature of a decision-making process that we consider always continuous and iterative; the *self-design* of the modeling tools to supply supports for decision-makers much suitable, much handy and much controllable. In this such a support of decision-making processes on territories, the technical supports are merely a sort of *mediating accompaniment*. The results of the four years experiment allow us to formalize a self-designed modeling approach, for simple maps as well as GIS, RPG and MAS supports. The outcomes also show that this sort of endogenous and self-designed participatory modeling is efficient to let an endogenous dynamic of governance come across into a bottom-up regional policy and planning, from local (2500 km²) to regional (18 000 km²) scales. In other words, a bottom-up participatory modeling and planning, more fitted with the more humble place where our post-normal Science should be in the XXI^{e} century.

Key-words: Participatory - Governance - Role Playing Games - Geographic Information System - Agent Based Modeling

1. FOR A SELF-DESIGNED PROCESS OF INFORMATION SYSTEMS

Multi-Land Uses Management (MLUM) is a complex and unpredictable issue that principals have to contend with along an iterative route. In the matter of modeling, it hence implies a participatory modeling within continual comings and goings between model and terrain. But, without deep adjustments, the grounds of participatory approaches seem to us not really suitable to support collective decision processes [D'Aquino, 2001], [D'Aquino et al., 2002]. In effect, the theoretical assumption lays on the interest within a parity appraisal and design (of models, planning, etc.) between expert and people. But on the contrary, we postulate here that the process of tools design and supporting advice is too deeply handled by experts to allow truly parity dialogue and influence right at the beginning. We then need before a classic participatory approach a different process with different theoretical assumptions to help people reach equal handling of knowledge tools and decision processes than experts and technicians. This is the kind of "pre"-participatory process we have experimented since 1996 in the Senegal river valley, within tools designing as well decision process leading. We are looking here for a supporting methodological environment that places information at the disposition and under the control and influence of civil society. In this fashion, the goal should be to target a deeper leading of people in all the decision-making processes involving information. This objective implies resolving the paradox between an international standardization of information on one hand and adjusting information to the needs of local people and their stakes on the others, in the way some authors [Lorentzon and Forsström, 1992] advocate a specific "gateway technology" that will develop new ways of link-up. For us, such a "gateway technology" should rest on first three principles: initially, the assembling of the

information desired by decision-makers; then, only providing external information (and IS) when the need is clearly expressed by people; third, the validation of everything through an internal debate before any implementation or information usage occur. But all this is still not sufficient for the setting-up of a democratizing decision-making process. The stake involved the handling of information, but also its organization, and its accurate representation in a process, must be in accordance with the decision-makers' perceptions. This new sort of information "access" means the users are also enabled to appraise information, including its weaknesses, and then to adapt and use it on their own.

In fact, the usual technical complexity designers often put in MLUM models is due to their wants to reproduce any possible impact, of an interaction between any players. This sort of designer sets thus instinctively their matter in the frame of a perfect decision being found in a given time (the decision time), face to a complex and realistic situation they can reach to set in their models. His tacit hypothesis is that all the elements essential for the decision can be select then put in the model. Moreover, he puts himself in the role of the expert who proposes to the principals his own, and presumed relevant, external perception as a support for the improvement of the decision-making process. The threat is in the difficulty to reach a model sufficiently close to the complex matter of the reality, without fallen in a so intricate device it is no more suitable for efficient uses. The possible weakness is in the ambiguous character of the designing expert, who is somehow put himself as the master of the decision process. Many participatory modeling or information systems fall in these traps. But here, the purpose of a tool cannot be to *produce right decisions* but to help people to improve *their own imperfect decisions*. We believe then the first crucial steps in order to improve a MLUM decision process lay much more in the reinforcement of principals' and stakeholders' *empowerment abilities* [D'Aquino et al., 1999], that are in the chronological order at first being considered by all parties as wholly responsible for their territory; next having access to an accurate and non biased[2] information for the decision; lastly being involved within a democratic making-decision process. In other words an *Information Systems Self-Governance*. This effectively implies we think the main constraint in MLUM issues lays not in any technical advice or knowledge but in the efficiency of a socio-political debate, decision and action. Consequently, the first aim of our tools is to accompany the decision-makers in their iterative and progressive own route towards a shared perception, then decision, face to their complex matters. That demands tools able to (i) designed *from* people' perceptions; (ii) putting advisers' knowledge at local disposal; (iii) being directly controllable by people. That means start without any model previous designed and *let principals of the decision process design themselves, progressively and incrementally, their own decision supports*.

Yet, in the current participatory modeling approaches, even before the participatory modeling steps, the previous modeling by expert selects thus items, the perception framework, the *important* information, dynamics and interactions, whereas we think the MLUM issues are too multifaceted to be simplified in a neutral way. Hence, in current participatory modeling approaches, the route toward the involvement of people may unfold then already boxed, little allowing people to configure the design with their own stakes, perception framework and implicit social interactions. Yet, we consider these kinds of endogenous point of view and implicit reality are highly crucial for the success of a collective decision supporting.

In the matter of modeling, all this leads to our *self-design* modeling principle[D'Aquino et al., 2001a] , [D'Aquino 2002] the most endogenous the design is, the most fitted the tool is. Our purpose is to set a novel design of some "mediating supports" [Boltanski and Thévenot, 1991], facilitating emergence of worthwhile debates, better taking into account all the different legitimate points of view instead of a supporting advice leaning only on one of them. Our use of the "mediation" term lies within the Boltanski's and Thevenot's fashion [1991]: it is often through adoption and sharing of some common technical devices that various people with different reasoning get to novel conventions where communication becomes feasible. Here, we add if we have not only "common" but really *joint* technical devices building up by their own, they will not only achieve common conventions but also come within joint actions and a more efficient learning by doing decision process. It would be more efficient because: (i) it is more fitted the stakes and points of view of the decision-makers; (ii) it is more fitted the pace and the incentives of their decision process; (iii) it is more receptive to the following evolvement of experts' knowledge and exchanges with external stakes. As a result, this means to test a "self" modeling design of tools (maps, GIS, MAS) by stakeholders and principals, right from the initial stages and with a prior design work by the modelers as little as possible. The method seeks to make people progressively formalize, solely the further they advanced in their debates, the elements which seem to us useful for

[2] That means information no previously interpreted by experts but provided by the more neutral way.

the improvement of their decision-making. This is that we experimented with since 1997 in the northern Senegal: a self-governance of Information and Modeling Systems within MLUM issues.

2. THE INFORMATION SYSTEMS SELF-GOVERNANCE (ISSG) EXPERIMENT

The ISSG experiment has been under way in the Senegal River valley. It was involved within a pilot project, which gathered local community representatives and public institutions in order to test new supports more fitted the community needs within the decentralization policies. The Senegal River valley is within a very dry area and water and other renewable resources uses entail strained competitions. Agriculture and breeding relationships are especially tricky, melding items about land tenure, water access and multi-purpose uses of the vegetation. Communities then ask for supports to help them to handle these multi-purposes uses competitions. Several workshops were organized through a year's time by the rural council of the local community of Ross-Béthio in Senegal, a local partner that volunteered for this experiment. Our experiment was thus laid on two methodological guidelines. First, right starting from people' reasoning for the framework modeling, then introduce only the external information (bio-physical and other) they identify by their own. Expert knowledge will be afterwards summoned up progressively by the principals on their own request and within the context of their own objectives. This is the strictly speaking *self-design stage*. Secondly, we let people organize a right handling of all the modeling and processing information tools set up. Strictly speaking, this is the *self-handle stage*. All this demanded to conceive and tested an appropriate learning by doing process that led to a complete Bottom-up and Incremental Regional Development (BIRD) planning [D'Aquino 2001].

The self-design stage is a special process coupling the self-design of a Geographic Information System (GIS), next the self-design of a Role-Playing Game (RPG), then the self-design of a Multi-Agent System (MAS). About the territory, maps are one of the best ways to transfer information. It is a very *visible* way to share the incentives of the decision process about the territory (see above our perception of "mediating support"). And GIS can more allow people to make visible, share and handle information previously not very available. At last, to go further than maps, towards more prospective supports, simulation tools are interesting : Role playing Games (RPG) and Multi-Agents Systems (MAS). RPG have already been often used in MLUM matters (Burton 1989, Ostrom 1994, Piveteau 1994, Heathcote 1998). But for operational uses, they are reported to be limited within a collective decision process because their cumbersome setting up, their slowness to develop a practical action and the uneasy analyses of their results. Then, computer modeling is interesting, and peculiarly multi-agent methodology (MAS). MAS promotes a gradual and iterative learning-by-doing progress vis-à-vis a complex environment: modeling only requires a few formal rules to begin and may be continuously improved through the input of earlier simulations in the decision-making process. This means taking up a complex situation within an incremental and iterative framing of a progressive modeling that leads to greater understanding. This also entails an ability to take into account the different perceptions of "world" (and space, and territory), which is central to putting modeling at everyone's disposal, whatsoever his perception of the world.

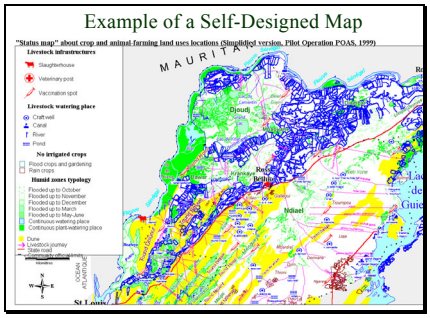
Our initial self-design of the GIS began by allowing people select by their own the first MLUM issues they wished deal with. Consequently, our GIS project team began work without any previously defined priority topics (soils characteristics, ecologic features, etc.). Next, they identified themselves during internal workshops the information and maps that they thought would be useful for resolving their MLUM issues. Furthermore, in comparison with current participatory approaches, our desire is to transfer the ability to handle information efficiently rather than to merely provide oversimplified (say local knowledge participatory appraisals) or already part-analyzed knowledge (say external diagnosis before participatory workshops). This implies placing at people' disposal *as early as the very beginning* a geographic information totally accuracy (data, legend, etc.) for very operational MLUM issues. The challenge was to succeed to sufficiently and quickly develop people abilities to identify, read and interpret very accurate maps that are similar to classic GIS products but defined by local people. In fact, the participants thus built a crude GIS, crude in its organization but not in its data resolution.

In practice, people identified their own informational needs for coping with their MLUM matters and afterwards helped the technical team to gather the knowledge until precise maps could be generated by GIS software[3]. Then, the first maps designed by this way were shown to people. At that point, participants determined gaps in the information based on their perception of the quality necessary. So, if they could complete by field investigations, they do it themselves and technical assistance only mend it for GIS. On one hand, the

[3] MapInfo software.

GIS team has its own "classical" GIS technology (remote sensing, data base,...) which allow it to supply quickly most of the information people ask for (soils characteristics, crops and settlements location, hydraulic schemes,...). On the other hand, thanks to the people's strong motivation and participation, the team could organize an accurate protocol for the collect of some peculiar data (types of wetlands, livestock journeys, follow-up of the multi-uses of ponds,...). Afterwards, this first basic cartographic information was returned to the local people in order to be appraised, rectified, enriched and finally acknowledged, during several workshops led by local principals in each decentralized community area. All this process rolled out during a short period (less than three months) through a learning-by-doing process of map analysis.

For instance, in the case of Ross Béthio community[4], the first subject chosen by local principals was the coordination of land use for crop and animal farming. One sees in the first map in Figure 1 an example of accurate maps designed and filled out by participants with the support of our method. For instance, the map in Figure 1 is the result of a collective decision concerning the location of breeding and farming activities drawn from the shared work of principals. This first stage of our *Information Systems Self-Governance* experiment was organized between 1997 and 2000 on a primary land-use scale of around 2,500 km² and 40,000 people and from then has been extended in the Senegal River valley (around 20 000 km² covered nowadays).



Then, people began to debate using their maps as support and searched communally for new ways to improve their collective situation. Outcomes of the experiment include new collective rules of land and resource usage that were legitimated in a formal charter [D'Aquino et al., 1999]. People finally asked for new supporting developments, peculiarly by requesting the inclusion of the dynamic effects of interactions between the different uses implemented and their medium-term evolutions. In concordance with our aims to transfer *empowerment abilities* in design, simulation, and modeling, this is the second step of our *Information Systems Self-Governance* approach: a self-designed simulation model, called the SelfCormas method [D'Aquino et al., 2001a], which begins with a self-designed Role-Playing Game (RPG) so far a self-designed MAS modeling. This self-designed simulation modeling was carried out in four situations, ranging in size from 180 km² to 700 km².

Role-Playing Games (RPG) has been already used to support land use management. But in our own experiment, we used a deeply different form of RPG. There were no priory rules and setting of the game drawn for our own previous diagnosis. The RPG is solely designed from the self-analysis of their situation the players produced in a first step, without knowing this analysis will afterwards used to set a RPG. Obviously, this kind of RPG rests on very crude and simplified rules and setting game. But the goal is not to conceive a game technologically achieved and satisfying for our own expert's point of view. This effectively implies we think a keen technical advice is less useful to start MLUM local governance than an accompaniment of the decision-makers in their iterative and progressive own route towards the complex and technically insoluble management matters.

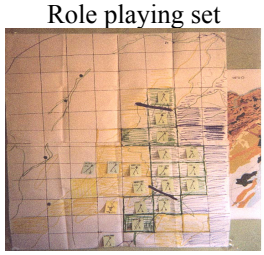
In practice, the first step of this second stage laid in the identification then acknowledgement by people of the *satisfaction criteria* of all sort of stakeholders involved, say as "the fundamental elements for every stakeholder to succeed to provide a living for his family". Here, there is no external input: merely a knowledge perhaps already known by every participant but not still build up shared in a public arena, not shown without indictment of anyone's behavior. The framework model must be tightly close to decision-makers, theirs perceptions as well their stakes and their needs: in other words, a self-designed simulating support, allowing people to "set in motion", and consequently to test, their first common representation of their MLUM issues.

Then, people began to debate using their maps as support and searched communally for new ways to improve their collective situation. Outcomes of the experiment include new collective rules of land and resource usages that were legitimated in a formal charter [D'Aquino et al., 1999], new agreements between farmers and breeders to use water for improving pastures [D'Aquino et al., 2001b], to settle conflicts between farmers and a National Park [D'Aquino et al., 2001c]. However, RPG are rather unwieldy at an operational level and for offering continuous support in a decision-making process. Moreover, RPG do not provide for a sufficiently

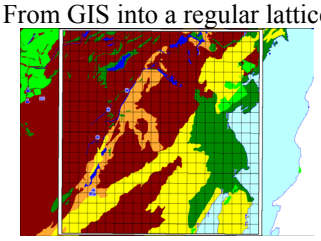
[4] Around 2 500 km² and 40 000 people, in the delta of Senegal river.

incremental and iterative process that progressively integrates information and knowledge. Consequently, after the start-up of a RPG, computer modeling, and especially Multi-Agent Systems (MAS), then becomes worthwhile. We used a special MAS platform, CORMAS[5] [Bousquet et al., 1999]. Our MAS platform, CORMAS, is coupled with GIS software and a cartographic support based on the previously designed maps. Thus, the same game setting, the same GIS maps, and the same crude rules designed by the participants are transferred from the game into a MAS model: a self-designed MAS. The MAS model is organized in "activities" (breeding, hunting, farming,...) gathering a group of features and a point of view, all withdrawn from participants. Given there is any constraint for adding new attribute, this process is very flexible and could integrate any sort of spatial representation, which is obviously useful in our self-design context. Moreover, new forms of land improvement could be created only by new combining of values of attributes. Then, every social MAS entity can have a real collection of points of view, as regards all the different activities is able to practice. At las, by switching runtime from an agent point of view to another, CORMAS allows to correct and valid during a simulation the first representations of stakeholders directly with them (for more details see [D'Aquino et al., 2001a].

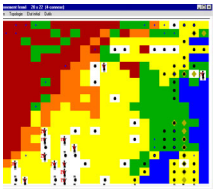
Role playing set



From GIS into a regular lattice



Spatial lattice in CORMAS



As they were themselves the initial designers of the simulations carried out, they were entirely aware of the distance between the model and reality and they did not consider computer outputs as reliable predictions of a "black box". The permanent link with an accurate GIS that presents data and precise maps enabled participants to shift from a mere exercise to a hot discussion of the future of each area and of each type of stakeholder (see Figure bellow). We are getting thus into the following stage of our *Information Systems Self-Governance* approach: the self- handling, which is a subtle learning-by-doing process starting within the self-design stage, then goes on through an autonomous local process of incremental decisions and management, which cautiously integrate expert advice, only on local demands and at the pace of the people progress in their MLUM issues.

3. OUTCOMES AND PERSPECTIVES.

In conclusion, it's a self-incremental modeling process supported by an accurate information system (GIS), which succeeded to make progress in the decision process within even so conflicting local situations. This *Information Systems Self-Governance* process (ISSG) is therefore quite different as regards the usual participatory assumptions. It could yet be put before these approaches, allowing decision-makers, peculiarly local decision-makers, to reach sufficiently sound status, power and knowledge in order to withstand a parity technician-people debate and exchange. This sort of supporting tools are growing richer progressively at the same pace as the shared decision-making process. They produce in this way a fitted and progressive self-improvement of MLUM negotiation and decision processes. However, our ISSG approach does not take care of the others phases within the decision process supporting: quantified technical appraisal, strictly speaking expert advice, technology transfer,... In effect, ISSG approach takes place before the usual technical advice, in order to develop the *empowerment abilities* (see above) of people as regards external perceptions and influences and to improve their IS usages. But the ISSG approach lays also upstream the current participatory approaches (and modeling), which implicitly rest on a parity nature in the technician-people couple [D'Aquino 2001].

[5] COmmon-pool Resources and Multi-Agent Systems: see http://cormas.cirad.fr.

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