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## \***ECOSENSUS: developing collaborative learning systems for stakeholding development in environmental planning.**

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### **Abstract**

ECOSENSUS \*(*Electronic/Ecological Collaborative Sensemaking Support System*) investigates the socio-technological issues around developing collaboration tools for participatory environmental decision making amongst (a) marginalised natural resource users, (b) professional 'experts' from different countries, and (c) key decision makers associated with managing ecosystems. An integral activity is the production of open content learning resources to support stakeholders in facilitating distributed environmental decision making. This involves the integrated use of three open source software tools: Moodle (online course management), Compendium (dialogue mapping) and uDig (user friendly desktop/internet GIS). In the first ECOSENSUS-1 phase, the pilot collaborative effort has been focused on supporting stakeholders in developing adaptive management plans for the Rupununi Wetlands in southern Guyana, a region rich in flora and fauna but also under intense pressure to expand the exploitation of its natural resources, including timber, gold, and commercially viable fish species. Results of the ECOSENSUS-1 are briefly described along with some preliminary notes on the current ECOSENSUS-2 phase of associated research in Guyana supported by an additional grant from DEFRA. The paper prompts questions on how ECOSENSUS can feed into wider open source course development using the LabSpace on the OpenLearn project.

### **Introduction**

ECOSENSUS (Electronic/Ecological Collaborative Sensemaking Support System)[<http://kmi.open.ac.uk/projects/ecosensus/>] began in 2005 as an ESRC e-Social Science pilot project exploring and developing the use of a participatory action research methodology to evolve tools and work practices for collaborative spatially distributed work in environmental planning. The participants included a European-based team lead by the Open Systems Research Group (OSRG) at the OU, and colleagues from Guyana including environmental scientists, land-use planners, and indigenous Makushi Amerindians and their representatives associated with the protection and development of the North Rupununi District of Guyana. The project had two immediate aims: firstly, to help develop open-source software tools for

enabling marginalized communities with (albeit limited) access to the internet to engage with environmental decision making; and secondly, to begin developing open-content learning resources to guide distributed groups in adaptive and participatory management of natural resources. Both aims sought to enable stakeholders to reconfigure their stakeholding in situations of conflict and uncertainty. Since the 18 month funding (£46K) for ECOSENSUS-1 finished in December 2006, two areas of development have advanced the project aims: firstly, a DEFRA supported 'Darwin Initiative' project (£106K) involving ECOSENSUS personnel is working on a second ECOSENSUS-2 phase in developing a North Rupununi Adaptive Management Plan (NRAMP) using ECOSENSUS tools; and secondly, the OU OpenLearn project is housing the ECOSENSUS learning resources for both phases on LabSpace. This paper reflects on the progress being made as part of a wider and longer-term endeavour to help support alternative forms of practice and understanding for collaborative environmental planning.

### **Context: the problem situation**

The North Rupununi District of Guyana is home to the Makushi Amerindian tribe which has traditionally 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 resource user 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 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 user rights. The use of the written language as exemplified through legislation has effectively excluded Amerindian participation in the decision making process. ECOSENSUS allows such communities access to information and gives them 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 (e.g., mining, fisheries and environmental agencies) and international agencies (e.g., the donor community) typically monopolize.

In addition to the particular socio-natural resource dilemmas described above, the problem situation also consists of two dilemmas relating to the intervention itself. Firstly, there are significant socio-technical issues regarding development and adaptive use of the open-source software tools. ECOSENSUS moves away from the classic use of a linear written language and replaces it with a visual language more appropriate to the integration of both specialist and non-specialist decision makers from a wide range of educational backgrounds (Schatz *et al.*, 2004). In the case of natural resource management, stakeholders are faced with complex tasks which need to integrate spatio-temporal information along with disciplinary knowledge (e.g., ecology, geomorphology, economics, sociology, anthropology and ethics). ECOSENSUS is developing the integration of visual language tools to facilitate distributed group decision-making. These tools include *Compendium*<sup>1</sup> (open source

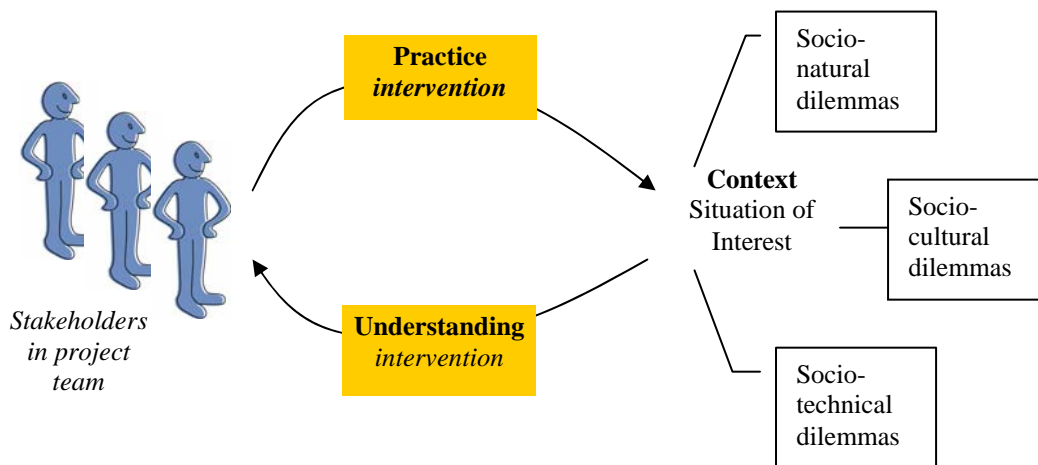
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<sup>1</sup> *Compendium* software, demonstrations, case studies and community: <http://CompendiumInstitute.org>

visual sense-making tool) and *uDig*<sup>2</sup> (open-source Geographical Information Systems-GIS tool). Just providing tools will not resolve complex natural resource management issues, and the project is therefore dedicated to developing open content learning material which guides distributed groups in adaptive and participatory natural resource management. Moodle provided the virtual learning environment (VLE) for developing these learning resources.

Secondly, there are inevitable socio-cultural differences between stakeholders in any project team. These range from differences between particular skill-sets of stakeholders to the less-tangible differences relating to cultural norms and expectations.

The context indicates a highly complex situation of socio-natural, socio-technical, and socio-cultural issues. Together with other complicating context-specific factors (illnesses, shortage of time, and robbery of project equipment at gun point among other things) the project was clearly dealing 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. Figure 1 summarises the problem situation in relation to the intervention process.



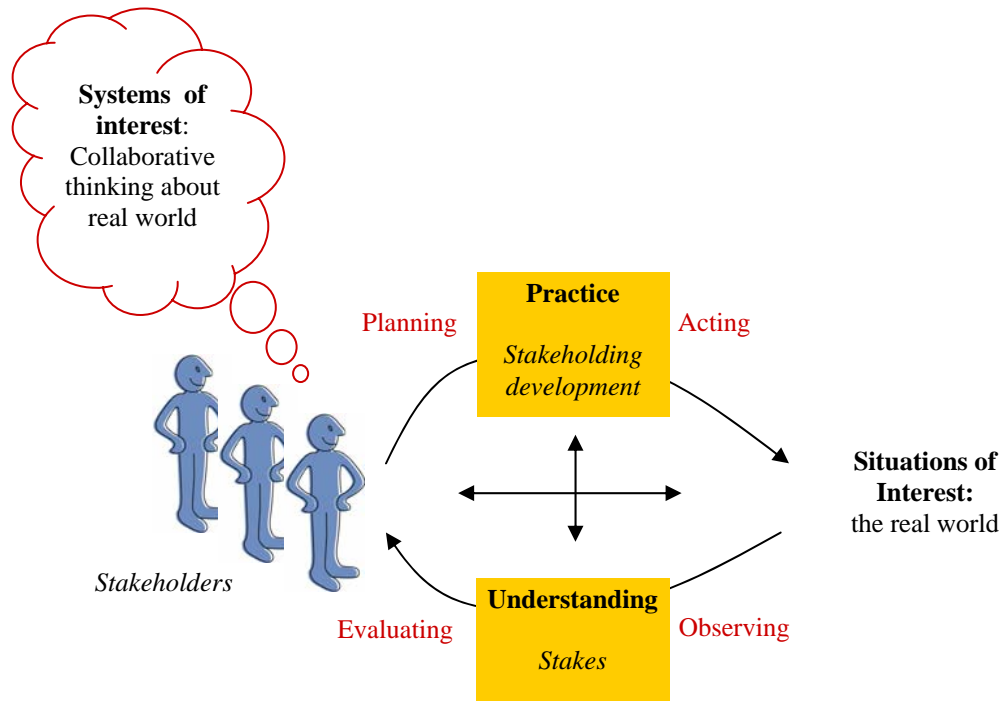
**Figure 1 ECOSENSUS intervention**

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

## ***A framework for stakeholding development***

In any intervention stakeholders perceive particular issues at stake. From this understanding, stakeholders may wish to either protect or alternatively actively develop their stakeholding in the situation. ECOSENSUS attempts to cultivate this second line of practice in stakeholding development. We adopted a research approach based on participatory action research (PAR) specifically involving soft systems methodology (SSM) (Checkland, 1981; Checkland and Holwell, 1998). SSM was specifically developed to move away from the paradigm of optimisation adopted in many information system applications and instead adopts a paradigm of learning in ill structured situations. 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. Also, recent developments in systems thinking and practice has proposed a distinctive approach which explicitly considers the ethical and power issues, common in wicked problems: critical systems heuristics (CSH) (Ulrich, 1983, 2000). CSH is a relatively recent development in systems thinking, which tackles the 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 is thus 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).

Figure 2 represents the ECOSENSUS framework as used both to guide our own research process and the development of resource materials for the VLE. The framework accommodates SSM and CSH features. The seven SSM stages can be mapped on to the learning cycle. The twelve questions associated with CSH provides a template for inquiry into the stakes, stakeholders and stakeholdings associated with any situation of interest. Both these features are illustrated in the learning resources developed on the VLE. In contrast to conventional project frameworks built upon a learning cycle, the ECOSENSUS framework makes explicit two dimensions of tension that require continual attention: a tension between *practice* and *understanding* between stakeholders; and a tension between *systems* as conceptual constructs of social reality, and *situations* of real world 'wicked' problems.



**Figure 2** ECOSENSUS e-PAR Framework

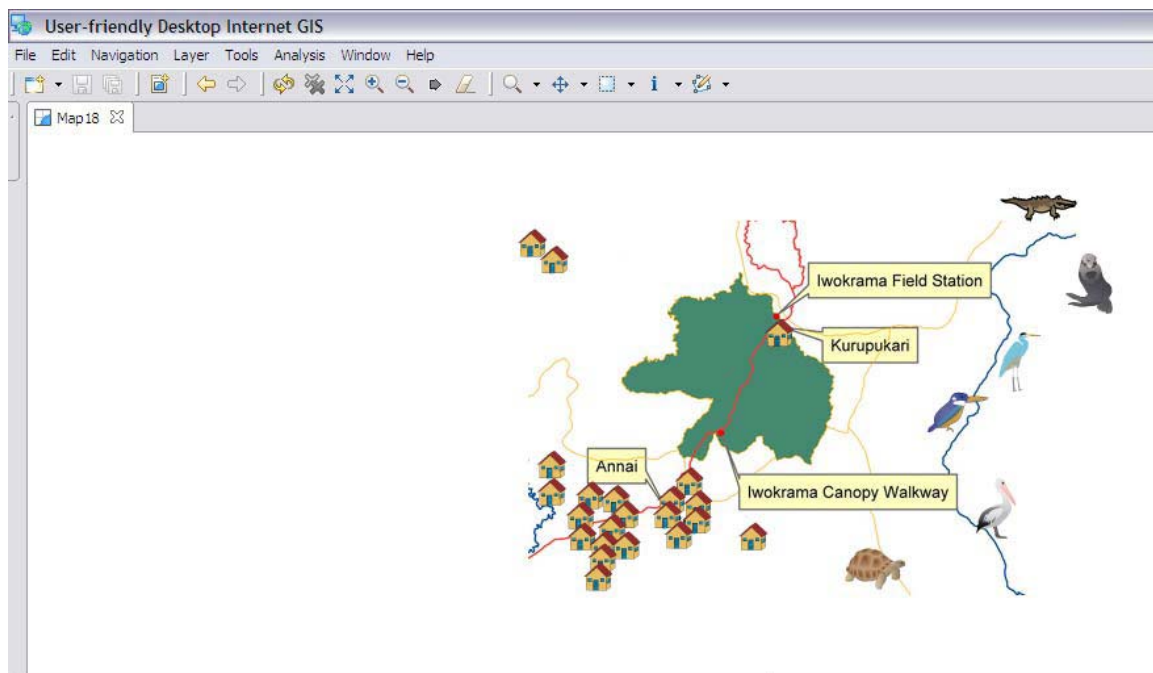
Both SSM and CSH function at their best through intensive face-to-face dialogue between interested parties, usually co-ordinated by a facilitator. Our challenge was to develop an SSM/CSH approach appropriate for distributed practice. To our knowledge this has never been done before. Information and Communication Technologies (ICTs) are notorious for their inability in conveying “social presence” crucial in communicating complex issues and building relational links among team members and wider stakeholdings (Warkentin, Sayeed and Hightower, 1997). The next two sections describe the emergent technical and social issues respectively.

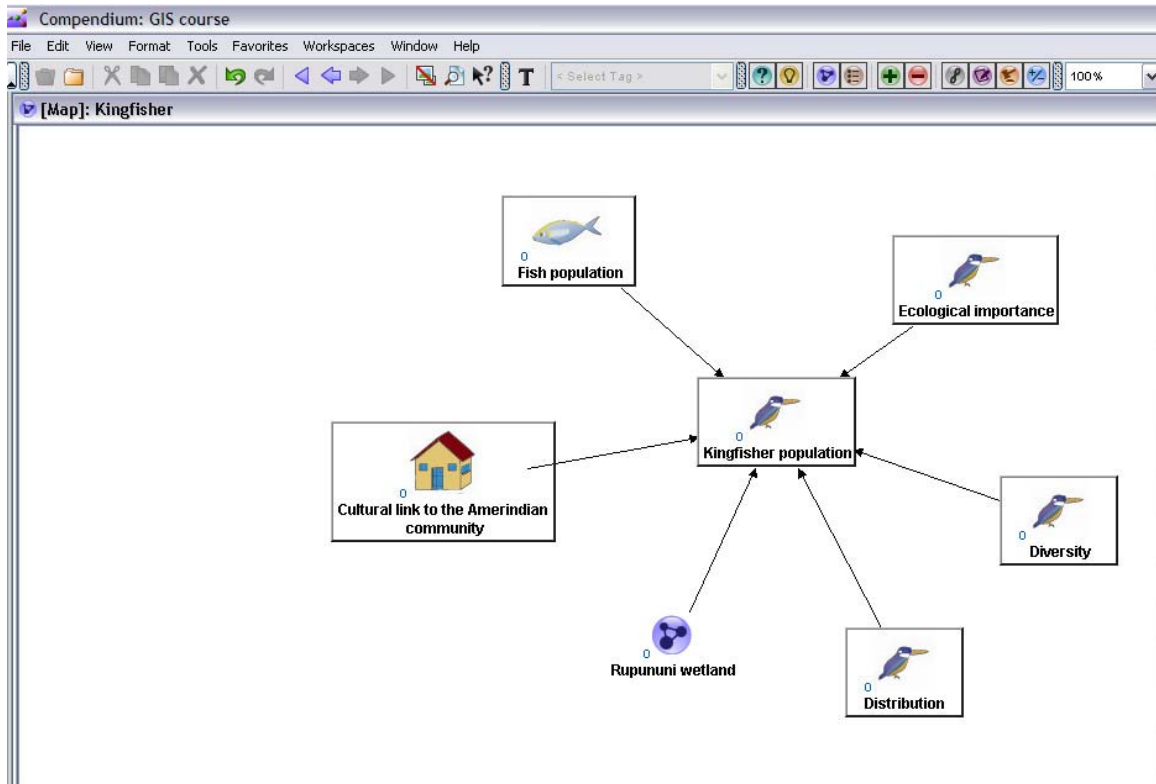
### ***Technical issues***

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-

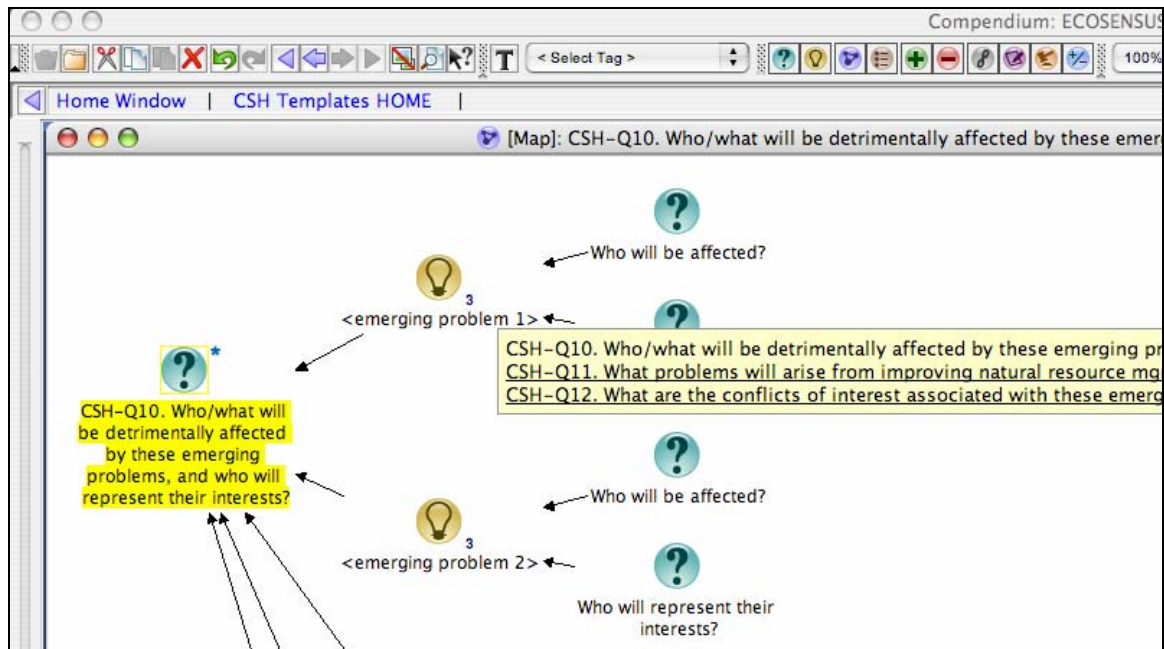
centric *Compendium*, which provides a medium to assist participatory, dialogical spatial decision-support. *Compendium* uses modelling approaches such as Dialogue Mapping (Conklin, 2005) and Conversational Modelling (Selvin, 1999), which derive from the formative ‘argumentative’ policy planning methods 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 3 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 3:** The integration of *uDig* and *Compendium* 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 4); we reflect on the indigenous Amerindians’ reactions to these below.



**Figure 4:** 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*; a 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.

### Participatory spatial decision-support for natural resource management

KMi Moodle » T865

<p><b>People</b></p> <ul style="list-style-type: none"> <li>Participants</li> </ul> <p><b>Activities</b></p> <ul style="list-style-type: none"> <li>Assignments</li> <li>Forums</li> <li>Lessons</li> <li>Quizzes</li> <li>Resources</li> </ul> <p><b>Search Forums</b></p> <input type="text"/> <p>Advanced search ?</p>	<p><b>Topic outline</b></p> <ul style="list-style-type: none"> <li>News forum</li> </ul> <p><b>1</b></p> <ul style="list-style-type: none"> <li>T1: Expressing your stake</li> <li>A1: Your personal profile</li> <li>R1: Team working</li> <li>Q1: Team working</li> </ul> <p><b>2</b></p> <ul style="list-style-type: none"> <li>T2: Expressing the problem situation</li> <li>A2: Rich mapping</li> <li>R2: Spatial Information</li> <li>Q2: Spatial Information</li> </ul>
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**Figure 5:** A screenshot of the ECOSENSUS *Moodle* interface in the first stages of development.

Whilst developing our first iteration of the course (ECOSSENSUS-1) using the Moodle VLE housed on the OU Knowledge Media Institute (KMI) website, the OpenLearn Project was being set up which effectively made the OU the largest single

collaborative participant in the open source Moodle partnership. Compendium is now integrated with Moodle.

In addition, the research teams associated with both ECOSENSUS-1 and ECOSENSUS-2 (the Darwin initiative project follow-up to ECOSENSUS) have been successfully using another open-source software tool, the videoconferencing FlashMeeting facility. The integration of Compendium with Moodle means that not only can maps linked to a learning resource be published, but annotations made during a FlashMeeting (eg showing a whiteboard, making a note, textchat posts) can now be imported afterwards into Compendium to give a set of hyperlinks back into the meeting video replay.

## ***Social issues***

The various ECOSENSUS trials encountered numerous difficulties, principally as we were trying to push the technology too hard without having the capacity to support individuals trying to use it. Initial attempts at following a structured process were problematic in that significant effort was expended in coping with the new technology while “team working” was found to be difficult to sustain asynchronously. The distributed team began to blend SSM with “opportunity driven problem solving” (Guidon, 1990). In essence, rather than going through SSM in a stepwise sequential format, individual team members could progress and iterate rapidly and asynchronously through the action learning stages, while contributing to the shared “memory” of the various stages held within an online content management system.

The idea of distributed opportunity driven problem solving was to facilitate team involvement regarding a range of issues, by integrating within the computer assisted argumentation mapping ‘issue-templates’ that offer hyperlinked questions and guidance for structuring reflection and dialogue.

So how could we define the outcomes of the project? A design for natural resource management where an accommodation between different stakeholders/participants is arrived at in the conventional sense of an action plan? Or a more process-orientated 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 “spiralling” 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 we wanted to achieve is:

- a capacity for sharing understanding of the environmental, social, and technological issues at stake in any context of intervention;;
- a distributed systems framework for moderating the participatory process which does the ethical and normative dimensions justice (the ability to constructively manage stakeholder concerns relevant to the environmental issues at stake);
- to develop and familiarise ourselves with a range of ICT tools for supporting distributed systemic understanding and practice thinking..

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 *FlashMeeting*). 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 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 distributed between 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.

## **Conclusions**

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.

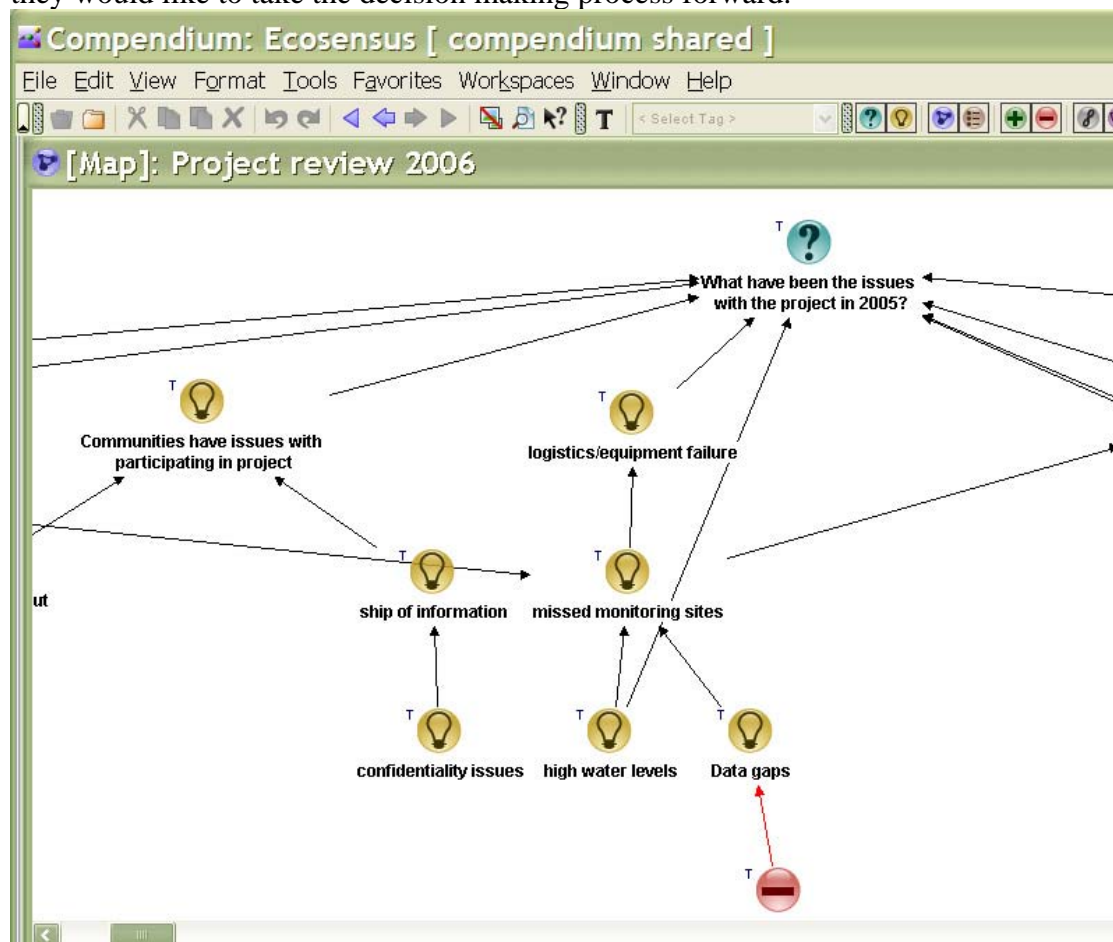
## **ECOSENSUS-1**

the team was driven more by the socio-natural issues 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 motivated 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 ideology 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 was to their field of specialisation or not. This is clearly reflected in the second phase where achievement is attributed mostly to team performance.

In ECOSENSUS-1, 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 was 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 6:** *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 propose have to be much more subtle and not so direct about the power issues involved in natural resource management within the North Rupununi.

## **ECOSSENSUS-2**

We hoped to work 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. ECOSSENSUS-2 has been successful in producing Amerindian constructed maps within uDig containing Compendium icons. It appears that the local Amerindians are becoming increasingly adept at using the technologies. The principle driver for these maps has been a demand by indigenous communities for such resources to support ecotourism activities. Another driver is associated with the need to deliver a management *plan* for DEFRA, as against a *planning process*. Whether these are appropriate drivers remain open to discussion, and invite questions as to the range of discursive activity informing such initiatives.

A second problem associated with the crafting of Moodle in ECOSSENSUS-1 was the dependence on a central resource-based focused curriculum typical of OU distance learning. The challenge for further ECOSSENSUS course development is in re-crafting the VLE in order to be more discursive-driven, with a central focus on 'forums' for discussion and to have 'resources' as optional sideline components that the participants can choose to engage with.

## **Summary**

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 ECOSSENSUS 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. Both ECOSSENSUS-1 and ECOSSENSUS-2 are now housed in the LabSpace of the OpenLearn project. An intriguing question is how these developments might be further taken up and used by a wider global community that may (or may not!) share similar interests.

## **Acknowledgements**

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