The ECOSENSUS Project: Co-Evolving Tools, Practices and Open Content for Participatory Natural Resource Management

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Abstract

ECOSENSUS (Electronic/Ecological Collaborative Sensemaking Support System)[www.ecosensus.info] is an ESRC e-Social Science pilot project, using a Participatory Action Research methodology to evolve tools and work practices for collaborative work in environmental and natural resource management between a European-based team, and stakeholders involved in the region of concern, the North Rupununi District of Guyana. To promote long term capacity building in the region and beyond, the project's outputs will be disseminated as open source learning resources. Given the disparities in knowledge and power in such a project, central to our work are issues of stakeholder empowerment in the geographical modelling, interpretation and decision making practices that constitute environmental management. We argue that in e-Science, such factors have yet to receive much attention. This paper reports work accomplished to date: progress towards an environment which integrates GIS modelling with participatory deliberation about the implications of the models, and reactions from the indigenous Amerindians to this tool.

Context

ECOSENSUS is an e-social science project, set up to investigate the capacity of e-science to empower marginalized communities through giving them access to sense-making and spatial information tools. The context of this research is based in the North Rupununi District of Guyana, home to the Makushi Amerindian tribe. Traditional Amerindian communities have thrived through direct sustainable exploitation of their natural resources. Since colonisation by Europeans, members of the Makushi Amerindian tribe have been increasingly disempowered with a gradual erosion of their resource use rights. These communities are now under intensive pressure to abandon their traditional land use practices due to new social, economic and cultural pressures resulting from the construction of a new road built through their land that connects northern Brazil to the Caribbean Sea and therefore the North American market.

Historically these Amerindian communities have been excluded from the decision making process, due to their inability to access and develop information about their own region and the political and policy process determining access and use rights within their region. The use of the written language as exemplified through legislation has effectively excluded Amerindian participation in the decision making process, since limited attempts were made at incorporating their traditional knowledge in ways familiar to them. The purpose of ECOSENSUS is to allow these communities access to information and provide them with a tool for developing their own information as a counterpart to the knowledge (and power to decide) that other stakeholders such as the national governmental institutions (such as mining, fisheries and environmental agencies) and international agencies such the donor community have over the region.

The aim of ECOSENSUS is therefore to develop a tool that moves away from the classic use of a linear written language and replaces it with a visual language familiar to the Amerindian communities. Visualisation facilitates the integration of both specialist and non-specialist decision makers from a wide range of educational backgrounds (Schatz *et al*., 2004). Stakeholders which previously were unable to participate in key aspects of the decision making process are enabled to do so by the use of a visual language. In the case of natural resource management, stakeholders are faced with complex tasks which need to integrate spatio-temporal information along with disciplinary knowledge (namely, ecology, geomorphology, economics, sociology, anthropology and ethics). ECOSENSUS is therefore developing the integration of visual language tools to facilitate distributed group decision-making. These tools include *Compendium*[1] (open source visual sense-making tool) and *uDig*[2] (open-source Geographical Information Systems-GIS tool). We also recognize that just providing tools will not resolve complex natural resource management issues. The project is therefore dedicated to developing open content learning material which guides distributed groups in adaptive and participatory natural resource management.

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1 *Compendium* software, demonstrations, case studies and community: http://*Compendium*Institute.org

2 *uDig*, User-friendly Desktop Internet GIS: http://*uDig*.refractions.net/confluence/display/*UDIG*/Home

Research Approach

The above introduction to the context of the project indicates that we are dealing with a highly complex situation. We are trying to empower a marginalised community that not only has limited access to technologies but is characterized by a world view that is distinctly different from that of the West. At the same, we are trying to integrate two rather different software tools (computer assisted argumentation mapping and environmental information systems). Finally, we are trying to work as a team that is distributed across three countries and is located in at least five different locations, with some of them being able to join on-line meetings only with dial-up modems or intermittent satellite communication; in addition, the expertise of the team members varies significantly from philosophy to Java programming, and not all of them have met personally or have previously worked together. The project clearly deals with a so called "wicked" problem (Rittel, 1972): the 'problem' manifests itself only as you try to engage and change the situation and in doing so the problem in turn changes; there is no definite solution that the project could aim at; no case history to draw upon; no right or wrong approach to take which would make everybody equally happy; and there is no way to anticipate the consequences of working through the project. To add to the difficulty, there is the social and the technical complexity of working as a distributed team when there is no established process for the team and off the shelf groupware for projects on a shoe string budget (we are aware of the availability of advanced shared desktop displays with video link-ups but with a budget of £45,000 over an 18 month period, there was no way that we could even dream of using such technologies).

The research approach adopted is based on participatory action research (PAR), specifically involving a combination of soft systems methodology (SSM) (Checkland, 1981; Checkland and Holwell, 1998) and critical systems heuristics (CSH) (Ulrich, 1983; 2000). SSM can be mapped onto David Kolb's (1984) cycle of experiential learning which underpins PAR. The various stages of SSM fit into the 4 steps of experiencing, reflecting, conceptualising and planning. CSH tackles issues of divergent interests and unequal distribution of information and power among stakeholders in developing human activity systems. It is a powerful discursive tool for structuring stakeholder dialogue and, in particular, for dealing with controversial issues of evaluation and emancipation. CSH supports a framework for reflective practice based on practical philosophy and systems thinking. CSH particularly supports one of the central tenets of PAR: "Participatory action research establishes self-critical communities of people participating and collaborating in the research processes of planning, acting, observing and reflecting. It aims to build communities of people committed to enlightening themselves about the relationship between circumstance, action and consequence, and to emancipating themselves from the institutional and personal constraints which limit their power to live by their legitimate, and freely chosen social values" (McTaggart, 1989).

By integrating CSH into *Compendium*, we aim to develop a collaborative e-science infrastructure that not only allows processing of spatiotemporal information such as provided by GIS, but equally allows capture and analysis of socio-economic and cultural information relevant to stakeholders.

In order to make our methodology participatory and applicable to distributed team working, we suggest to use SSM and CSH within a basic learning cycle based on the following four steps: Observe; Evaluate; Plan; and Act. Each of these steps is supported by a range of techniques specifically developed for integrating distributed team working with spatio-temporal and multidisciplinary information. In particular, issue-based templates are to offer hyperlinked questions and guidance for structuring reflection and dialogue. The templates are being developed not only for our current team but are also aimed at a scalable application of both the process and the tools to issues of natural resource management. A significant expansion of the distributed team is to take place during the life time of the ECOSENSUS project, with the aim of involving local stakeholders in Guyana. Ultimately, our hope is to engage Amerindian communities in the research as well as the later practical application of the collaborative e-science infrastructure developed by the research.

Collaborative e-Science infrastructure

Our initial technical vision was to extend the characteristics of GIS tools (large spatial data volumes and computationally intensive routines) with tools to capture and support a distributed team's decision-making process as it works through a distributed computational infrastructure. The aim was to allow team members to be able to collaboratively work on exploring complex issues using a tool to record stakeholders' views, while simultaneously providing fluid access to spatial information in support of the collaborative deliberations.

The project has extended *uDig*, an advanced open source GIS project providing a range of powerful spatial data visualisation and modelling tools, with the dialogue-centric *Compendium*, which provides a medium to assist participatory, dialogical spatial decision-support. *Compendium* uses modelling approaches such as Dialogue Mapping (Conklin, 2005) and Conversational Modelling (Selvin, 1999), which derive from the formative 'argumentative' policy planning methods of Rittel and Webber (1973). *Compendium* adds hypermedia concept mapping to support Rittel's Issue-Based Information System (IBIS). Used well, the approach has established a track record in supporting real world mediation and participatory design (e.g. CI, 2005), and has recently started to prove its value as a collaborative e-Science medium (Clancey *et al*., 2005; Buckingham Shum *et al*., 2006). Figure 1 shows *uDig* and *Compendium*. Integration work has resulted in fluid movement between states in the GIS model, associated discussions and any other information source mapped in *Compendium*.

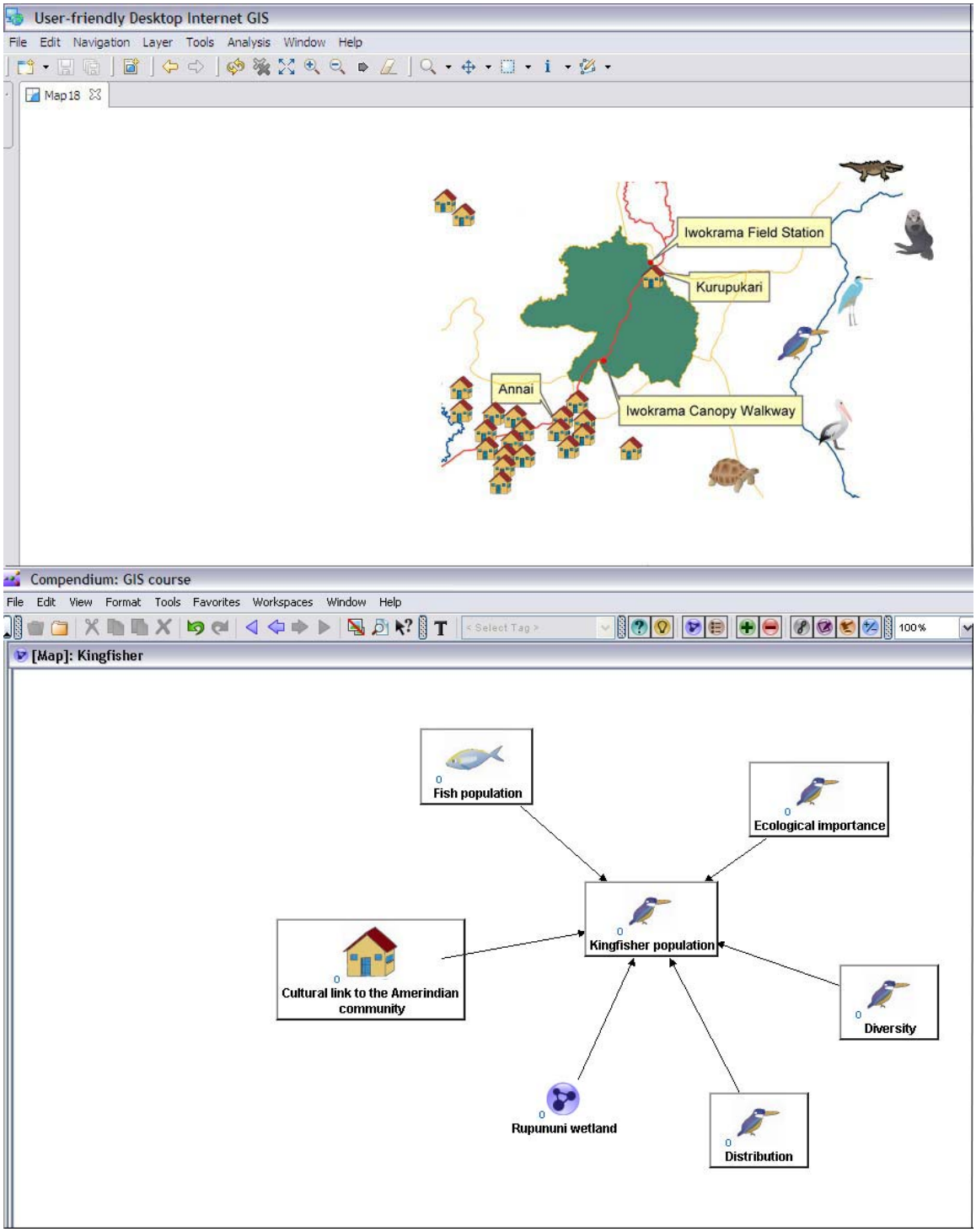

Figure 1: The integration of *Compendium* and *uDig* in spatial analysis, dialogue mapping, and sense making. In this case, the 'kingfisher' icon can be inserted within a GIS map of the Rupununi region (top image). The same icon can be used within the dialogue mapping (bottom image). A facility allows the user to navigate between the GIS and sensemaking tools.

Compendium supports Conversational Modelling (Selvin, 1999), which provides a dialogue-oriented visual language for collaborative modelling. This is used in the service of any methodology, which focuses a group's attention on addressing specific Issues. Issue-templates can be linked within the software tool, so that answers linked

to one Issue may 'ripple through' to other related views, automatically inheriting keyword 'tags' in the process. Issue-templates have been developed to scaffold the action learning SSM/CSH approach, introduced above (Figure 2); we reflect on the indigenous Amerindians' reactions to these below.

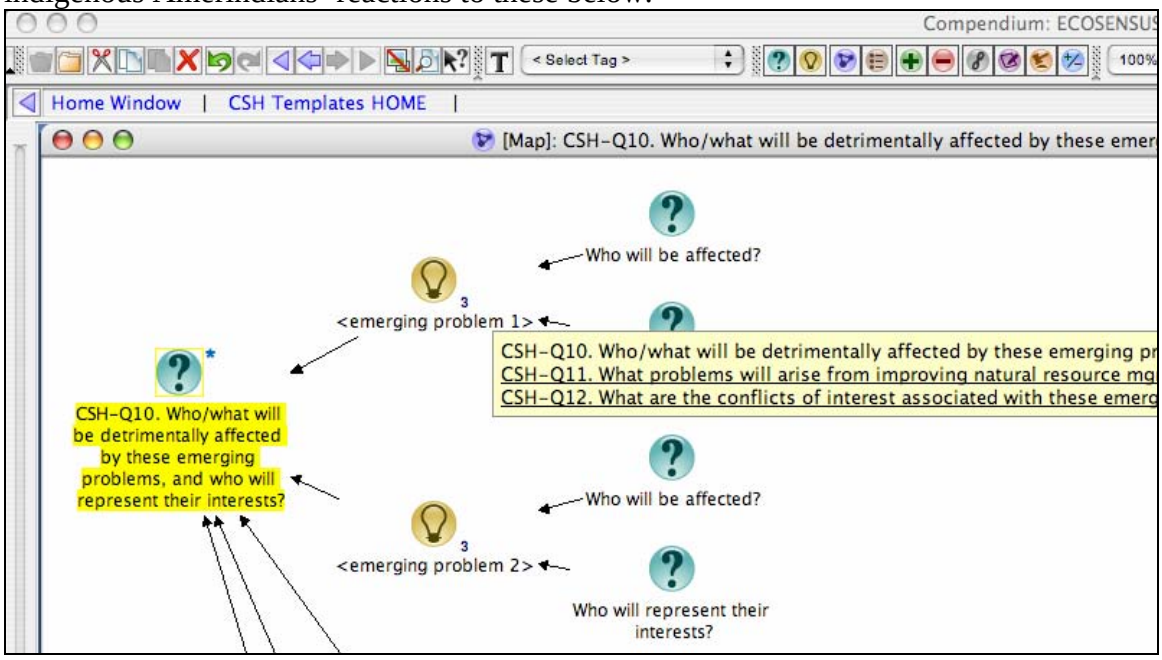

Figure 2: A *Compendium* Issue-template derived from Ulrich's Critical Systems Heuristics. On the left is one of the 12 critical questions within the CSH approach. Consequent questions are shown on the right. The pop-up window provides a hyperlink menu to other issue maps where the answers also appear.

A late addition to the collaborative e-science infrastructure was the adoption of *Moodle*[3]. *Moodle* is a sophisticated course management system developed by an active open source community for supporting participative online learning. This effectively became the team's capacity building tool and content management system. Justification for the integration of *Moodle* is provided below.

[3] *Moodle*, open source on-line course management system: http://moodle.org/

Figure 3: A screenshot of the ECOSENSUS *Moodle* interface in the first stages of development.

Preliminary results

So how could we define the outcomes of the project? A design for a human activity system where an accommodation between different stakeholders/participants is arrived at? Or an action plan? This is a major issue that participatory action research has to contend with in that the essence of the approach is an ongoing "spiraling" of the action learning cycle so that there is no final solution or output to what is essentially a complex and "wicked" problem. Change in understanding and practice may emerge as outputs during different phases of the action research cycle. Overall, what the team would like to achieve is:

- a basic shared understanding of the environmental issues at stake.
- a distributed systems framework for moderating the participatory process which does the ethical and normative dimensions justice. In other words, the ability to constructively manage the stakeholder concerns relevant to the environmental issues at stake.
- to develop and familiarise ourselves with a range of ICT tools for supporting distributed systems practice and thinking.

We are now at a stage where we can present our findings of the first 12 months of the 18 month project. Within this period, we have had to develop a distributed team working process that could cope with the spatio-temporal, ecological and social complexity of natural resource management issues while at the same time incorporating our particular critical systems approach to participatory action research. This first phase of research involved the participation of the ECOSENSUS team in the UK, Guyana and Switzerland, in developing a participatory action research and learning methodology with a host of supporting open source tools (*Compendium*, *uDig* and *Moodle*). This was in preparation for the second phase of the project (May – August 2006) which involved the direct engagement with stakeholders in the North Rupununi, Guyana, building the capacity of various Guyanese stakeholders (especially the Amerindian community) for distributed participatory action research. The aim in this second phase is to have measurable impacts on the situation.

This first phase was set up in a way that recognised the need for the research team itself to discover and learn about new ways of working participatively online. A range of tools were experimented with including asynchronous (e-mail, website, *Compendium* dialogue mapping, word documents) and synchronous (video/audio and chat through the use of *Flash Meeting*[4]). A major challenge soon became apparent in that the variety of media used and file formats made it difficult to build up both a digital knowledge base and a shared mental model ("How does it come together?!" was one of the comments from a team member) . There was also a significant effort expended in coming to terms with the wide range of software tools in use and the tools themselves were found to be more time consuming than the equivalent face-to-face meetings. An additional difficulty was coping with ICTs that favoured individual actions as opposed to group working (everybody has experienced the rapid

[4] *Flashmeeting*, open source video conferencing: http://flashmeeting.open.ac.uk/index.html

breakdown of coherent argumentation and/or overloading when e-mail discussions involve the participation of more than 3 individuals). Thus our challenge was how to use ICTs in ways that promoted our participatory and inclusive stance. Yet, the team had no choice but to use ICTs in that we were all distributed in up to 5 different geographical locations (3 different locations in the UK, one in Switzerland, and one in Guyana).We therefore had to try out on ourselves what we wanted the communities to experience.

A major realization was the need for an ICT framework which could facilitate the participatory action research approach while at the same time integrating the various synchronous and asynchronous modes of communication. We also need a tool which could act as a growing knowledge base for the project.
In the end, the team focused on the same tool which was initially identified to host the open content learning material for the second phase of the project. Quoting a team member: "I am not sure whether we as a team master the 3 basic tools [*Moodle, Compendium* and *uDig* for distributed team working]. When I look at the learning outcomes for the course [developed to build capacity in both the process and the tools], I think the team members should be the first students on it!". The integration of *Moodle* was the clearest example of the opportunity driven problem solving approach adopted in the project. The original proposal made no mention of *Moodle* and the software only became essential after the team experienced the various difficulties outlined above. During the same period, the open university received a significant award to integrate *Moodle* and *Compendium*, thus the case for adoption within the project could not be any stronger.

Yet the team was driven more by the problem at stake in the North Rupununi and the ethical principles of emancipation rather than the technological tools per se. Our priority was to understand the kind of issues we were dealing with and establish the ideals that powered us while the technological tools took a secondary place as a means to an end. Our fear was that in focusing our research and learning too exclusively on the technology would ultimately disillusion and estrange both the team members and the eventual end users.

An issue that the team was faced with, both in working through the project and developing the course, was how much space we would allow individual members to continue and/or initiate a process of individual specialisation as opposed to emphasising the need for shared understanding and practice. Here the idealogy of the team played a major role through the influence of educationalists such as Paolo Freire, where we favoured collaboration and co-operation over competition and individual achievement. Throughout the project there was pressure for all team members to participate whether the item on discussion to their field of specialisation or not. This is clearly reflected in the second phase where achievement is attributed mostly to team performance.

In the first phase of the project, an attempt was made to engage the end users in the process and tool development. The initial feedback has been encouraging, especially with the Amerindian communities, where they have readily engaged in the use of the *Compendium* visual language and its adaptation for integration with *uDig* - within 20

minutes of demonstration they themselves were able to develop their own visual sense-making maps, with recommendations to change the visual argument mapping icons to imagery familiar to them. For example, the 'decision' icon currently represented as a hammer hitting a block will be replaced with a 'handshake'. This is with a community that has had limited experience of academic and professional sense making activities. *Compendium*, through the predominant use of a visual language, was seen to be much easier for the communities to identify with and they rapidly developed maps showing what they understood of natural resource management within the region and what they understood of the decision making process, and how they would like to take the decision making process forward.

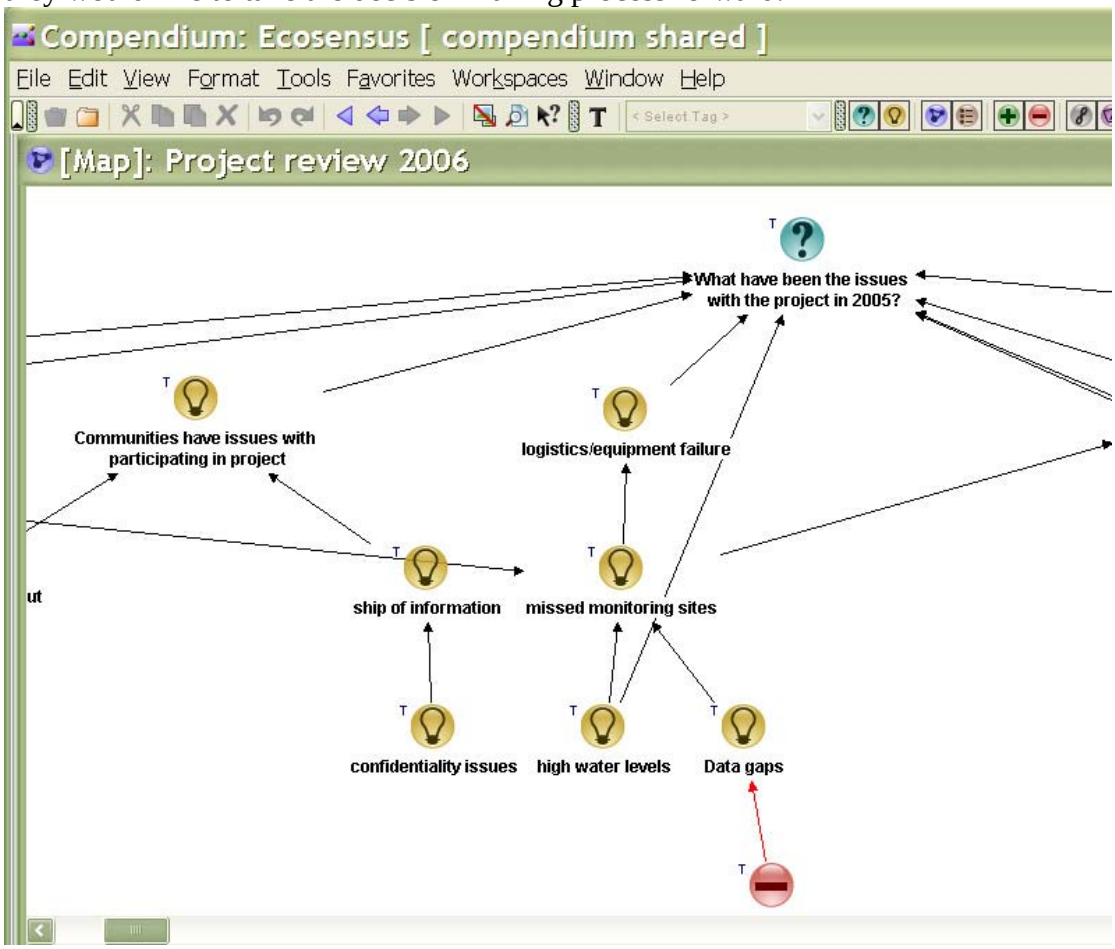

Figure 4: *Compendium* map developed in Guyana during an exploration of the appropriateness of the tool for decision support in natural resource management.

The problems that we encountered were with the proposed use of a range of templates dealing with stakeholders involvement within decision making. Some community members were very weary of explicitly identifying the power struggles that they have been subjected to especially because of their history of ethnic cleansing and disempowerment. Thus the templates we have to propose have to be much more subtle and not so direct about the power issues involved in natural resource management within the North Rupununi. We are therefore working on integrating within *Compendium* a number of SSM/CSH templates that would offer stakeholders a simple and adequate way of expressing their views and concerns.

Next steps

The second phase of the project will involve the expansion of the distributed ECOSENSUS team and will include 3 members of the Amerindian community (one male and two female) and 3 members of the coastland community which have historically held decision making power (also of mixed gender). This second phase will certainly introduce a new host of issues, both social and technological, which the enlarged distributed team will have to work through and adapt both the tools in use and the SSM/CSH process templates. The final phase (September - December 2006) of the currently funded NCeSS project will coincide with the start of a new £106,000 18 month project whose aim is to engage a significant number of stakeholders in the action research/learning process.

Conclusion

This paper has illustrated the development of e-science tools and processes while actively engaged with a complex real world situation using opportunity driven and participatory action research approaches. The outputs of the first 12 months of the project include integrated open source GIS and sense-making tools, which are also integrated with open content learning material to build capacity for evolving both the tools and processes while at the same time having a real impact on the ground. The ultimate vision is to empower marginalised local communities in controlling and managing their own natural resources in ways which are ecologically sustainable, participatory, equitable, and respectful of cultural diversity.

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