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Using Soft Systems Methodology to develop a Mangrove Forest Management and Planning Decision Support System in a Buffer Zone

– The Case of Dam Doi Forest Enterprise, Vietnam

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Contents

Preface

This paper is the outcome of a study undertaken to investigate the potential use of soft systems methodology in a complex natural resource management setting in the southern part of Vietnam.

This work is part of a larger exploration, assessing the appropriateness of using hard- and soft systems methodologies in complex natural resource management contexts undertaken by the Center for Forest and Landscape Denmark (FLD) and Cantho University, Vietnam.

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Abstract

The use of technical linear rational analysis in complex and conflict-prone natural resource management situations has been heavily criticised. Ecosystem management has emerged as an alternative, recognising the need for a systemic perspective, adaptive management, integration of learning, and participation of stakeholder groups. 'Soft' operational research provides a foundation for project management based on ecosystem management principles.

This paper illustrates the use of soft systems methodology (SSM) in relation to environmental conservation and protected area management. The case study project described aims at developing a forest management planning system for a 10,230 ha mangrove forest enterprise in the Mekong Delta.

A presentation and discussion of the use of SSM as a project framework for development of a planning system is provided. It is shown that SSM has the potential to provide a very rich picture of social and environmental complexity at hand, through the use of individual stakeholder interviews and cognitive maps. The cyclic nature of SSM provides an opportunity for systems development and adjustment as well as participants' reflexive learning. The comparison and dialogue stage of SSM proved a very useful tool in creating discussion about possible futures as well as in disclosing stakeholders' attitudes and present systems constraints.

SSM is in principle a participatory approach. But the case study showed that political and cultural aspects may restrict the feasibility of using participatory inquiry processes. If so, SSM does not necessarily provide a means for stakeholder emancipation. This places an ethical responsibility on the 'problem solver' or facilitator managing the SSM process. Finally, it is argued that SSM provides a means for stakeholder deliberation and negotiation about the use of inquiry and problem-solving methodologies.

Key words: Soft OR; Soft Systems Methodology; Southeast Asia; Buffer zone management; Mangrove forest; Silvo-aquaculture-fishery systems; Participation; Learning

1. Introduction

During the 20th century forestry and natural resource management developed from being largely considered a technical problem solved by gathering data and applying linear rational analysis to choose and implement strategies. This approach, although useful in many situations, has failed in more complex and often conflict-prone management situations, evolving as public attitudes to the use of forest resources have been modified by social, economic and philosophical considerations during the last decades of the century (Smith, 1997; Solberg & Miina, 1997; Daniels & Walker, 2001, Kennedy *et al.*, 2001). Today, forestry is also recognised as a social field

(Schanz, 1999) subject to social change processes in pluralistic societies characterised by highly uncertain and ambiguous social and economic conditions (Shannon & Antypas, 1997; Daniels & Walker, 1997). Shortcomings of traditional forest management have initiated recognition of the need for a systemic and holistic approach to nature management, using systems concepts as a powerful vehicle for improving the understanding and communication about the full range of interests involved in forest and nature management (Behan, 1997; Ison *et al*., 1997). The ideas of 'sustainable development' and 'ecosystem-based management', developed during the last two decades, have emphasised the integration of biological and social issues into resource management. Ecosystem-based management of forest and nature situations recognises that a *systemic perspective* is useful, *learning* is an integral aspect of management, *adaptability* is essential for system survival, and *participation and involvement* of stakeholder groups is needed to obviate conflicts and obtain ownership, commitment and empowerment (Holling *et al*., 1998; Kohm & Franklin, 1997).

In the field of environmental conservation and protected area management, the same development is recognised, leading to a re-orientation from the former top-down, state-controlled and expert-driven 'fence and fines' approach to a bottom-up, community-based and integrated conservation and development approach (Gbadegesin & Ayileka, 2000; Lane, 2001). In rural development a similar movement resulted during the 1990s in the transfer-of-technology paradigm being challenged by the farmer-first approach, emphasising local empowerment and collaboration, facilitation rather than expert advise, and enhanced adaptability rather than application of standard solutions (Chambers, 1993, 1997; Röling & Wagemakers, 1998).

In the development of new methodologies, methods and techniques for natural resource management, professionals have often turned to the field of operations research (OR). OR has provided natural resource managers with comprehensive planning systems based on optimisation (Garcia, 1984; Dykstra, 1984; Johnson *et al*., 1986) simulation (Holling, 1978; Walters, 1986), information systems (Dykstra, 1997), and combinatorial heuristics (Murray & Church, 1995; Boston & Bettinger, 2002). These technologies all belong to the branch of OR labelled 'hard' systems thinking (Checkland, 1981). 'Hard' systems methods are often structured according to Herbert Simon's (1957) model of linear 'rational comprehensive planning', and basically rely on the assumption that systems of all types can be identified by empirical observation of reality and analysed by the same methods used in natural science (Jackson, 2001). 'Hard' OR methods are contingent on a prior definition of objectives of the system investigated. Although 'hard' OR approaches and reductionistic science are highly efficient in solving some specific types of problems, they fall short when faced with management problems of a more social and political complex nature where identifying the objectives is part of the problem (Checkland, 1981; Rosenhead, 1989). Referring to the concept of 'second order science' (Funtowicz & Revetz, 1990), Chambers (1997, pp. 193) contends that precise understanding of environmental issues can be elusive and *judgement* has come to play a more recognised part in dealing with local agro-eco-social systems.

Within the OR community, recognition of the inadequacy of 'hard' OR in dealing with ill-defined problems emerged during the 1970s and 1980s, leading to a new branch of OR labelled 'soft' OR. This branch included such approaches as organisational cybernetics (Beer, 1995), soft systems thinking (Churchman, 1971; Ackoff, 1974; Checkland, 1981) and critical systems thinking (Ulrich, 1994). Today, 'soft' systems thinking technologies include a range of methodologies and methods such as System Dynamics models (Vennix, 1996), Decision Conferencing (Phillips, 1984), Strategic Option Development and Analysis (Eden, 1990), Strategic Choice Approach (Friend & Hickling, 1987), Soft Systems Methodology (SSM) (Checkland, 1981; Checkland & Scholes, 1990), Strategic Assumption Surfacing and Testing (Mason & Mitroff, 1981) and Critical Systems Heuristics (Ulrich, 1994). 'Soft' OR methodologies address 'messy' situations Ackoff (1974). Messy situations differ from 'problems' that are less complex sub-aspects of the situation. Users of 'soft' OR recognise that final 'solutions' are unlikely to exist in 'messy' complex management situations, and the focus is on problem structuring, learning, dialogue, and stakeholder participation and action. 'Soft' OR provides a venue for enhancing decision-maker and stakeholder judgement in complex situations.

Few applications of 'soft' OR methodologies have been reported in the field of forestry and natural resource management. For example, Wilson & Morren (1990) present some applications in agriculture and resource management. Daniels & Walker (1996, 2001) and Blatner *et al.* (2001) integrate SSM in the collaborative learning approach to public participation and conflict management in natural resource management. Brown & MacLeod (1996) suggest an approach that integrates ecology and SSM in natural resource management policy formation and implementation. Macadam *et al.* (1995) use SSM in a case study in development planning, generating a Master Plan for the livestock sector in Nepal.

The objective of this paper is to investigate the potential of 'soft' OR as a framework for ecosystem-based resource management planning. SSM is used in a case study, as a means for organising the initial phases of a development project aimed at designing a forest management and planning system for a forest enterprise administering 10,230 hectares of conservation and buffer zone, situated in the costal zone of the Mekong Delta, Vietnam. The management and planning tasks are embedded in an environment characterised by a large number of stakeholders using the area for many and often conflicting purposes. This situation is considered to be 'messy', and an important aspect of the project is to generate thorough understanding of the environmental and social dynamics shaping the natural resources addressed by the planning system. Hence, the use of 'soft' OR, with its focus on problem structuring and stakeholder involvement.

The first part of the paper provides an overview of the SSM process. This presentation is based on 13 sub-aspects addressed using the methodology. The case study is then presented based on the same 13 sub-aspects, followed by a discussion.

2. Soft Systems Methodology

A pioneer of 'soft' systems OR was Soft Systems Methodology (SSM). Its development was initiated in the 1970s through an action research programme aimed at developing a methodology useful for organising purposeful action in complex management situations, through explicit application of systems thinking ideas (Checkland, 1981). The methodology constitutes a cyclic problem-solving and learning process, expressly aimed at coping with 'soft' problematic situations in which people interpret the world in their own ways and make judgements about it using their individual standards and values (Checkland & Scholes, 1990).

Central in SSM is the notion of systems. Although no unanimously agreed definition of the word 'system' exists, in the literature the notion implies a set of mutually related elements, delimited by a system boundary constituting a whole having unique properties as an entity. This is referred to as emergent properties. Wholes are characterised by the ability to survive and adapt to changes in their environment by taking control action in response to external influence. Input and output are defined as anything that crosses the system boundary. A system may have sub-systems and at the same time it is part of a wider system. The ontological status of systems is taken as a demarcating feature between 'hard' and 'soft' systems thinking. The 'hard' tradition takes the world to be systemic, whereas the 'soft' tradition uses systems thinking as a way of organising thoughts about the world. As Checkland & Scholes (1990) contend
"the essence of soft systems thinking [is] that it provides a coherent intellectual framework … as an epistemology which can be used to try to understand and intervene usefully in the rich and surprising flux of everyday situations."

The notion of a *human activity system* (HAS) is fundamental to SSM. A HAS consists of a set of human activities related to each other so that they can be viewed as a whole. HASs distinguish themselves from natural systems by the fact that they could be very different from what they are, which natural systems cannot if left alone. This has implication on the way human activity systems can be investigated. Natural systems can be researched by well-established positivistic and reductionistic methods of science because the observer can be taken for granted. But because the human activity system could be different from what it is, a description of the system must include "an account of the observer and the point of view from which his observations are made" (Checkland, 1981). The basic philosophical principles of SSM are derived from the interpretive paradigms in an effort

"to take seriously the subjectivity which is the crucial characteristic of human affairs and to treat this subjectivity, if not exactly scientifically, at least in a way characterized by intellectual rigour" (Checkland & Scholes, 1990).

The conventional seven-stage model of SSM by Checkland (1981) consists of the following stages:

1. the problem situation unstructured;
2. problem situation expressed;
3. root definitions of relevant purposeful activity systems;
4. conceptual models of the systems named in the root definitions;
5. comparison of models and real world;
6. identification of feasible and desirable changes; and
7. action to improve the situation.

During the 1980s the methodological framework of SSM developed into the model suggested by Checkland & Scholes (1990) presented in Figure 1. This evolution was characterised by increased emphasis on the experiential-learning dimension of management and a more flexible use of the methodology (Checkland & Holwell, 1998).

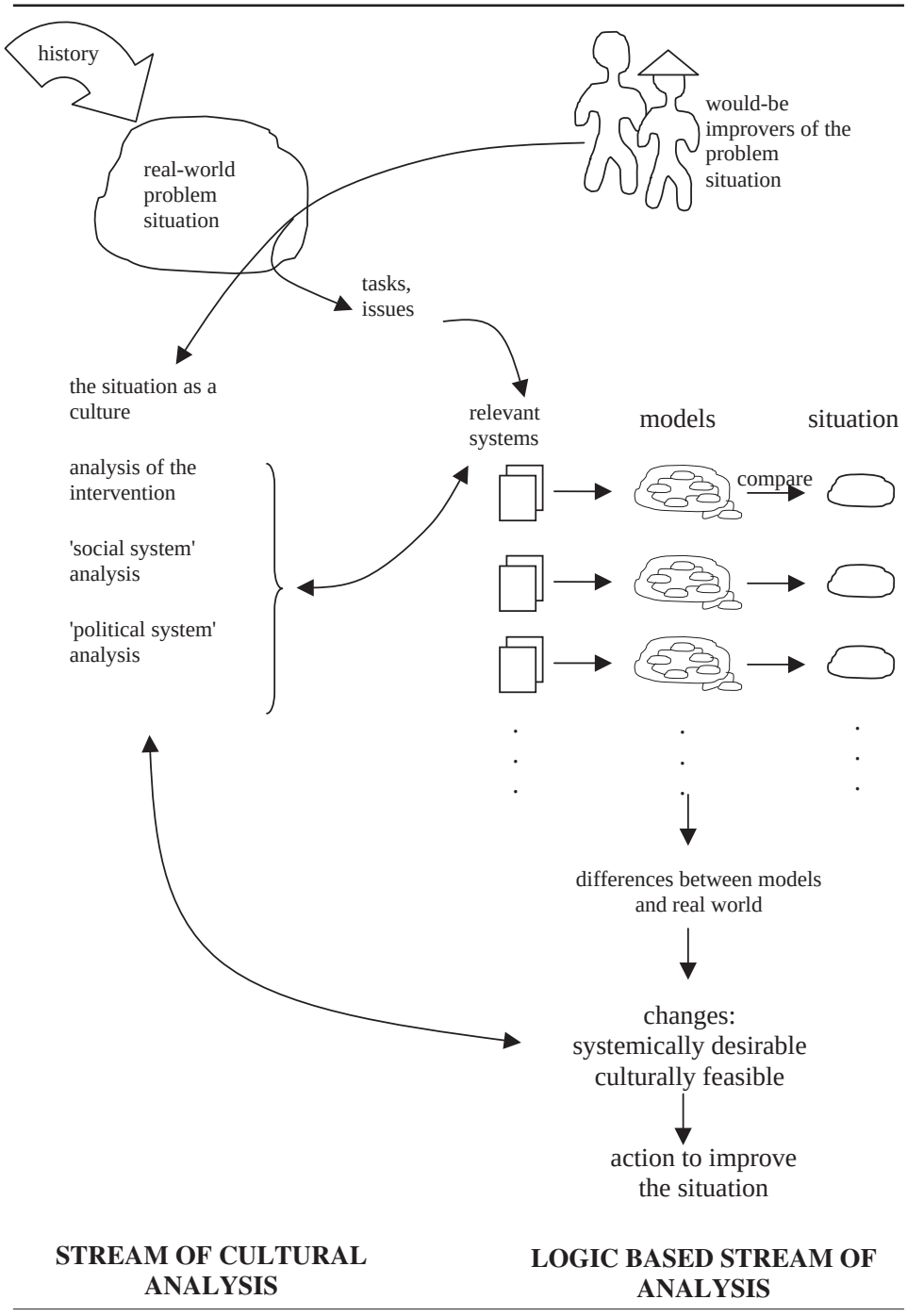


Figure 1. *The process of SSM (adopted from Checkland & Scholes, 1990).*

In the following, the SSM process is described based on the different elements of the model. SSM consists of two interacting streams of structured enquiry informing each other: A) *the cultural analysis* and B) *the logic-based analysis* (Figure 1). The two forms of analyses are intertwined and the analyses do not necessarily follow a linear process.

The aim of the cultural analysis is to "gain insight into the 'systems' of myths and meanings which constitute what we imply by 'a culture'." (Checkland & Scholes, 1990). Three dimensions of the problem situation are addressed: 1) the 'intervention' itself, 2) the 'social system', and 3) the 'political system', where 'social' and 'political' have their everyday meaning (Checkland & Scholes, 1990). The stream of cultural analysis continues throughout the project concurrently with the logic-based stream. The logic-based stream consists of the process of naming, modelling and comparing a set of human activity systems to the perceptions of the real-world situation in order to foster debate about change. Next the three dimensions of the cultural analysis are described, followed by a description of the elements of the logic-based analysis.

2.1 Intervention

The analysis of the intervention is structured around three roles: 'client', 'would-be problem solver(s)', and 'problem owner'. The role analysis includes considerations of: What caused the 'client' to initiate the intervention? What are the perceptions, knowledge and resources of the 'problem solver'? And, finally whom the 'problem solver' considers the 'problem owner' in the situation (Checkland & Scholes, 1990).

2.2 Social system

For the analysis of the 'social system' Checkland (1986) suggests a model where the social system is understood as

"a continually changing interaction between three elements: roles, norms and values. Each continually defines, redefines and is itself defined by the other two, […]"(cf. Checkland & Scholes, 1990).

Roles are social positions recognised by stakeholders in the situation. Roles are associated with an expected behaviour, the norms by which actual behaviour is judged.

2.3 Political system

The analysis of the 'political system' aims to disclose the nature of power-related activities in which differing interests reach accommodation. The three elements of the cultural analysis support the activities in the logical stream. In the following these activities are described.

2.4 History

A problematic situation is part of a particular history of which there will always be more than one account. A literature review may provide a facilita-

tor with initial knowledge about key institutions and persons. Qualitative research interviews (Kvale, 1996) are recommended for the initial exploration phase in order to disclose the individual appreciations of the situation held by stakeholder representatives.

2.5 Would-be improvers of the problem situation

Would-be improvers of the problem situation are persons motivated to improve it. They are not restricted to the client and hired specialists but should include other stakeholders that may be affected by the problem and its proposed solutions. It is important to state that SSM is intrinsically a collaborative approach.

2.6 Real-world problem situation

The information collected under 2.4 is used to reflect on who could be considered potential stakeholders. Relevant stakeholder accounts of the present situation and its history, as well as documentary information related to the situation are collected. This information is transformed into a structured expression of the problem situation. The objective is to build the richest possible picture by capturing involved stakeholders' perspectives on the situation (rather than specific problems involved). The process should be conducted in a participatory mode, emphasising mutual learning and empowerment of stakeholders (Wilson & Morren, 1990). Useful techniques at this stage are mind mapping (Buzan, 1983) and cognitive mapping (Eden, 1988).

2.7 Tasks and issues

In the process of expressing the situation, so-called 'rich pictures' have been found very useful for communicating and recording relationships and connections rather than written text (Checkland & Scholes, 1990). A rich picture and its corresponding written reports provide a record of stakeholder groups, their relationships, concerns, worldviews, the historical context, key human activities involved, decision-making structures and processes, environmental factors, climates related to structure and process, and qualitative and quantitative data on physical, biological, economic and demographic features of the situation (Wilson & Morren, 1990).

2.8 Relevant systems

The next two steps in the SSM approach are concerned with selecting and naming of relevant purposeful human activity systems, by formulating so-called root definitions and subsequently developing conceptual models of the systems. Two kinds of systems can be developed: *primary task systems* and *issue-based systems* (Checkland & Wilson, 1980). Primary task systems often reflect real-world organisation of purposeful activities (e.g. a short-term operational planning system) whereas issue-based systems are conceptualisations of systems not necessarily mirrored in institutional structures but associated with mental processes of participants (e.g. a system to enhance farmer ownership of forestland). The root definition of a system expresses the core purposeful action as a transformation process in which some entity,

the 'input', is changed into some new form of that same entity, the 'output' (Checkland & Scholes, 1990). An example of a transformation process could be:

Forest Enterprise in need of reliable planning system (input)	(transformation) ⟶	Forest Enterprise with implemented reliable planning system (output)

Smyth and Checkland (1976) suggested that root definitions should be based on the CATWOE mnemonic (adopted from Checkland & Scholes, 1990):

1. '**C**ustomers', the victims or beneficiaries of the transformation process (T).
2. '**A**ctors', those who would do T.
3. '**T**ransformation process', the conversion of input into output.
4. '**W**eltanschauung', the worldview, which makes this T meaningful in context.
5. '**O**wners', those who could stop T.
6. '**E**nvironmental constraints', elements outside the system which it takes as given.

A root definitions core transformation process describes "a human activity system to do X by Y in order to achieve Z", where the transformation process (T) will be the means Y, Z is related to the owners' long-term aims, and Y is an appropriate means for doing X (Checkland & Scholes, 1990).

2.9 Models

Based on the root definition, relevant human activity systems can be modelled. The modelling language is based on verbs (e.g. accommodate, acquire, allocate, appreciate, assemble, communicate, create, define, establish, identify, implement, maintain, monitor, negotiate, obtain, provide, etc.). The objective is to identify the minimum number of activities to carry out the transformation process described in the root definition. The model can also be used to structure inquiry into the problem situation. It is advised to limit models to 7±2 activities in an operational system. Moreover, each model should include a control system, using criteria for *efficacy*, *efficiency* and *effectiveness*. The primary objective of developing models is to provide a means to structure debate about the problematic situation.

2.10 Compare with situation

During the comparison phase the developed models (based on a range of worldviews as stated in each model's root definition and CATWOE mnemonic) create a media for discussing with stakeholders their perception of the model's 'reality grounding'. Here the most common approach is to try to model the world in the structure of the conceptual model (Checkland & Scholes, 1990). This initiates questions about the real world and answe-

ring these questions leads to debate. It is important to recognise that during the comparison stage

"the aim is not to 'improve the models' – as management science enthusiasts sometime tend to think – it is to find an accommodation between different interests in the situation, an accommodation which can be argued to constitute an improvement of the initial problem situation." (Checkland & Scholes, 1990).

The comparison stage is highly contingent on the climate in the stakeholder group as well as other cultural aspects hopefully identified in the stream of cultural enquiry and this analysis should inform the process of developing and discussing conceptual models. Checkland (1981) describes four modes for the comparison phase: *informal discussion*, *formal questioning*, *scenario writing* based on operating the system, and trying to *model the real world* in the same structure as the conceptual model. The second method is the most common approach.

2.11 Differences between models and real world

In this phase differences between models and real world are recorded in a matrix approach. Questions are asked about each activity in the model concerning: its current existence in reality, how it is done and judged and whether the activity is feasible to introduce. The links between activities are questioned in the same manner.

2.12 Changes: systemically desirable/culturally feasible

The purpose of SSM is to arrive at improvements on problematic situations that may be seen as 'systemically desirable' and 'culturally feasible'. The two streams of SSM support a structured debate aimed at identifying change that would improve the situation. Systemically desirable implies that improvements arrived at through comparison of the conceptual models with reality are perceived as truly relevant to the problem situation.

"Implementation of changes will take place in a human culture, and will modify that culture, at least a little, and possibly a great deal. But the changes will be implemented only if they are perceived meaningful within the culture, within its worldview." (Checkland & Scholes, 1990).

2.13 Action to improve the situation

The last phase in the SSM is action to improve the situation. SSM rests on the assumption that changes identified as 'systemically desirable' and 'cultural feasible' are potentially easier to implement than solutions derived through, e.g. 'hard' technology-focused systems thinking. The focus on the cultural dimension is highly relevant to implementation of development projects in which knowledge and technology are transferred from one culture to another, typically with a very different worldview.

Once action has been taken to improve it, the situation itself has been changed which leads to a new situation and context. The new improved 'real-world problem situation' may now constitute the object of a new iteration of SSM or parts hereof.

3. Experiences from using SSM as a framework for project development

One of the authors had previously conducted a number of trials and field studies regarding social, economic, and technical issues of aquacultural farming in the buffer zone (BZ) of Dam Doi Forest Enterprise (DDFE), Camau Province, Vietnam. During a field visit in 2000 forest enterprise requested that author to assist in developing a forest management and planning (FMP) decision support system (DSS) for the BZ and full protection zone (FPZ). The initial ideas of DDFE planning staff was centred around a GIS system as a tool for keeping track of spatial information. Walker (2002) contends that the understanding of natural resource systems is often incomplete. Decisions need to be made in circumstances characterised by rapid environmental and economic change, ambiguously defined problems, multiple objectives and multiple stakeholders. This was felt to be the case in the DDFE also. For example, during the previous field studies a level of animosity of the farmers towards DDFE had been sense and farmers had expressed their discontent with the current forest management practices.

Realising that sustainable improvement of the forest management planning at DDFE would involve aspects of social as well as ecosystem complexity, the need for a project methodology developed for intervening at the organisational level was realised. With its explicit focus on problem structuring and stakeholder involvement, SSM seemed an appropriate methodological framework. In the context of development work, making explicit the assumptions, expectations, worldviews, etc., and by this shaping the judgement of 'would-be problem solvers' seems to be of particular importance. The situation involved representatives from very different cultures, professions and institutions and SSM provides a means for explicating 'personal realities' (Chambers, 1997) and facilitating individual and institutional reflexivity (Giddens, 1990).

Considering the DDFE expectations for a 'hard' DSS solution and the research team's interest in examining the 'soft' dimension, SSM seemed a reasonable methodological choice for framing the intervention. The explicit use of systems ideas seemed a very useful way of addressing both 'hard' (DSS) and 'soft' (human activity systems) aspects of the problem within the same methodological framework.

SSM was used in the multimethodology sense suggested by the Hawksbery model (Bawden, 1985; Sriskandarajah *et al.*, 1991). SSM is seen as the starting point from which an intervention can evolve into other forms of inquiry,

such as 'hard' systems thinking and applied technological inquiry, depending on the development of the intervention. Compared to other 'soft' approaches SSM is relatively well known to OR practitioners (Munro and Mingers, 2000) and since the DDFE case study was also an attempt to suggest an alternative to contemporary developmental project framework it was considered an advantage to rely on a relatively well described and well documented approach.

The intervention was designed and implemented by the two first authors (the research team) during February-March 2002. The findings are presented in accordance with the disposition used to describe the SSM in Section 2. The written account may give an impression of a linear process – which it was not. A more adequate description is that the SSM cycle was used as a framework, and the project performed in an iterative mode including all activities shown in Figure 1.

3.1 Intervention

The cultural-based stream of analysis took its point of departure in the background knowledge of the researches and their reflections on the situation, literature review, and findings from the initial interviews. From this starting point, the analysis was constantly revised and sophisticated throughout the entire intervention. The status of the *intervention analysis* towards the end of the case study is presented in Table 1. The objective of conducting the analysis is to induce reflections regarding the premises for intervention on the part of the would-be problem solvers (the research team). DDFE (the client) has initiated the process by opting for a managerial system to improve their overview of the annual income opportunities. Furthermore, it was anticipated that DDFE has to be self-reliant in the future, with no provincial government subsidies. Therefore, the initial focus of the researchers was to provide a technological solution to the isolated problem of harvest and economic planning at DDFE. However, early in the process it became evident that the mangrove forest and local aquaculture farming had significant interactions. It seemed essential to the researchers that the influence of these interactions between social processes and forest management should be taken into account. Therefore, it was decided to include farmers in the category 'problem actors' because an improved planning process would strengthen the long-term validity and effectiveness of the FMP system. Furthermore, the ethical point of explicitly including farmers, whose livelihood is extremely dependent on the decisions made by DDFE, was fundamental to the worldview of the researchers. In general, conducting the analysis proved helpful in clarifying and harmonising the perspectives and objectives of the researchers within the team.

***Table 1**. Intervention analysis conducted during the DDFE case study.*

Client	Dam Doi Forest Enterprise (DDFE)
• Client's aspirations	DDFE wants to develop and implement a FMP system
	FMP system to improve harvest planning - uncertain about possibilities
• Resources	Interest and commitment from local planning staff
• Constraints	Limited technical skill in operating computer-based systems, limited inventory data available and poor data quality, budget constraints
Problem solvers	(1) C.N. Hjortsø and S. M. Christensen (Danish researchers), (2) staff at the Coastal Management Unit, College of Aquaculture and Fisheries and GIS unit at the Soil Science Department, Cantho University, (3) local planning officer DDFE
• Perception	We are dealing with a technical problem primarily concerned with finding a suitable DDS for optimising or simulating future harvest planning
• Resources and knowledge	(1): SSM, forest management planning (inventory, mathematical programming, GIS)
	(2): Expertise in standard use and development of customised GIS platforms (3): Local insight in the planning situation and associated problems and possibilities
• Constraints	Accessibility to DDFE (very timely and costly to visit the DDFE), time, limited forest inventory data, limited forest growth and yield models, highly socially complex management situation
Problem owners	DDFE and farmers influenced by DDFE management
• Implications of problem owner chosen	The primary problem owner is DDFE and the success of the project depends on its staff's whole-hearted participation. The usefulness of a new planning system also depends on whether it includes relevant issues concerning livelihood of local farmers. This dimension of the problem should be ensured by thorough inquiry into the farmer-DDFE relationship
• Reason for regarding the problem as a problem	Present planning practice may be far from 'optimal' because very few alternative solutions are considered. Present management practice reflects standard rules formulated at higher political levels. Better anchoring in local needs and expectations might improve forest management performance and integration of forestry into farming practices
• Value to the problem owner	More flexible planning approach and better resource overview would improve results and perhaps decrease workload for DDFE planning staff. Improved management could improve local farmers' benefits from the forest on their land and hence facilitate a greater acceptance of this, leading to increased willingness to protect the forest
Problem content	The aim is to improve and develop the DDFE management function, with special emphasis on development of a management and planning DDS in relation to buffer and full protection zone management. The management task is highly influenced by social change occurring due to the impact from aquaculture integrated to the buffer zone forest area. In addition to traditional forest inventory issues, the integration with aquaculture farming must be explicitly addressed in order to support social, economic and environmental sustainable development in the area

3.2 Social System

A first draft of the social and political analyses was conducted parallel with the intervention analysis. The conclusions based on the first round of interviews indicated that the planning context was a top-down decision-making environment where actors saw it as their primary role to follow rules issued by higher authorities. Farmers perceived DDFE as a control body, primarily concerned with protecting the forest against farmer encroachment. This in turn led to situations where farmers totally refrained from using the forest

products, contributing to the discontent with forest on farmland. At the operational level little incentive existed to take chances with new ways of doing business. It seemed essential to address this issue and include structures in a new planning system, which could improve communication between stakeholders and provide venues for experimenting and collecting practical experiences made by farmers. This supported the researchers' perception that measures for improving the planning situation should not focus on technology only (the 'hard' approach) but also include improved stakeholder management (a 'softer' approach). The social analysis disclosed that the development pressure from more than 1,000 Silvo-Aquaculture-Fishery System (SAFS) households situated within the BZ of the DDFE led to a continued decrease of forest. Many of the SAFS stakeholders perceived the forest as a hindrance for economic (aquaculture) development on their farms. At the same time DDFE seemed unable to enforce land-use regulation (e.g. securing the legally stated minimum ratio of agricultural land to forestland). Another interesting feature of the situation is that most DDFE employees operate private SAFS farms besides working at the enterprise. Recognising this situation it was decided to proceed with the inquiry process, following two lines: 1) the specific forest management system, and 2) a collaborative process involving DDFE and farmers in developing forest management alternatives more beneficial to both stakeholders. In the account of the SSM process we will focus on the latter sub-component of the FMP system.

3.3 Political System

The political analysis showed that power was exercised, e.g. through trade monopoly (i.e. farmers could only sell timber through DDFE), top-down bureaucratic, limiting the information flow (i.e. farmers being uncertain about their user rights with regard to farm forests, or farmers who's requests for harvest permission were not responded to).

All three analyses (3.1-3.3) were developed throughout the different stages of the SSM process. Especially, the dialogue stage (3.10-3.12) in which conceptual models were discussed with Department of Agriculture and Rural Development (DARD) (provincial level) and DDFE, disclosing attitudes, perspectives, social and political issues of significant importance to the development of the FMP system and enhancement of planning procedures.

In the following the individual steps in the logic-based stream of analysis are presented.

3.4 History

DDFE was established in 1984 as a result of uncontrolled exploitation of the mangrove forest and conversion of forestland into aquaculture-fishery systems. The original task of DDFE was to protect the remaining mangrove forest and ensure that farmers did not encroach further on the forest resource. DDFE is a sub-unit of Unit of Forestry under Department of Agriculture and Rural Development (DARD) in Camau Province.

The enterprise is situated on the east coast of Camau Province; it consists of 10,230 ha of land, of which approximately 70% is mangrove forest. It is DDFE's task to effectively protect and commercially utilise the forest. Due to the dual objective of DDFE, the entire enterprise has been divided into two zones. The full protection zone (FPZ) has 100% forest crown coverage and no human settlement. The buffer zone (BZ) has forest crown coverage of 60%, and the remaining 40% may be utilised for agricultural purposes (GoV, 1999). More than half of the land in the BZ (8,013 ha) is inhabited by farmers who have acquired a 20-years lease on the land-use rights, provided they adequately protect the forest on their land. The farming systems can be characterised as SAFS, and their main emphasis is on tiger shrimp aquaculture and catch of natural shrimp and fish in tidal operated sluice-gates on the farms. The main mangrove species cultivated is *Rhizophora apiculata,* planted at a density of 10,000 stems/ha with a rotation period of 20 years.

Contrary to the majority of mangrove areas worldwide the mangrove forest in Camau Province has in this way maintained state owned management units as a strategic platform for integration of private commercial activity (farming) and nature conservation. This constitutes a unique mangrove management structure seen in global perspective.

It soon became clear to the research team that the FMP situation was relatively complex and that it involved a range of stakeholders (see Figure 3). The livelihood of several population groups is directly or indirectly affected by the management practices applied to the mangrove forest. The main management objectives of DDFE include maintaining the erosion protection functions of the natural ecosystem and timber production, the latter provides cash for running the enterprise. At the same time, the forest enterprise is in rapid transformation due to the economic incentives of aquaculture expansion, and the conservation objectives of the state may become out of touch with reality due to the human pressure to change land-use practice.

3.5 Would-be improvers of the problem situation

Given the initial insight in the problem situation, it appeared that DDFE would be satisfied with a traditional FMP system consisting of a resource inventory, growth and yield models, and a geographic information system for display of spatial data. From this perspective, 'would-be' improvers would primarily comprise the research team and DDFE staff members. On the other hand, the identification of relevant actors to include should be kept open until a broader picture of the situation has emerged. Later in the process, as the importance of socio-aquaculture-forest interactions became clear, farmers were included as an explicit 'would-be' improver category.

3.6 Real-world problem situation

During the initial exploration phase qualitative research interviews (Kvale, 1996) were made with two Vietnamese coastal management specialists who

would later participate in the field interviews as interpreters. During the initial interview, interpreters were instructed in accordance with an interview protocol and subjected to the same interview form and recording technique that would later be used during the field exploration phase. Based on the two initial interviews, an interview guide was developed for the semi-structured qualitative interviews (Kvale, 1996) to be made with representatives of identified stakeholder groups.

All interviews were recorded in cognitive maps (Eden, 1988; Eden & Ackermann, 1998) developed by one of the researchers during the interview. This allowed the researcher to follow emerging issues and pursue formulation of causal relationships as perceived by the interviewee. Moreover, the visual display of the cognitive map facilitated an ongoing verification of the interpretation of the interviewee statements, as the researcher could ask the interpreter to verify the emerging structure of issues and relationships. The first farmer was interviewed by the entire research team to ensure that all members agreed on the protocol, the next interviews were conducted by two teams of one researcher and interpreter, apart from the DDFE interviews. Based on *purposive sampling* (Tashakkori & Teddlie, 1998) with the purpose of establishing a detailed impression of the diversity of issues involved in the situation, with an emphasis on forest-farm interaction, the following stakeholders were interviewed (number of interviews in brackets): DDFE staff (one group interview), SAFS-farmers (7), canal/near shore small-scale fishers (2), and bag-net fishers (2). Stakeholders identified but not interviewed during the first round: Department of Agriculture and Rural Development - Ca Mau Province, Department of Fisheries - Ca Mau Province, Provincial Peoples Committee - Ca Mau Province, tiger shrimp post-larvae suppliers, seafood buyers, off-shore fishers, and landless people.

In the case of interviewing SAFS-farmers, emphasis was on obtaining a representative selection of interviewees. Based on previous studies (Christensen *et al.*, 2002) researchers knew that farmers' wealth level vary substantially and that this in turn influences farmer worldview and management practice. Wealth level is not necessarily obvious from the visual appearance of the farm or farmer. Furthermore, individual prosperity may be something that interviewees do not want to display openly and obtaining such information is contingent on the creation of an atmosphere of confidentiality. To obtain a reasonable representation, each household status was subsequently evaluated based on the interview data and the general impression of the farm and its household members. This evaluation heavily depends on understanding the specific culture in which the intervention is conducted, and outsiders often misinterpret major elements of wealth and income (Chambers, 1997). Based on an 'ad hoc' evaluation by the local interpreters, representatives of poor, average, and rich farmers were identified and interviewed, having the geographic representation within the forest enterprise in mind.

The initial round of interviews focused on locally based communities with a direct dependency on natural resources in DDFE. During these interviews new stakeholders were identified. For example, it was disclosed that the

landless group consisted of other than migratory landless as first assumed. A group of permanent dwellers working seasonally with forest and aquaculture activities could be permitted to stay on DDFE land (outside the FPZ) or SAFS farmland by the respective owners. During a follow-up interview with two representatives of this new group the issue of being allocated a small land area for agricultural purposes, that a number of previous landless had achieved in the past, was raised. A representative of this new group (small-scale agri-aquaculture farmers without mangrove forest) was located and interviewed. One of the main income generation strategies of this farmer was fruit production. This raised questions about the feasibility of establishing and running fruit gardens in the area. As a consequence a long-term fruit producer was identified and interviewed. The above description illustrates a process of *snowball* or *chain sampling* (Tashakkori & Teddlie, 1998) applied in qualitative research for purposive selection of interviewees. The use of cognitive mapping during the interview supported the process of identifying additional stakeholders by providing the interviewer with a structure, guiding the inquiry process into interviewees' perceptions of linkages of livelihood issues with other direct or indirect stakeholder activities. In this way a dynamic view of stakeholders and emerging issues is maintained and updated in the field, supporting rapid and comprehensive data collection.

For each stakeholder group a synthesis of the information collected was merged into one cognitive map. This result provided an excellent overview of the linkages between the different issues presented during the interviews.

3.7 Tasks and issues

The 15 individual cognitive maps produced in Section 3.6 were subsequently merged into an aggregated cognitive map, a so-called 'facilitative device' (Eden, 1989) providing a comprehensive picture of stakeholders' perceptions and their use and dependencies of the natural resources. The emergent picture is an inherently messy situation characterised by a number of complex interrelationships between actors, their uses and perceptions of natural resources, livelihood issues and the ecosystem function of the mangrove forest. Focusing on forest management the main issues included among others:

- No incentives for farmers to protect mangrove on their land.
- Present forest management practice conflicts with shrimp production.
- Present mangrove management not feasible with changing geological conditions (elevating forest floor).
- Insufficient communication between farmers and DDFE.
- Insufficient clarification of forest user-rights.
- Lack of locally adjusted forest growth and yield models.
- Lack of up-to-date forest inventory system.
- Present short-term planning system very time consuming and neither flexible or accurate.
- Some farmers initiate on-farm experimentation with alternative forest and agriculture strategies.

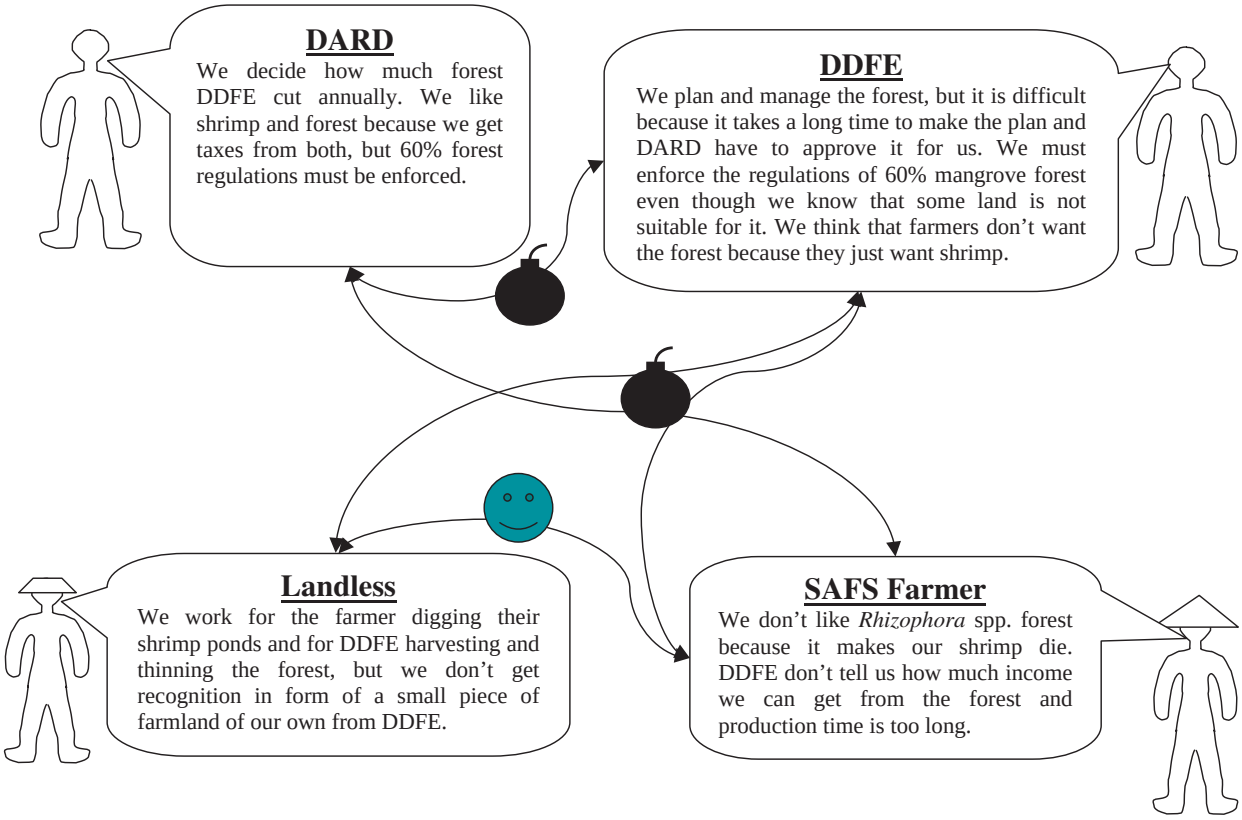


Figure 2. *A rich picture of the forest stakeholders' situation and their interaction in the buffer zone of Dam Doi Forest Enterprise*

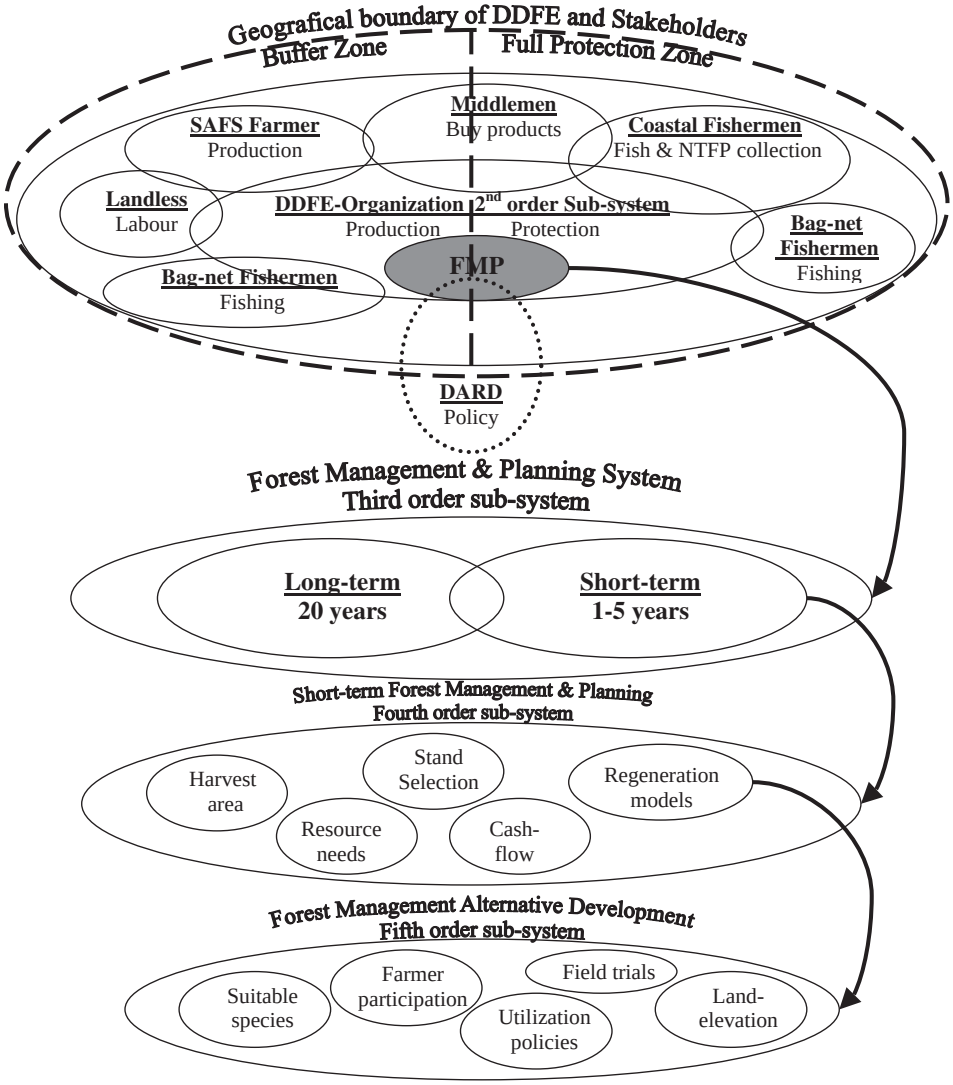
- No systems to collect and extend individual on-farm experiences.

A more detailed account of these issues and an extended discussion of the use of cognitive mapping in stakeholder analysis are provided in Hjortsø *et al.* (2002). The cognitive mapping process allowed the research team to identify areas of conflict in relation to stakeholders' strategies for the natural resource and the positive/negative influence on their livelihood which, when drawn into a rich picture, expresses relationships that would otherwise require much prose to expound. Figure 2 shows a rich picture, illustrating stakeholders' perceptions and mutual relationships.

3.8 Relevant Systems

The next step in SSM is to formulate root definitions for relevant sub-systems of the overall HAS identified in the previous phase. Emerging sub-systems developed from the pre-defined tasks, or perceived as having an influence on this task, were identified through an iterative process. During the process the research team went back and forth between the 'facilitative device' and temporary root definitions of potential sub-systems, until agreement among team members were reached. At this stage, root definitions provide a platform for focusing on the whole context rather than discipline-oriented technical solutions. The overall HAS was defined by human activities performed within the physical boundary of DDFE. Within this boundary a second-order sub-system constituted the DDFE organisation. This sub-system included other third-order systems, such as a forest ma-

Figure 3. *The figure illustrates the systemic perspective applied in the case study. From the top to the bottom a sequence of five systems are identified. The geographic area of DDFE bound the overall system considered. The second is the DDFE organisation. The third is the FMP system within the DDFE organisation. The fourth system is a short-term planning system and the fifth systems is a forest management alternatives development system with in the short-term FMP system.*



nagement system, and within this system the specific short-term planning activities constitute a fourth-order sub-system (Figure 3). Within the short-term planning sub-system a fifth-order sub-system was defined as 'a forest management alternative development system' (Figure 3).

Figure 4 illustrates one possible (issue-based system) root definition of the forest management alternative development systems identified in Figure 3. The process of formulating root definitions was experienced as very useful in providing a venue for open discussion and assumption surfacing within the research team. The use of CATWOE proved very useful in providing a framework for making explicit underlying assumptions and ethical positions of the involved problem solvers. Furthermore, CATWOE enabled the researchers to demonstrate the dual focus on DDFE's need for a FMP system on the one hand, and enhancement of rural development through

A DDFE owned and operated *system* which provides DDFE with a managerial decision-making tool to dynamically select management alternatives based on land, land-use characteristics and farmer grounded species knowledge *in order to* ensure that forestry will provide a continuous benefit to farm families, thus enhancing their awareness and stake in protecting the forest	
Customers	FE, Farmers, Landless
Actors	FE, Farmers, Researchers
Transformation	Mono-culture forests, few species, and limited functionality and integration with local needs → Diverse multifunctional forests with a broader range of species, integrating conservation objectives with livelihood needs of local people
Weltanschauung	A forest on farmland that contributes positively to the household economy throughout the rotation period of the stand may result in an inclusion of farm-forest into the household production strategy, hence improving the incentive for its preservation an sustainable utilisation
Owners	FE
Environment	FE is dependent on the income from farm forestland within BZ and its protection. Currently it is a top-down relationship between farmers and FE which could be improved by recording farmers' know-how (from experimentation with other tree species) and utilisation needs, in order to preserve the forest

Figure 4. *Root definition and CATWOE for a sub-system to develop new forest management alternatives.*

participatory farmer involvement on the other hand; the latter is expressed in the root definition in Figure 4. The root definition has a rather different perspective than the initial aspiration of the client (Table 1). In this case study it proved very productive to introduce this alternative perspective in the process. At this stage no mentioning of farmer involvement in designing forest management alternatives has been made by any of the stakeholders first interviewed. As shown in the next section, it turned out that a similar farmer involvement system had in fact been implemented, but had some problems of working in practice.

3.9 Models

Based on the transformation process defined in the root definition in Figure 4 the researchers asked what input and activities should be included in a conceptual model to allow the transformation process to take place, resulting in the desired output? Conceptual models were developed through a series of temporary sketches. The emerging models reflected the knowledge obtained, accommodating the perspectives captured in the cognitive mapping, the cultural and political analysis and the technical expertise within the research team. It was essential for the design to strive to accommodate the different interests in the situation, in order to make more realistic and robust systems. The team members, originally grounded in natural sciences, experienced that they were inclined to frame model design in terms of specific technical solutions rather than designing a representation of a HAS describing and linking actions and human processes. The team was conscious of the need to refrain from transforming the overall conceptual model into technical solutions. This was felt necessary because the discussion about obtainable improvements would be kept more open-ended in this way. The modelling process concerned with the root definition in Figure 4 converged on the conceptual model shown in Figure 5.

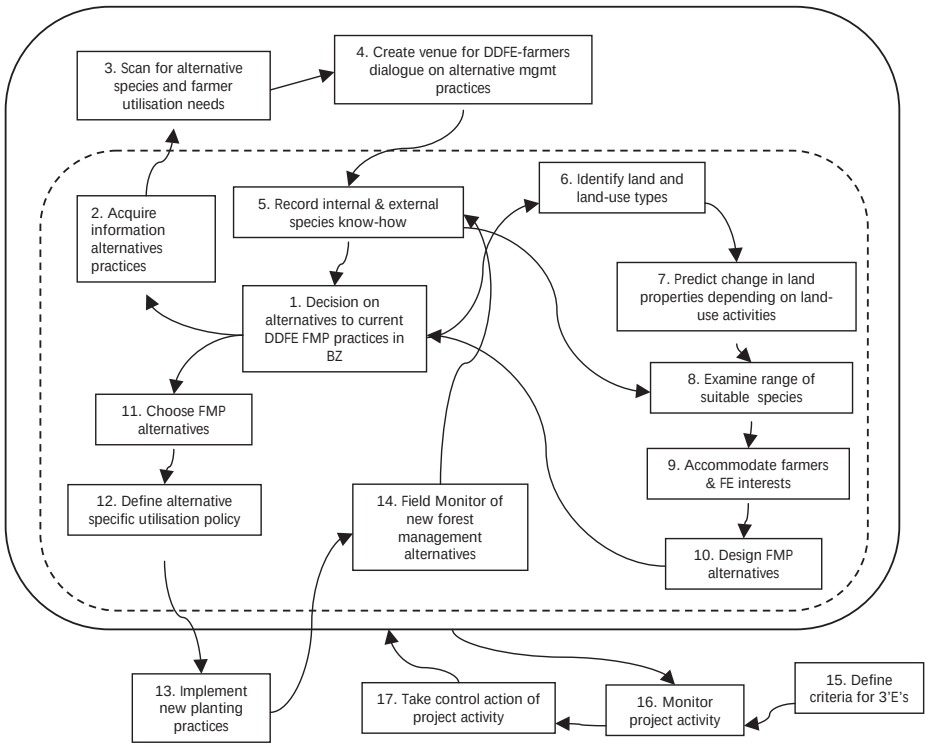


Figure 5. *Conceptual model of the forest management alternative development system defined in figure 4.*

The first round of comparison and dialogue would deliberately be conducted in a more inquiring mode because this stage was expected to broaden the understanding of the situation as a culture and bring about new issues and tasks that might need to be integrated into this and the following iterations of the SSM process.

3.10 Compare with situation

Formal questioning was chosen as the most appropriate approach because of time limitation and because meetings were held with agency representatives assumed to be comfortable with this procedure. The interviews included a general introduction to the purpose of the activity and the conceptual model. During the interview one activity at the time was drawn on a large piece of paper, starting with a core action well known to the interviewee. The interviewer tried to involve the person, getting him to identify actions that should or might follow the present activity in real life. As an interpreter was being used the activity would be written in English and then translated into Vietnamese, so each activity would be visually presented in both working languages. This provided an excellent media for communication between the researcher and the interviewee, as the arrows linking the activities soon became the communicative focus rather than the interpreter. Each activity was compared to the real-world situation and discussed. The interviewer used a table to note comments during the interview (similar to Table 2 but only including info from one interview).

Table 2. *Part of output of comparison stage of forest management alternative development system (Figure 5) to 'real world'.*

Activity		Does it exist?	How is it done?	By which criteria is it judged?	Comments
1. Decision on alternatives to current DDFE FMP practices in BZ	DARD	Partly	Annual meeting between farmers, DDFE and Dept. tech., DARD, to decide on alternatives for planting in the next year's plan	---	DDFE mainly makes it decisions on making alternatives from pre-fabricated growth/yield tables in a monoculture setting with little integration of locally grounded knowledge
	DDFE	Yes	During a previous reforestation development project (1996-1999)	By volume and impact on shrimp culture if non-mangrove species are tested	DDFE have experience with experimental trials of 50 ha during a pervious development project. Two non-mangrove (*Melaleuca* spp., *Acacia* spp.) and one mangrove species (*Ceriops* spp.) have been tested. DDFE don't do active testing anymore and does not express concerns about getting involved in such
2. Acquire information on alternative practices	DARD	Yes	DDFE acquire information on alternative species for planting mainly from documents	DDFE calculate expectations and if they look good (to DDFE and farmer) they can choose the alternative species	New alternatives purely grounded in local know-how. No explicit focus on adaptive (trial-and-error) forest management at DDFE level. Level of knowledge may result in an institutional barrier at DDFE level
	DDFE	Yes	Gets information from other DDFE's. Gets approved forestry practices documents from DARD	If other forest enterprises are successful then it is good	*Eucalyptus* spp. is not good for aquaculture as its leaves pollute water. *Melaleuca* spp. has no negative impact on aquaculture and therefore there is no need to test for other species. Uses cautious principle when selecting species (with regard to impact on aquaculture)
3. Scan for alternative species and farmer utilisation needs	DARD	Poorly	Mainly by documents but farmer utilisation needs are defined at an annual planning meeting	Alternatives are mainly judged based on economic performance	Planning meeting only involves farmers who are about to get their forest harvested, thus utilisation needs for farmers with younger forest is not accommodated. Farmers wants to chose species which have the highest potential value disregarding land suitability for species
	DDFE	No	---	---	Don't involve farmers because they don't like the mangrove forest
4. Create venue for DDFE-farmer dialogue on alternative mgmt practices	DARD	Yes	Dialogue with farmers who follow regulations and have positive experiences with current and alternative species	Only farmers who follow land-use regulations and management prescriptions are invited to participate in dialogue	DARD requests DDFE to make an annual workshop inviting farmers and DARD representatives. Only an annual meeting not a continuous process. DDFE may be reluctant to use farmer information because it is based on experience and not documented in growth and yield table, which is the normal basis for selecting alternatives. Local farmer knowledge may be lost by not including the farmers how don't follow regulations
	DDFE	No	DDFE sub-compartments are suppose to give community extension to farmers but this is normally not done	---	DDFE wants volume and farmers don't want mangrove therefore cannot make a dialogue
...	...	...	...	...	...

3.11 Differences between models and real world

Using the inquiry format in Table 2, stakeholders can be interviewed separately and then at a later stage their statements can be merged into one table that gives an overview of the coherent/conflicting perceptions. Table 2 presents findings of the DDFE and DARD interviews on the conceptual model in Figure 5 and it illustrates the perceptions of the situation depending on perspective. It is seen that attitudes towards and perception of actual farmer participation vary, depending on whether the process is observed from provincial (DARD) or local level (DDFE). In this case the interviews supplied important information as to the social feasibility of implementing participatory processes at DDFE level. This knowledge would be essential if the basic idea behind the conceptual model should be pursued. In the case study the discussions during the comparison stage contributed significantly to the social and political analyses.

3.12 Changes: systemically desirable/culturally feasible

In the case study the notion of farmer participation in developing alternative forest management options does not seem to be 'culturally feasible' within DDFE management culture. At the departmental level (DARD) it seems to be more acceptable, but still participation is reserved to farmers who follow land-use regulations and management prescriptions and farmers who are about to have their forest harvested. The above discussion on desirability and feasibility illustrates how the information obtained through the comparison phase supports further development of the conceptual models, made subject to a new comparison and debate in a later phase of the SSM inquiry process.

3.13 Action to improve the situation

DDFE recognised that the forest within the buffer zone is threatened because the farmers who are to protect it feel that it threatens their livelihood. Furthermore, they are open to the suggestion that new forest species should be introduced, partly because of the farmers' animosity towards the existing practice and partly because DDFE is aware that BZ land is becoming increasingly elevated, which makes it unsuitable for *Rhizophora spp*. plantation in the future. The DDFE management culture does not have a history of involving farmers in neither the decision-making nor the information collection processes, and it is only customary in the setting to gain information 'top-down' rather than 'bottom-up'. However, the fact that all DDFE staff members have their own SAFS farms allows them to appreciate the farmers' animosity towards the forest.

One action that is suggested taken prior to implementing the given forest management alternative model proposed, which is acceptable to DDFE apart from the continuous farmers' participation activity, is: third party intervention by initiating a pilot study on forest management alternatives, involving farmers and DDFE, the latter involved in a mode allowing them to be both DDFE staff and farmers. Experimental on-farm trials should be

conducted and farmer-DDFE workshops conducted. The common goals of the two stakeholders are to improve/increase income from the forest and decrease its negative impact on aquaculture production. It is up to the third party to steer the process with these positions in mind. The forest management alternative model should not be regarded as a static model usable for infinity. It may be that the activity processes are only used for a limited time and then another unique human activity system is developed within DDFE. Such a new system may not be recorded on paper (as the would-be improvers now are DDFE themselves, rather than the research team) but it may have evolved from the discussions of the first model and an acceptance of the meaningful contents of the model.

The original task given to the research team was to develop an FMP system. Parallel to the example used to illustrate the SSM process, conceptual models for a more traditional GIS-based resource planning approach based on standard growth and yield models and economic optimisation was developed and discussed. Results from this process indicated that an optimisation-based FMP with its 'black-box' solutions would not be systemically desirable, as the quality of the raw data is perceived low by DDFE not having any tradition for inventorying and local adjustment of growth models. Therefore, it was agreed that the first step in making an FMP system would be to mimic the existent practices from a paper/map/calculator process to a GIS-based simulation model. The simulation process will allow the staff to conduct actions similar to present practice but with an opportunity to experiment with different solutions. This was perceived as both systemically desirable and culturally feasible by the DDFE planning staff and the development has been initiated in collaboration between DDFE, the research team and the Dept. of Soil Science at Cantho University.

4. Discussion

4.1 The case study

The relatively free dialogue based on semi-structured interviews led to interesting findings, and the cognitive mapping technique was found to provide a very useful tool for structuring and verifying data during the interview. The use of translators made verification an important issue because of the added level of interpretation. Moreover, it proved useful in securing that necessary follow-up questions were asked. The cognitive maps provide good support in explicating stakeholders' mental models (Senge, 1990) by keeping track of chains of arguments and complex interrelationships between different issues.

Stakeholders' willingness to engage in discussion may depend on personal, cultural and political aspects, and openness cannot be taken for granted. The success of using SSM is highly contingent on an open dialogue. Anticipating sources of communicative distortion (Habermas, 1984) is considered an essential part of the cultural analysis. If stakeholders do not have

a culture supporting open discussion, this can have significant influence on the project viability. At several occasions the research team experienced that interviewees did only reply to direct questions. Information considered very useful by the researchers when it later emerged was not shared when not directly asked for. This may be due to individual character, but in a culture characterised by top-down authority it could also be a social norm that could have very significant impact on a project process if not addressed.

The quality of the information obtained in the case study might have been different if official representatives had joined the interviewing teams. The use of the individual qualitative semi-structured interview form was found to give people confidence in addressing sensitive issues, which might not have been forwarded in a participatory workshop or some other setting where different stakeholders, including official representative, are confronted face-to-face. During the DDFE case study, dealing with potential conflicts between authorities and local farmers, the research team considered independence of the authorities as essential. Due to the circumstances such independence was established in this case. This might be different if the project had been part of a formalised collaboration between government agencies. The level of critical awareness on behalf of the 'would-be improvers' is essentially a matter of personal ethics and political environment. In development projects focusing on poverty elevation the cultural analysis provides a framework for identifying the potential for emancipation and empowerment on behalf of the group of affected citizens, defined by Ulrich (1994) as actors who personally have to bear some of the consequences of the project outcome.

The initial inquiry phase of SSM disclosed a number of conflicts between stakeholders over the use of natural resources at DDFE (Hjortsø *et al.*, 2002). Failing to understand and recognise these conflicts may undermine the ability of a new FMP system to improve the situation. On the other hand, wanting to integrate too much complexity in problem solving may be an impediment to reach implementable action. The use of systems and subsystems of different order as a guidance tool for focusing on the original task was useful in structuring the large number of creative ideas that emerged during the process. Many of which would probably not have been palatable to the client, taking the original task definition into consideration.

Based on the experiences from the case study sensitivity as to when what kinds of models are introduced is useful. When discussing systems improvements with the forest enterprise a 'primary task system' in terms of a short-term planning system was first introduced. Framed within this task-oriented context, the somewhat abstract 'issue-based system' for development of forest management alternatives (Figure 5) was easily comprehended, accepted as useful and constructively discussed.

Comparison of conceptual models with real-world activities showed to be a very fruitful process, providing a significant input to the further project development as well as substantially complementing the political and social analysis. This stresses the importance of keeping the two streams of inquiry

active throughout the SSM intervention. Conceptual models also showed useful in bringing up for discussion problem owners' ethical considerations regarding local stakeholders affected by FMP. Once powerful stakeholders accept to discuss the situation in terms of human activity systems, it may become difficult for them to disregard ethical issues involved. Such issues may be relatively more difficult to introduce if discussion is primarily framed in terms of technological solutions.

DARD perceived the forest alternative system (Figure 5) culturally feasible but it was clear that this view was not shared by DDFE who would be the actual implementers of it. Based on this finding is was suggested to develop a system where a third party intervention facilitates interaction between farmers and DDFE staff in terms of a forest alternative pilot study. This activity may foster learning and co-learning and change the Weltanschauungen of all involved parties allowing for the forest management alternative system to be culturally viable.

One of the biggest design challenges in developing successful decision support is making it relevant to the users' needs and decision-making process Walker (2002). Risk of irrelevance increases as the social distance between developer and potential user grows. Based on the experiences from using SSM in the DDFE case study it seems that this methodology provides a powerful tool for allowing an intervener to gain insight into the overall context and needs of the end-users. Moreover, the interactive and iterative nature of SSM increases the likelihood of reaching relevant and implementable system designs.

4.2 SSM in a developmental context

The cyclic nature of SSM seemed useful when addressing development projects influenced by significant uncertainty and risk, and hence involving a large degree of judgement on the part of the problems solvers. The incremental nature of SSM supports an adaptive management strategy (Holling, 1978; Walters, 1986; Lee, 1993) where incremental improvements are implemented and the resulting learning re-analysed in successive methodological cycles. Development project management based on SSM additionally provides a means for an ongoing revision and adjustment of project scope, depending on actual performance. Forest and natural resource projects often have a long time horizon. Social change processes or new scientific findings may affect projects by continuously changing initial project assumptions. It seems that SSM might provide a feasible methodology for dealing with this dilemma.

Stur *et al.* (2002) state that participatory tools can give developmental workers a false sense of achievement because it is not enough just to understand farmers, one must also help them to solve their problems. The SSM inquiry process provides a potential platform for overcoming this dilemma with its focus on action. 'Systems learning' (Macadam *et al.*, 1995) based on integration of SSM and experiential learning (Kolb, 1984) provides ways of integrating understanding and action, as well as learning participants to learn

(Bawden, 1990; Schon, 1983). Participatory development through adaptive learning is contingent on high quality facilitation in terms of visioning, empathy and 'culture of inquiry' (Hagmann & Chuma, 2002). But valuing learning and integration of new insight into future decisions may also be very dependent on personal attitude, cultural norms, and political climate. In management systems characterised by a centralistic top-down culture, the willingness to take responsibility for local initiatives may be limited. This emphasises the importance of identifying 'decision takers' or 'sources of control' (Ulrich, 1994) and their positions during the CATWOE and political analysis.

SSM provided an efficient means for inclusion of multiple stakeholders and their livelihood concerns during the initial inquiry and hence counteracts early framing (Bazerman, 1998) of the problem. In developmental projects based on government-to-government collaboration, project framing may reflect receiving or donor governments' agendas rather than actual livelihood needs as experienced by the affected local people (Brukas *et al.*, 2001). SSM has the potential to address this issue. On the other hand, critics of SSM point to the fact that the methodology does not explicitly address existing power structures. As argued by Flood (1990):

"there are no explicit directives in the theory that aim to prevent the approach from being expert driven; […] because false consciousness and effects of material conditions are not dealt with critically, the rationality [...] may lead to ideological conservatism: and therefore […] there is nothing in the rationality that helps to prevent the maintenance of power relations."

Ulrich's (1994) twelve critical heuristic categories for boundary judgement might constitute a useful extension of the SSM cultural analysis. In this analysis, *involved* actors are identified and categorised as client(s), decision-taker(s), and planner(s). Furthermore, the system description includes those *affected* by decisions. This group is seen as a source of legitimation, and the planner ought to initiate a process of emancipatory self-reflection on the part of the affected, as well as include possible worldviews of the affected in the process.

5. Conclusion

We do not contend that SSM is a sufficient method for solving complex management problems in natural resource situations. Rather, SSM should be seen, as demonstrated in the case study, as a useful platform for structuring the necessary learning, reflexivity and deliberation that should be an integral part of any developmental project management. An important management quality is the ability to characterise issues and judge whether 'soft' holistic, 'hard' reductionistic, or a combination of these methodologies, is most suitable depending on the specific nature of the issue addressed (Bawden, 1985; Sriskandarajah *et al.*, 1991). SSM not only provides a means for participatory learning and dialogue about the project content. It also provides a potential platform for negotiating methodological integration and

evaluation of the 'sources of guarantee' (e.g. scientific data, computer models, ideological consciousness, and intuition) on which different 'sources of expertise' (the different sources of theoretical and practical reasoning) rely, (Ulrich, 1994) and hence a means for establishing a 'culture of inquiry' (Hagmann & Chuma, 2002).

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