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Information systems which support water management – cases from rural water supply in Uganda and WFD implementation in the North Baltic River Basin District, Sweden

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APPENDIX

This thesis is based on the following papers which are reproduced in full in Appendix I-V.

I Quin A, Balfors B, and Kjellén M, (2011) How to "walk the talk": The perspectives of sector staff on implementation of the rural water supply programme in Uganda. *Natural Resources Forum* 35:269-282, United Nations, New York.

II Quin A, Balfors B, and Kjellén M, Monitoring and Evaluation of Rural Water Supply in Uganda: Tracking Progress towards Achieving the Human Right to Water. Submitted to Singh, N., and Thomas, S., (eds) *Realizing the Right to Water: Some Critical Reflections*. Wageningen Academic Publishers, Wageningen, The Netherlands.

III Hammer M, Balfors B, Mörtberg U, Peterson M, Quin A, (2011) Governance of Water Resources in the Phase of Change: A Case Study of the Implementation of the EU Water Framework Directive in Sweden. *Ambio* 40:210-220, Royal Swedish Academy of Sciences, Stockholm.

IV Quin A, Balfors B, Hammer M, (Submitted) Information in support of action: implementation of the EU Water Framework Directive's information requirements in the North Baltic River Basin District, Sweden. Submitted to *Environmental Management*, Springer, New York.

V Quin A, Balfors B, Hammer M, (Submitted) Towards local actor involvement in water management – the perspectives of farmer's on WFD public information and consultation in Åkerströmmen catchment, Sweden. Submitted to *Environmental Science and Policy*, Elsevier, Amsterdam.

ABBREVIATIONS AND ACRONYMS

DPSIR	Drivers-Pressures-States-Impacts-Responses
DRA	Demand-Responsive Approach (Uganda)
DWD	Directorate of Water Development (Uganda)
DWO	District Water Officer (Uganda)
EU	European Union
IS	Information Systems
IWRM	Integrated Water Resources Management
LRF	Federation of Swedish Farmers
M&E	Monitoring and Evaluation (Uganda)
MDG	Millennium Development Goal
MWE	Ministry of Water and Environment (Uganda)
NGO	Non-Governmental Organisation
RBD	River Basin District
RWSSD	Rural Water Supply and Sanitation Department (Uganda)
SSM	Soft Systems Methodology
TSU	Technical Support Unit (Uganda)
WFD	Water Framework Directive
WSC	Water and Sanitation Committee (Uganda)

ABSTRACT

Successful water management implies tackling multi-level governance and improving integration between sectors. Sound information and related processes will be required to support water management decision-making at these various levels. Additionally, considering Principle 10 of the UN's Agenda 21, actors should have access to information to enable their involvement in shaping water management outcomes. This thesis draws on the results of two separate cases where information systems support action: (i) rural water supply in Uganda; and, (ii) water management according to the Water Framework Directive in Sweden. A research approach was formed based on: (a) a model conceptualising how information systems support organisational processes which lead to action; and, (b) a systems-thinking methodology. The results reveal that there are numerous, similar challenges to achieving information support for action in both the Ugandan and Swedish cases. In both cases, information quantity and quality is limited; consequentially, the use of information to support action is inhibited. Furthermore, not all actors are involved in information system processes; in particular, local-level actors. Overall, there is limited support of strategic decision-making and weak support of operational, or local, decision-making. The results suggest that it might be possible to tailor strategic-level information processes to local needs, hopefully encouraging active involvement of local actors. Improved involvement, together with a suitable systems approach, could be used to further develop information systems, improving integration between multiple levels of governance and across sectors – suiting not just the needs of strategic decision-making but also the needs of operational, or local, decision-making.

Key words: information support, actors, water management, organisational action, Soft Systems Methodology

1. INTRODUCTION

A major conclusion of the first World Water Development Report (UNESCO–WWAP, 2003) was that water resources management worldwide is predominantly limited by governance issues. Tackling the challenges of water resources management thus implies tackling governance. Tropp (2005) recognises four dimensions of water governance: social, economic, political and environmental. Water governance is multi-level, involving actors in government, civil society and the private sector (UNESCO–WWAP, 2006).

In the past, water resources have often been managed sector-by-sector. With the realisation that a more holistic approach is necessary, a new paradigm has arisen: Integrated Water Resources Management (IWRM) (UNESCO–WWAP, 2006). IWRM promotes co-ordinated management of water catchments or basins, aiming to maximise both economic and social welfare without compromising ecosystem sustainability (Global Water Partnership, 2000). In order to implement the IWRM approach, the Global Water Partnership (2004) has identified thirteen key areas within water governance requiring change; one of which is 'information management and exchange'.

Development of information management and exchange will need to take into account the multiple dimensions and levels of water governance and should ensure the inclusion of multiple actors. This principle has been enshrined in *Agenda 21* (UN, 1993), an action plan for international policy.

'Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities,

including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.'

Principle 10, Agenda 21 (UN, 1993)

Ensuring that this principle is fulfilled implies finding a suitable methodology which can tackle the challenge of organising information processes for water management over multiple levels of governance. Checkland and Holwell (1998) have developed a generic model which provides an account of how organised Information Systems (IS) can support organisational action. Recognising that systems thinking also has relevance for IS development (Checkland, 1988), they integrated their IS work with a systems-thinking approach, namely Soft Systems Methodology (SSM), for tackling complex situations (Checkland and Scholes, 1990; Checkland, 1999; Checkland and Poulter, 2006). SSM has been progressively developed since the 1960's and has been used in many studies and contexts. The use of SSM for the field information systems is a more recent development. While many published cases recounting use of the SSM approach for IS have focused on information support within a single organisation, one published case deals with the development of IS to support organisational action across multiple levels and organisational bodies, specifically, the development of IS in the United Kingdom's National Health Service (Checkland and Holwell, 1998; Checkland and Poulter, 2006). SSM has also been used to develop information systems to support water management (Bunch, 2003; Kayaga, 2008); however, these studies have not made use – at least not explicit use – of the generic model for organised IS developed by Checkland and Holwell (1998).

The research presented in this thesis draws on the generic model for IS, as well as SSM, to form an approach for investigating the use of IS to support water management action, taking into consideration the involvement of multiple actors. The research draws on results from two, separate cases:

(i) rural water supply in Uganda and its monitoring and evaluation (M&E)
(ii) implementation of the WFD information requirements in support of water management in the North Baltic River Basin District (RBD), Sweden.

This research is not meant as a comparative study. However, while seemingly somewhat different, the cases are linked by a number of characteristics. Both cases necessitate multi-level governance of water resources, involving numerous actors operating at multiple levels, from international to local. Both cases fall under the sphere of IWRM. Additionally, both cases fall under the focus of the research, concerning how IS can be organised taking into account water management complexity over multiple levels of governance and with the involvement of numerous actors. The following subsections contain a brief summary of the background to each of the cases. More detailed background, covering the water management processes to be supported and the organisation of IS in support, is presented in the papers appended to this thesis (*Papers I–V*).

1.1. M&E of rural water supply in Uganda

Uganda is one of the poorer developing nations in the world, placing 157th out of 182 countries ranked in the *Human Development Report* (United Nations Development Programme, 2009). However, thanks to both donor-funding and a strong commitment to development, the country has progressed much during the past couple of decades and, in the provision of water supply in particular, it has stood out from its neighbours in Sub-Saharan Africa. The country has worked hard to reach the Millennium Development Goal (MDG) pertaining to water supply ('to halve the proportion of people who are unable to reach or to afford safe drinking water') and has made much progress (Jønch-Clausen, 2004; Sinclair, 2004; WHO and UNICEF, 2008). The country has set national goals

and targets for water supply beyond the MDG target, aiming to achieve 100% access in urban areas and 77% access in rural areas by 2015 (Ministry of Water and Environment, 2009). To facilitate achievement of these goals, Uganda has implemented M&E of its rural water supply programme; however, there are still many problems to be tackled if the country is to continue to make progress (*Papers I & II*).

1.2. WFD information in support of water management in Sweden

In contrast, Sweden is one of the richer developed nations in the world, ranked 7th in the *Human Development Report* (United Nations Development Programme, 2009). Consequently, Sweden's priorities in water management are very different compared to Uganda. With the introduction of the EU Water Framework Directive (WFD) in 2003, emphasis is on improving or, at least, halting the degradation of the ecological and chemical status of water bodies, which includes surface water, groundwater and coastal water. Sweden has adopted the WFD environmental objectives, which include achieving *good* ecological and chemical status of water bodies by 2015. To help achieve these objectives, keep track of changes in water bodies and support water management action, Sweden has implemented information processes required by the WFD. However, due to the challenges of meeting the environmental objectives by the deadline of 2015, Sweden's Water Authorities have extended it to 2021 for many water bodies. This is permitted for up to two of the WFD's 6-year water management planning cycles (i.e. up to 2027). Sweden has many challenges to tackle if it is to meet the WFD environmental objectives by the final deadline of 2027 (*Papers III–V*).

1.3. Objectives

The overall purpose of the research was to investigate the use of information in support of water management, while taking into consideration the roles of various actors in carrying out water management action. A principle in the development of IS underpins the strategy behind this research: in order to establish a *system which serves*, it is first necessary to characterise the *system to be served*. This reasoning prompted selection of the following research objectives:

(i) to investigate the action being carried out in a problematical, water management situation (i.e. the *system to be served*); to identify actors involved in, or expected to carry out, the action; and, to appreciate particular challenges to carrying out action (*Papers I & III*);
(ii) to investigate the current means of providing information support (i.e. the *system which serves*) for the action (i); and, to appreciate challenges to the provision of information support (*Papers II & IV*);
(iii) to assess the inclusion of local actors in IS (ii), who are otherwise involved in, or expected to carry out, action (i); and, to suggest improvements to the provision of information support (ii), based on consultation with them (*Paper V*);
(iv) to consider the usefulness of the research approach (sub-section 5.2 and section 6 of this thesis).

From the outset, it was intended to carry out all the research in Uganda, investigating M&E of the rural water supply programme. However, due to various difficulties it became necessary to shift the research to Sweden. Despite this shift, the overall objectives of the research, outlined above, have remained the same. In the Ugandan case, first, the means by which rural water supply is currently provided was investigated (*Paper I*); then, M&E of rural water supply in Uganda was investigated (*Paper II*). At this point the research was shifted to the Swedish case. First, background work, and co-authorship of a paper (*Paper III*) helped with understanding water management in Sweden implemented in accordance with the WFD. Next, the means by which WFD-required information is used in Sweden to support water management was investigated (*Paper IV*). Finally, the inclusion of farmers in the provision of information support for water management in Sweden was assessed and their information needs appreciated, based on a questionnaire. This led to suggestions for improvements to the means

of carrying out WFD information and consultation processes with farmers to help encourage their involvement in water management (*Paper V*).

2. CONCEPTUAL BACKGROUND

This section presents the background to concepts used throughout this thesis and which underpin the research approach. The background to the cases – rural water supply and its M&E in Uganda and water management according to the WFD and its information support in Sweden – are covered in the papers appended to this thesis (*Papers I–V*).

Taking a general perspective, both of the cases can be seen as situations where there is organised use of information to support action. This general perspective has been the subject of research conducted by Checkland and Holwell (1998); also, Checkland (1988), Holwell and Checkland (1998) and Checkland and Poulter (2006). Aspects of their work on information systems which provide the basis for this thesis are summarised here. Also, how other strands of thinking in water management take up the subject of information is considered briefly. This section concludes with a summary of the background to SSM, the methodology which has helped to shape the research approach.

2.1. Information systems

In reviewing information systems literature, Checkland and Holwell (1998) suggest that the field, as an emerging one, is somewhat confused. They point out that there are many contradictory positions and approaches, as well as consciously or tacitly accepted assumptions. Regarding the assumptions, they argue that information systems thinking is dominated by a 'hard', functionalist approach. This approach, they argue, assumes that organisations are capable of unambiguously setting and achieving goals.[1] Reconfirming the role of information systems in organisational situations, Checkland and Holwell (ibid.) propose that the core concern of the field should be the provision of information in support of organisational action. They further argue that it is necessary to re-consider the nature of *data*, *information* and *information systems*, as well as *organisations*. Additionally, the provision of information within an organisation should be regarded as something which develops and changes in response to technological developments.

2.1.1. Data and information

In a broad review, Checkland and Holwell (1998) examined the use of concepts such as *data* and *information* in information systems literature. They discovered that there was no clear agreement regarding definitions of these concepts or how they were related to each other; based on this review, they developed their own account of *data* and *information* and the relationship between them.

Regarding the concept of *data* in information systems literature, there is convergence towards the notion that *data* refers to facts. Checkland and Holwell (1998) distinguish between undiscovered facts and facts which we perceive or create, referring to these as *data* and *capta* respectively. They point out that the process of choosing which *data* to perceive is a cognitive one and dependent on previous experience. Regarding the concept of *information* in literature there is convergence towards the notion that *information* is created from *data* which has been given a meaning in a particular context. The process of attributing meaning to perceived *data* (i.e. *capta*) is significant: the creation of *information* is a human act. This process may occur either individually or collectively, which implies that different individuals or groups may attribute different meanings to the same perceived *data*. Checkland and Holwell (ibid.) add that information gathered over time may lead to knowledge; however, they do not dwell on this subject, which is considered in other research (for example, Davenport and Prusak, 2000).

[1] Consider the goals of IWRM, mentioned earlier: '…to maximise both economic and social welfare without compromising ecosystem sustainability'; these goals are ambiguous, in that there may be multiple perspectives as to what constitutes economic or social welfare, as well as environmental sustainability.

2.1.2. Organisations

Checkland and Holwell (1998) carried out an examination of the term *organisation* in IS literature, similar to their examination of *data* and *information* as described above. They argue that the notion of *organisation* in IS literature is dominated by a 'hard', functionalist strand of thinking. As already described, this line of thinking regards organisations as capable of unambiguously setting goals and carrying out decision making which should determine the course of action necessary to achieve those goals; i.e. organisations are 'goal-seeking' entities. Checkland (1999) refers to Vickers, who proposes a more subtle concept of organisations as entities which seek to manage multiple relationships:

'Vickers suggests replacing the goal-seeking and goal-seeking-with-feedback (cybernetic) models by one in which personal, institutional or cultural activity consists in maintaining desired relationships and eluding undesired ones. The process is a cyclic one which operates like this: our previous experiences have created for us certain 'standards' or 'norms', usually tacit (and also, at a more general level, 'values', more general concepts of what is humanly good and bad); the standards, norms and/or values lead to readinesses to notice only certain features of our situations, they determine what 'facts' are relevant; the facts noticed are evaluated against the norms, a process which both leads to our taking regulatory action and modifies the norms or standards, so that future experiences will be evaluated differently.'

Checkland (1999)

Checkland and Holwell (1998) consider the concept of *organisation* and identify some differences between their 'soft' interpretation and the 'hard' interpretation (Table 1). In order to appreciate how information systems can support organisations, they argue that there is a need to explore the organisational processes that lead to intentions being formed and actions being taken, taking into consideration both individual and collective processes.

2.1.3. IS and organisational processes

Checkland and Holwell (1998) develop the concept of IS based on: the notion that it should exist to support people taking purposeful action; the concepts of *data* and *information*; and, the more subtle concept of *organisation*. They consider the personal and social processes by which people selectively perceive the world, attribute meanings, make judgements, form intentions and then act. Combining these processes together with the three concepts above, they form a generic model which represents 'the social process in which meanings are established and lead to information support for people undertaking purposeful action' (Fig. 1). This model is not intended to be a definitive account of how information systems support organisational processes; it is rather meant to be 'a defensible device with a structure and language which can be used *to make sense of* life in real organisations and their provision of information systems' (Checkland and Holwell, 1998).

The model has implications for IS development. Foremost, is the notion that an information system exists to support another system i.e. a system for carrying out action. Thus, the system which serves can only be developed based on an account of the system to be served. They point out that it is not uncommon for information technology to be adopted into organisations only to be left unused. To overcome this challenge, the authors propose a set of principles relevant to IS development (Box 1). Furthermore, it is important to ensure that both the creation and use of IS are treated as opportunities for continuous learning (Holwell and Checkland, 1998).

Table 1: Differences between the 'hard' and 'soft' interpretation of organisations in the field of IS (Checkland and Holwell, 1998).

'Hard' organisational thinking	'Soft' organisational thinking
Consensus	Accommodations
Take decisions	Manage relationships
Pursue goals	Seek desired relationships and elude undesired relationships
Unthinking reification	Conscious reification

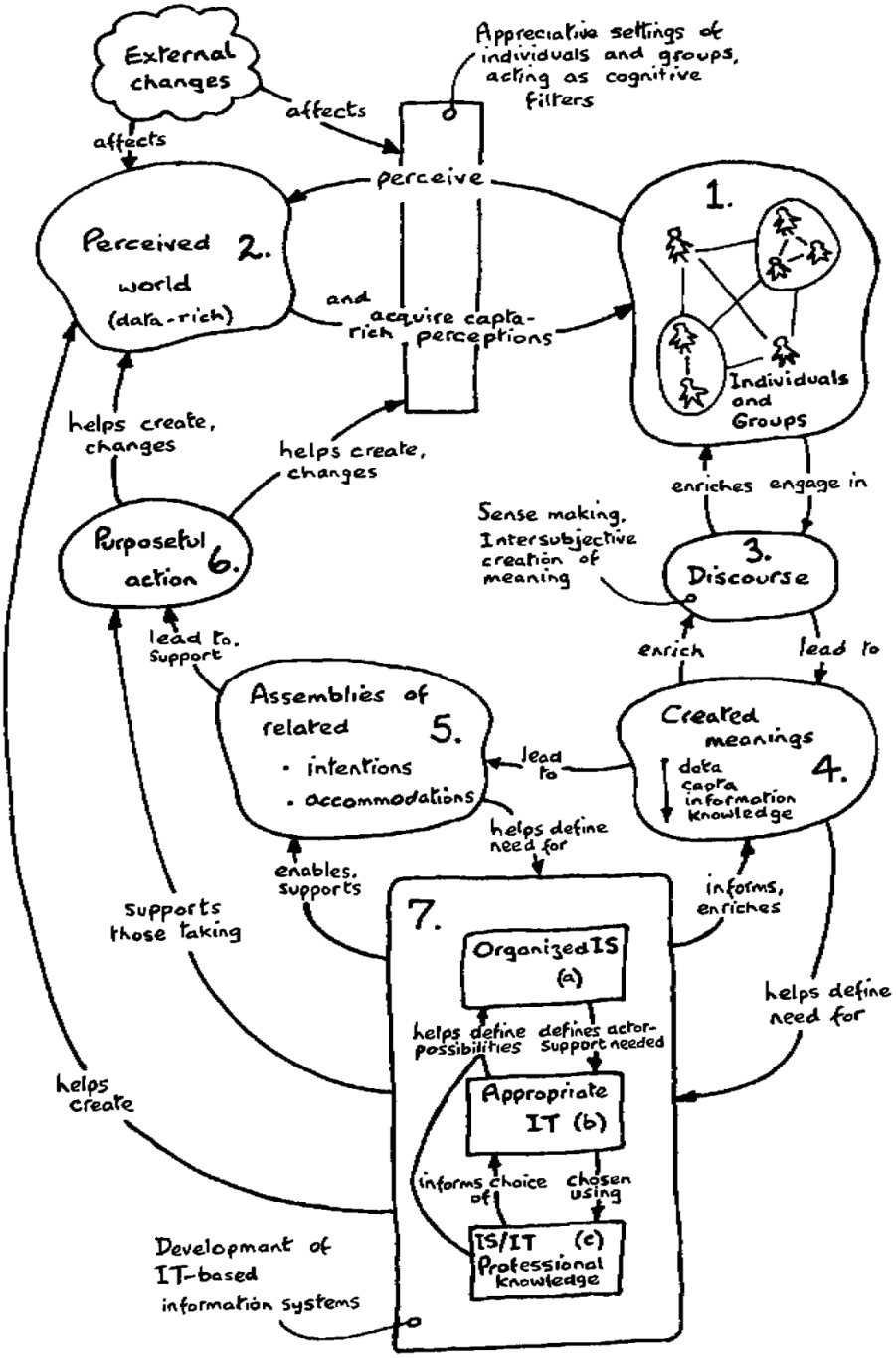

Fig. 1: The 'processes for organisations meanings' model, representing how organised IS can support organisational processes which lead to purposeful action (Checkland and Holwell 1998).

Box 1: Principles relevant to IS development (Checkland and Holwell, 1998).

- Start by exploring, with the people concerned, the action which is to be supported
- Express that purposeful action
- Hence explore, with the people concerned, the information they feel they need to carry out the action and to monitor and control it.
- Then explore how IT could provide the required capta† processing and select a design method.

†*Capta:* data selectively perceived or created by people.

2.2. A brief account of information in water management

In progressing towards an IWRM approach, the management of information and its exchange is highlighted as one of thirteen areas requiring change within water governance (Global Water Partnership, 2004). Simonovic (2009) suggests applying a systems view to the management of water resources, expanding the analysis to include the social and ecological systems of which water resources are a part; Simonovic highlights the importance of information flows to ensure that water management matches usage of the resource.

Authors have highlighted the challenges of supplying useful information to decision makers for environmental management generally (Cash et al., 2003; McNie, 2007), as well as for water resources management more specifically (Ward et al., 1986; Timmerman and Langaas, 2005; Nilsson, 2006; Timmerman et al., 2010). However, McNie (2007) suggested that there is no comprehensive analysis which links the use of scientific information to decision-making.

This thesis presents the results of using a research approach based on information systems ideas in support of organisational action, and incorporating a systems-thinking methodology: SSM. As will be explained later (section 6), the approach can be used to both provide a broad analysis, but could also be used to assess the information needs of numerous actors operating at various levels, and then consider how these needs might be integrated across levels.

2.3. Soft Systems Methodology (SSM) – a brief background

Checkland and Poulter (2006) provide a succinct account of SSM in its current state of development. In short, SSM is an approach for dealing with complex (or problematical) situations where it is desirable to bring about improvements. Ideally, the methodology should be action-oriented, such that measures leading to change (hopefully improvements) can be brought about. SSM has developed since the late 1960's, after a research programme initiated at Lancaster University set out to apply the principles of systems engineering to management situations. Since then, thousands of SSM studies have been carried out around the world, covering a wide range of topics, including corporate planning and environmental management. The development of SSM has been shaped by two characteristics of problematical situations: multiple, interacting perceptions of reality (termed 'worldviews'); and, people trying to act purposefully.

Today, SSM can be broken down into four main activities:

(i) find out about a complex (problematical) situation;
(ii) develop models of purposeful activity based on the worldviews of selected actors;
(iii) compare models to the complex situation in order to help structure a discussion about desirable and possible change; and,
(iv) define and carry out action for change.

Each of the SSM activities is ideally carried out in conjunction with people involved in the complex situation. In this regard, the application of SSM together with actors in a situation can be related to action research and social learning.

2.3.1. Systems thinking and SSM

Checkland and Poulter (2006) outline how SSM is based on systems ideas; also, Checkland and Scholes (1990) and Checkland (1999). Systems ideas are concerned with the interactions between parts that make up a 'whole'. The whole (or 'system') is characterised by *communication processes, control processes,* a *layered structure* and *emergent properties*. Incorporating these concepts of systems in SSM led to the idea that 'purposeful' action, based on declared worldviews, can be treated as a system. Thus a way of modelling purposeful action was developed, where a set of linked activities are defined, complete with *communication and control processes*. Activities may require sets of sub-activities, or may be part of an overarching activity, thus incorporating the idea of *layered structures*. The activities

together form the whole, characterised by purposefulness. The purposefulness of the activities is an *emergent property* of the whole.

2.3.2. SSM and the research process

Checkland and Holwell (1998) argue that hypothesis-testing and repeatability, central to the natural sciences, cannot be matched when studying social phenomena. Instead researchers of social phenomena must rely on recoverability – i.e. the research process should be made clear, and documented, so that any reviewer may understand how the outcomes were reached. For recoverability to be achievable the researcher needs to, among other things, state the epistemology to be used during the investigation – i.e. the researcher must state the methodology used and the framework of ideas within which the methodology makes sense.

Regarding techniques used in SSM, such as the preparation of 'rich pictures' (introduced in sub-section 3.1) and models of purposeful activity, they are not descriptions of the real world, but rather 'intellectual devices' based on declared worldviews that enable structured inquiry into a situation (Checkland and Poulter, 2006).

3. METHODOLOGY AND METHODS

This section provides a description of the SSM-based approach, as well as the methods that have been used in the research. SSM is a methodology and not a method; thus a researcher may adapt it to suit the situation being studied. This does not mean that anything goes; rather, the researcher must be able to justify and defend choices made. Part of the purpose of this section is to present these choices. Furthermore, an SSM-based approach may be combined with other research methods in order to aid a study. Methods used in this research include interviews, reviews of documents, observations during meetings and a questionnaire.

3.1. The SSM-based research approach

It is possible to use SSM formulaically, following the methodology step-by-step while applying each of the SSM techniques.[2] However, another approach is possible, whereby the user brings to the fore techniques and methodological steps perceived to be useful and relevant to the particular context of the situation being investigated (Checkland and Scholes, 1990). This research attempted to follow the latter approach; thus certain techniques were brought to the fore, while others were used in background work.

While there is no standard application of SSM (Checkland and Poulter, 2006), typical usage often includes carrying out broad stakeholder discussions to arrive at desirable and feasible changes which should lead to action to improve a situation. Considering the practical limitations to affecting both Ugandan rural water supply and Swedish water management, this research employed another approach. While one aim, as already indicated, primarily seeks to bring about action to improve a situation, the other aim uses the methodology as a means of aiding 'a survey of a particular area of concern' (Checkland, 1999). This latter type of aim can help to bring understanding to a situation and contribute to collective knowledge. The research presented in this thesis aspires to achieve the latter aim, insofar as it seeks to make sense of the two situations in which information systems are deployed in support of water management.

As described in section 2, this research combines an SSM-based approach with the thinking of Checkland and Holwell (1998) on information systems. The principle of first characterising the *system to be served* before the *system which serves* was followed. Thus, the rural water supply programme (i.e. the *system to be served*) was characterised before the M&E framework (i.e. the *system which serves*) was analysed. Similarly, water management in Sweden according to the

[2] SSM techniques include: rich pictures, the CATWOE tool (Customers-Actors-Transformation-Worldviews-Owners-Environment), and conceptual modelling of purposeful activity. These tools are described extensively in SSM literature (Checkland & Scholes, 1990; Checkland, 1999; Checkland and Poulter, 2006).

WFD was characterised before carrying out an analysis of the organisation of information in Sweden. In the latter case, it should be noted that implementing the WFD implies adopting certain information routines, following the Drivers-Pressures-States-Impacts-Responses (DPSIR) approach. WFD action is thus already tightly linked to information processes.

In both cases, the research approach involved 'finding out' about the situation. This was achieved by conducting interviews, reviewing documents and making observations during meetings. In both cases, SSM 'rich pictures' were prepared to help form descriptions of the complex situations being investigated. Additionally, conceptual models were formed which represented the 'purposeful' activities which should be undertaken. In the Ugandan case, the conceptual model was based on how international and national government actors intended the rural water supply sector to function (*Paper I*). In the Swedish case, the conceptual model represented how the information requirements should be implemented according to the WFD (*Paper IV*).

For each case, the results of the 'finding out' stage were compared with the conceptual models in order to identify challenges affecting implementation of the international and national policies for carrying out action, as well as information support.

Additionally, for this particular text (section 4), aspects of how information systems are used to support action in the Ugandan and Swedish cases have been mapped onto Checkland and Holwell's (1998) generic model of the organisational processes which information systems support (Fig. 1).

3.2. Methods

For both the Ugandan and Swedish cases, the results of qualitative research methods supplemented the SSM-based research approach. These methods included: in-depth, semi-structured interviews; document reviews of, primarily, government reports; and, observations made during meetings. Additionally, for the Swedish case, a questionnaire was employed. In using the methods, qualitative research guidelines were followed (Baxter and Eyles, 1997; Denscombe, 1998). For example, in order to avoid interviewer effects, or to at least make them explicit, a clear introduction to the respective studies was provided to interviewees (including, e.g. the university involved and study topic). During interviews, field notes were taken and recorded.

3.3. The Ugandan study

For the Ugandan case, interviews and a document review were conducted in order to carry out SSM activity (i), i.e. to *find out* about the rural water supply programme and, also, the M&E framework. Activity (ii) was supplemented by carrying out a document review. This helped to reveal the policies and strategies that the Government of Uganda aims to implement in its rural water supply programme. This enabled a *conceptual model* to be constructed (*Paper I*), based on the worldview that certain approaches are desirable within the rural water supply programme, including: community-based management, community participation and the demand-responsive approach. The document review also helped to form a model for the M&E programme (*Paper II*). These models are based on a style of drawing that emerged from SSM (Checkland, 1999), allowing complex institutional frameworks to be summarised visually.

The conceptual models can be used to structure an enquiry into the real situation, helping with the identification of desirable (and feasible) changes, i.e. activity (iii) (*Papers I & II).* Finally, thesis objective (iii) was partially achieved for the Ugandan case by analysing the results of investigation into the rural water supply programme (*Paper I*) alongside the results of investigation into the M&E programme (*Paper II*). These results are presented in section 4 of this document.

In-depth, semi-structured interviews were carried out with seventeen government actors in the rural water supply sector, including:

- four employees of the Rural Water Supply and Sanitation Department (RWSSD), in the Directorate of Water Development (DWD);
- three head officers from three of eight Technical Support Units (TSUs); and
- ten District Water Officers (DWOs); in two cases, these were other officers temporarily appointed.

A purposeful sample of interviewees was selected, based on the four administrative regions in Uganda:

- Northern: one DWO, one TSU officer;
- Eastern: three DWOs;
- Central: two DWOs, one TSU officer;
- Western: four DWOs, one TSU officer.

Many districts in Northern Uganda were excluded from the study due to the special circumstances in the region created by many years of internal strife.

During the interviews two questions were posed: (i) what challenges have you encountered in the rural water supply programme; and, (ii) what challenges have you encountered with M&E? The response to these two questions from all interviewees was enthusiastic – interviews lasted a minimum of 45 min, with some lasting close to 90 min.

Relevant government documents and donor reports were reviewed, dating from 1999 until the present. The key policy document, the *National Water Policy* (Government of Uganda, 1999), was reviewed to determine the foundation blocks of the national policy and strategy for rural water supply. These findings were complemented by analysing several more recent documents.

The annual meeting for TSU officers, held on the 11th March, 2009, and the annual meeting for DWOs, held on the 12th March, 2009, were attended. Notes were recorded and presentations were obtained for analysis.

Finally, in order to see first-hand the water supply problems faced by rural communities, informal visits to numerous water points in villages throughout the country were made. This made possible general observations, informal interviews with villagers and guided walks. Although these visits have not been used to obtain data for analysis in this study, they have helped in acquiring a more complete picture of the challenges which the rural water sector faces.

3.4. The Swedish study

In the Swedish study, finding out about the situation, SSM activity (i), was carried out by conducting interviews and reviewing Swedish government and EU reports. Compiling the results led to the formation of a 'rich picture' which tried to capture the complex situation of how Sweden has implemented the WFD information requirements to support water management (*Paper IV*). A conceptual model of purposeful activity, SSM activity (ii), was prepared based on the EU WFD (2000); this model highlights information tasks that EU Members States are required to carry out for the management of, specifically, surface water bodies (*Paper IV*). (Certain information requirements were not included in the study, such as the economic analysis and details concerning, for example, heavily-modified and artificial water bodies.)

The results of SSM activities (i) and (ii) were compared in order to identify implementation gaps and challenges in meeting the WFD information requirements. This also enabled an appreciation of the linkage between information processes and action.

One of the challenges encountered concerns the vertical integration of information processes to support actors operating at various levels, from national to local. According to the WFD, Member States should encourage the active involvement of all actors involved in water management, including local actors. Furthermore, actors are required to be given access to basic information and consulted. This implies that WFD-required information should be provided to actors, including DPSIR information and RBD management plans and related documents. For the purposes of this research, one particularly large group of local actors who are likely to be greatly affected by water management in Sweden was selected: farmers.

In order to appreciate how local farmers currently obtain and make use of WFD-required water management information and reports, a water catchment area being prioritised for planning by the Stockholm County Board was selected for further analysis. Selection of this catchment had the additional advantage of having on-going activities which together formed a pilot case for studying how local actors might be appropriately involved in catchment management in Sweden in the future. To first appreciate how local farmers were involved in catchment management, as well as obtain some initial perspectives on how they felt about current information processes, several local catchment planning meetings were attended. This led to the preparation of a questionnaire designed to assess farmers' perspectives on WFD information processes in greater detail. Following qualitative research guidelines (Denscombe, 1998), the questionnaire was piloted and adjusted based on feedback from supervisors, other researchers, a County Board employee, a regional representative of the Federation of Swedish Farmers (LRF), as well as two farmers noted for their involvement in local water management. The questionnaire was posted to fifty-five farmers (of an estimated sixty residing within the catchment); the envelope included a postage-paid return-envelope and a short slip briefly explaining the purpose of the questionnaire and requesting a response within one month. After this month, a reminder was sent out, allowing farmers a further two weeks to respond. There were ten responses.

4. RESULTS

In this section the main results from the two cases are presented, covering: (i) the use of M&E to support rural water supply in Uganda; and, (ii) the use of WFD information requirements to support achievement of the WFD objectives of *good* ecological and chemical status for water bodies in the North Baltic RBD, Sweden. More detailed results are provided in the articles appended (*Papers I–V*). In this section, Checkland and Holwell's (1998) model (Fig. 1) has been used as a sense-making device, in order to help reveal how information supports water management in both of the research cases. This is achieved by addressing each of the elements (1–7) of the model. For element 7, organised IS, some of the links between it and other elements are highlighted (links 7–2, 7–4, 7–5 and 7–6). Where necessary, the articles appended to this thesis are referred to (*Papers I–V*).

The purpose of this section is not to associate actors with specific worldviews, or behaviours; however, the section attempts to lift forward worldviews and behaviours which appear to have significant effects on the two situations and which came to light based on the evidence gathered.

4.1. M&E of rural water supply in Uganda

In the Ugandan case, M&E can be seen as the organised IS (element 7, Fig. 1) which should support organisational processes in the rural water supply sector in Uganda. Monitoring can be considered to refer to the process of *data* collection, while evaluation can be considered to refer to the somewhat more complicated act of transforming collected (and perceived) *data* into useful *information* for use in decision making. Each of the elements (1–7) of the generic model (Fig. 1) are dealt with in the following sub-sections.

4.1.1. Element 1: Individuals and Groups

Numerous actors are involved in rural water supply in Uganda (Fig. 2) operating at various levels: international, national, regional, district, sub-county and village. Some of the key actors involved are summarised here. International donors provide much of the financing for the sector, while also partaking in national-level planning meetings. The Rural Water Supply and Sanitation Department (RWSSD), under the Directorate of Water Development (DWD) and the Ministry of Water and Environment (MWE), is responsible for overall co-ordination of the sector. Technical Support Units provide regionally-based capacity-building for district officers and sub-county

extension workers and help to promote the adoption of national strategies. At district level, District Water Officers (DWOs) and sub-county extension workers engage with village communities to provide water supply facilities, as well as provide training in the operation and maintenance of facilities. At the community level, Water and Sanitation Committees (WSCs) should be responsible for operation and maintenance of community water supplies. Each of these actors, from the international to the regional level, should play their role according to national strategies, which are based on international norms of best-practice. However, actors do not always fulfil their roles, particularly at the operational level in the districts and sub-counties, as well as at the community level. Additionally, district politicians, whose sole role in the rural water supply sector should be to approve district-level budgets, play unintended roles (*Paper I*).

4.1.2. Element 2: Perceived World

Vickers' notion of 'appreciative settings', affecting how actors selectively perceive the world based on previous experience, is summarised here for some of the key actors in the Ugandan case. International financial donors see rural water supply as key to fighting problems of poverty and health in Sub-Saharan Africa and thus provide financial support. These financial donors consider a decentralised approach to be appropriate, and encourage private sector involvement and community-based management approaches. Since Uganda has adopted these approaches, sometimes as a condition for receiving financial support from international donors, it could be argued that the RWSSD have the same, or similar, appreciative settings.

For DWOs, their main consideration might simply be the value of having and maintaining a good job (*Paper I*). Furthermore, work as a DWO might simply be a stepping-stone to 'greener pastures', as evidenced by the bleeding of capacity in the rural water supply sector (*Paper I*). The situation for DWOs and, to some extent, sub-county extension workers is a difficult one. While they may wish to follow policies set by the RWSSD, DWOs and sub-county extension workers also answer to district politicians and administrative officials, from whom they receive their salary. This means that they must tread a careful balance between meeting RWSSD requirements and meeting district politicians' desires. In some cases the pressure on DWOs from district politicians may become too great, and they may be forced to resign (*Paper I*).

Local district and sub-county politicians might perceive the current rural water supply situation as a way of obtaining votes from communities in return for awarding water supplies; or, simply, as a way of helping their communities (*Paper I*). A commonly held view of politicians was that water supply should be provided for free – politicians even discourage their communities from following the community-based management approach promoted by the RWSSD. Some politicians also used their position to improve business opportunities for themselves – e.g. by ensuring that businesses they owned were awarded water supply construction contracts.

In general, communities may see the opportunity to obtain a reliable water supply as a way of making their lives easier. Some communities feel that they should be awarded a water supply for free as a reward for voting for the current government (Appelblad, 2008). Communities are aware of the different means of obtaining water supplies, either by following the RWSSD policy of community-based management approach, or else by trying to obtain a water supply through the influence of their political representatives.

4.1.3. Elements 3 and 4: Discourse and created meanings

Actors in the rural water sector engage in both formal (Table 2) and informal discourse with other actors in order to interpret their perceived world and engage in the 'intersubjective creation of meaning'. As a concrete example, during the 1980s there was a major shift in international thinking from the a supply-led to a demand-responsive approach (DRA) to rural water supply

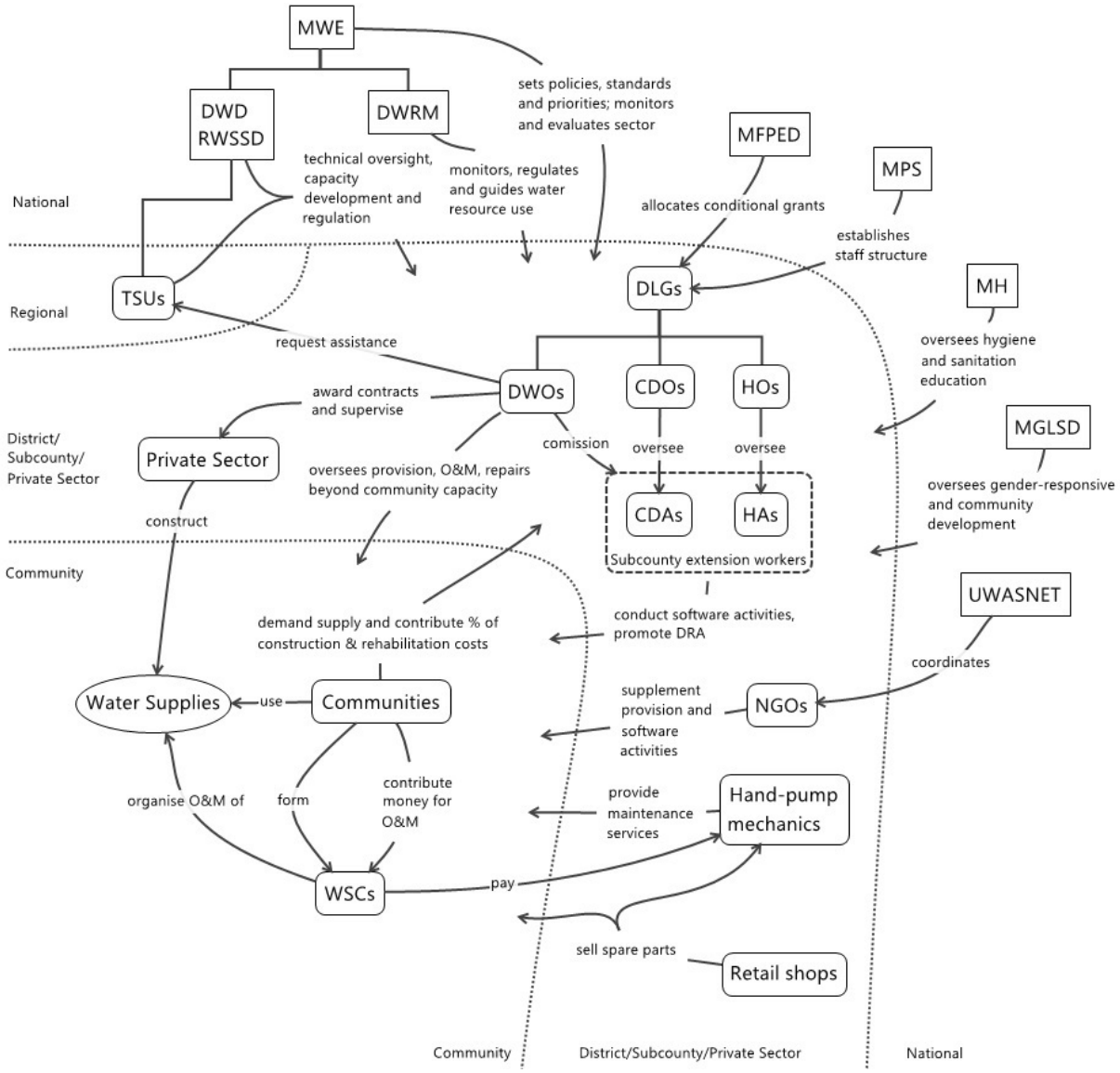

Fig. 2: The organizational framework for delivery of rural water services in Uganda.

Abbreviations: MWE–Ministry of Water and Environment; DWD–Directorate of Water Development; RWSSD–Rural Water Supply and Sanitation Department; DWRM–Directorate of Water Resources Management; MFPED–Ministry of Finance Planning and Economic Development; MPS–Ministry of Public Service; MH–Ministry of Health; MGLSD–Ministry of Gender, Labour and Social Development; UWASNET–Ugandan Water and Sanitation Network; TSUs–Technical Support Units; DLGs–District Local Governments; DWOs–District Water Officers; CDOs–Community Development Officers; HOs–Health Officers; CDAs–Community Development Assistants; HAs–Health Assistants; NGOs–Non-Governmental Organisations; WSCs–Water and Sanitation Committees; DRA–Demand-Responsive Approach; O&M–Operation and Maintenance.

when it was realised that the former led to, among other problems, the widespread breakdown of water supplies (Black, 1998). This experience led to widespread promotion of DRA, including promotion of decentralisation of delivery and community-based management. Over time, the DRA has trickled down from international to national and sub-national levels. In Uganda today, the formal occasions for discourse (Table 2) provide higher institutional levels with a chance to convince lower levels of adopting DRA policies. With decentralisation, an important issue identified in Uganda was the low capacity of districts; this led to the formation of the TSUs in 2003. During the course of this research, another issue brought to the fore in the Ugandan rural

water supply sector was the low functionality of water supplies; this led to the decision to expand and improve data in order to better understand the causes of this issue and to monitor it.

4.1.4. Element 5: Assemblies of related intentions and accommodations

International donors and departments within Government of Uganda ministries which are involved in the rural water supply sector form intentions and make accommodations at meetings, including the Water and Environmental Sector Working Group (Table 2). A number of important intentions have been formed in the past, perhaps the most significant of which was to reach the goal of 77% rural water supply access by 2015.

With regard to DWOs, given that they have essentially two employers, they must constantly make accommodations to please both the RWSSD and politicians in the district in which they operate. The situation is similar for the sub-county extension workers, who must accommodate the intentions of both politicians and their respective ministries. As already explained, the intentions of politicians, which are based on how they perceive the situation, can vary from following central policy to directly opposing it.

If a community forms the intention to obtain a water supply, then they must either accommodate RWSSD policy, or else, they must make an arrangement with a sufficiently influential politician, who may influence district-level decision making in their favour in return for, most often, votes.

4.1.5. Element 6: Purposeful action

The main action is the provision of rural water supply. In addition to carrying out strategic action, such as the formation of the TSUs, the RWSSD also distributes funding to districts based on estimates of their current rural water supply, i.e. using the indicator for access. This, however, creates a problem; since districts officials know that the amount of funding they receive is linked to the indicator for access they sometimes report lower figures for access to the RWSSD in order to receive more funding (*Paper I & II*).

DWOs and sub-county extension workers are responsible for operational action. Their work includes water supply construction supervision, awarding contracts to private sector construction firms, rehabilitation operations, training of communities, etc. These actions should be completed in accordance with central policy; however, pressure from district politicians may result in a DWO acquiescing to the demands of

Table 2: Formal committees and meetings at various levels in the Ugandan rural water supply sector.

Level	Committees/Meetings	Actors involved	Purpose
National	Water and Environment Sector Working Group	Government ministries, international development partners, NGOs	Policy and technical guidance for the sector
National	Water Policy Committee	MWE, MLG, private sector, NGOs	Assists and advises MWE; promotes inter-ministerial and inter-sectoral co-ordination;
Regional	Inter-District Meetings	TSUs, district politicians, DWOs, HOs, CDOs, private sector and NGOs	Share experiences, progress reports and plans; enables TSUs to explain policy-related issues, on behalf of MWE
District	District Water and Sanitation Coordination Committees	District politicians, DWOs, HOs, CDOs, private sector and NGOs	Oversees implementation of programmes; strengthens collaboration and coordination with other sectors (health, gender and development, education and agriculture) and actors (private sector and NGOs)
Sub-county	Sub-county Water and Sanitation Committees	Sub-county council officials	Selection of pump mechanics and water-equipment retail shops

Abbreviations: CDOs: Community Development Officers; DWOs: District Water Officers; HOs: Health Officers; MLG: Ministry of Local Government; MWE: Ministry of Water and Environment; NGOs: Non-Governmental Organisations; TSUs: Technical Support Units.

politicians. District politicians' actions might include, for example: influencing DWOs to award contracts to favoured businesses; discouraging communities from collecting fees for operation and maintenance; or, discouraging the construction of water supplies for communities who do not vote for the politician.

4.1.6. Element 7: Organised IS

The rural water supply and sanitation sector in Uganda is dominated by one information system in particular, namely M&E. It was developed by the RWSSD together with consultants (Kayaga, 2008). Eleven indicators were identified, nine of which are used in the rural water supply sector to keep track of provision (Table 3). This information should help the RWSSD to identify emerging issues and to respond with strategic action. However, it is the responsibility of district-level actors, such as DWOs and sub-county extension workers, to collect the data which forms the basis for information used by the RWSSD. This leads to a number of problems (weakening link 7–2, Fig. 1), since data can be out-of-date or incorrect. There are various reasons for this, such as: low capacity for carrying out monitoring in districts; false reporting of low access figures to obtain more funding; political pressure; and, a low interest among district actors in collecting and using data (*Paper II*). Regarding low interest, a DWO explained that if a water supply was broken down, he just knew; thus he felt it unnecessary to record it. The results of the study revealed that while the RWSSD might find the indicators useful for strategic planning if sufficiently accurate, it was apparent that districts actors did not necessarily share the same view. That is, organised IS might support the 'creation of meanings' (link 7–4, Fig. 1), the forming of intentions and accommodations (link 7–5, Fig. 1) and purposeful action (link 7–6, Fig. 1) to some extent for RWSSD strategic planning; however, organised IS is of less use to district actors, including DWOs and politicians. In order to increase incentives for district actors to carry out monitoring more effectively, indicators other than the indicator for access could be linked to funding, thus helping to target local issues as they arise. Also, organised IS (element 7, Fig. 1) could be better used to inform and engage local actors and thus hopefully help them to appreciate the problems that their communities are facing (*Paper II*).

4.2. WFD information in support of water management in Sweden

In the Swedish case, implementation of the WFD information requirements can be seen as the organised IS (element 7, Fig. 1) which should support organisational processes which lead to action – primarily outlined in the Programmes of Measures. Action should help towards meeting the WFD environmental objectives. *Data* is collected and transformed into useful *information* for use in decision making following the DPSIR

Table 3: 'Golden' indicators used in the rural water supply sector in Uganda (Ministry of Water and Environment, 2009).

Indicator	Description
Access	% of people within 1 km of an improved water source
Functionality	% of improved water sources that are functional at time of spot-check
Per capita investment cost	Average cost per beneficiary of new water and sanitation schemes (US$)
Sanitation	% of people with access to improved sanitation (households)
Water Quality	% of water samples taken at the point of water collection that comply with national standards
Equity	Mean sub-county deviation from the district average number of persons per improved water point
Handwashing	% of people with access to handwashing facilities
Management	% of water points with actively functioning Water & Sanitation Committees
Gender	% of Water and Sanitation Committees with women holding key positions

approach (European Environment Agency, 1999). Prior to the WFD, the organisation of information for water management in Sweden was geared towards controlling point-source pollution from specific sector operations – mostly industrial and municipal wastewater sources of pollutants. This involved, for example, industrial sector actors and municipalities monitoring impacts on water bodies of their activities and ensuring that requirements established in law were met. Diffuse source pollution was typically not tackled, except in special cases (e.g. problems of acidification), and generally the ecological effects of, for example, dams were not widely monitored. The adoption of the WFD has shaken things up substantially. Now there is a need to meet environmental objectives, which include both chemical and ecological objectives. For a given water body, the previous requirements on point-source pollution may no longer be sufficient to meet the environmental objectives. Furthermore, diffuse pollutant sources can no longer be ignored. Implementation of the WFD requires Sweden to develop new processes for taking action and, in turn, implies that information to support action will also need to be developed. This sums up the complex situation which Sweden faces today; forming the backdrop for the organisational processes which lead to action, including actors' discourse, created meanings, intentions and accommodations, as well as purposeful action. These organisational processes for carrying out water management in Sweden according to the WFD, as well as its information support, are recounted below.

4.2.1. Element 1: Individuals and groups

The EU Commission plays an important role in water management, primarily overseeing implementation of the WFD in EU Member States. In Sweden, there are many actors involved in water management (Fig. 3). The Swedish Agency for Marine and Water Management, a central government authority, was recently formed to co-ordinate national water management. Other central government authorities with important roles in water management include the Swedish Environmental Protection Agency and the Geological Survey of Sweden. Water Authorities were formed to co-ordinate water management at the RBD level. County Boards and municipalities have responsibilities for water management at their respective levels. In some catchments, various forms of local water organisations bring a range of actors together to co-ordinate catchment planning. Additionally, there are numerous actors operating at various management levels; these include actors within industry, agriculture and forestry. Other government authorities are responsible for regulating actors within these sectors; for example, the Swedish Board of Agriculture is responsible for regulation within the agricultural sector. Although there are many sector actors, this thesis focuses on farmers, who are a particularly large group of local actors.

4.2.2. Element 2: Perceived world

It can be argued that an important 'appreciative setting' of the EU Commission is that nature is the 'natural' goal for water management (Bishop, et al., 2009). Sweden is obliged to implement the WFD; thus, while Swedish government authorities might not fully agree with all aspects of the WFD, they must nevertheless meet WFD requirements using limited resources and budgets. The Swedish government, and politicians in general, are likely to regard water management as simply one issue among numerous others (from interviews carried out with people involved in water management, it was apparent that politicians involved at RBD and municipal levels were interested in water management but felt disarmed by its complexity). Sector actors can hold many perspectives, for example, farmers (*Paper V*). Ultimately we can synthesise them by saying that farmers must ensure that they continue to make a profit under economical pressure – whether water makes it onto their radar might be highly dependent on individual farmer's available financial security, though their ecological knowledge can also play a role.

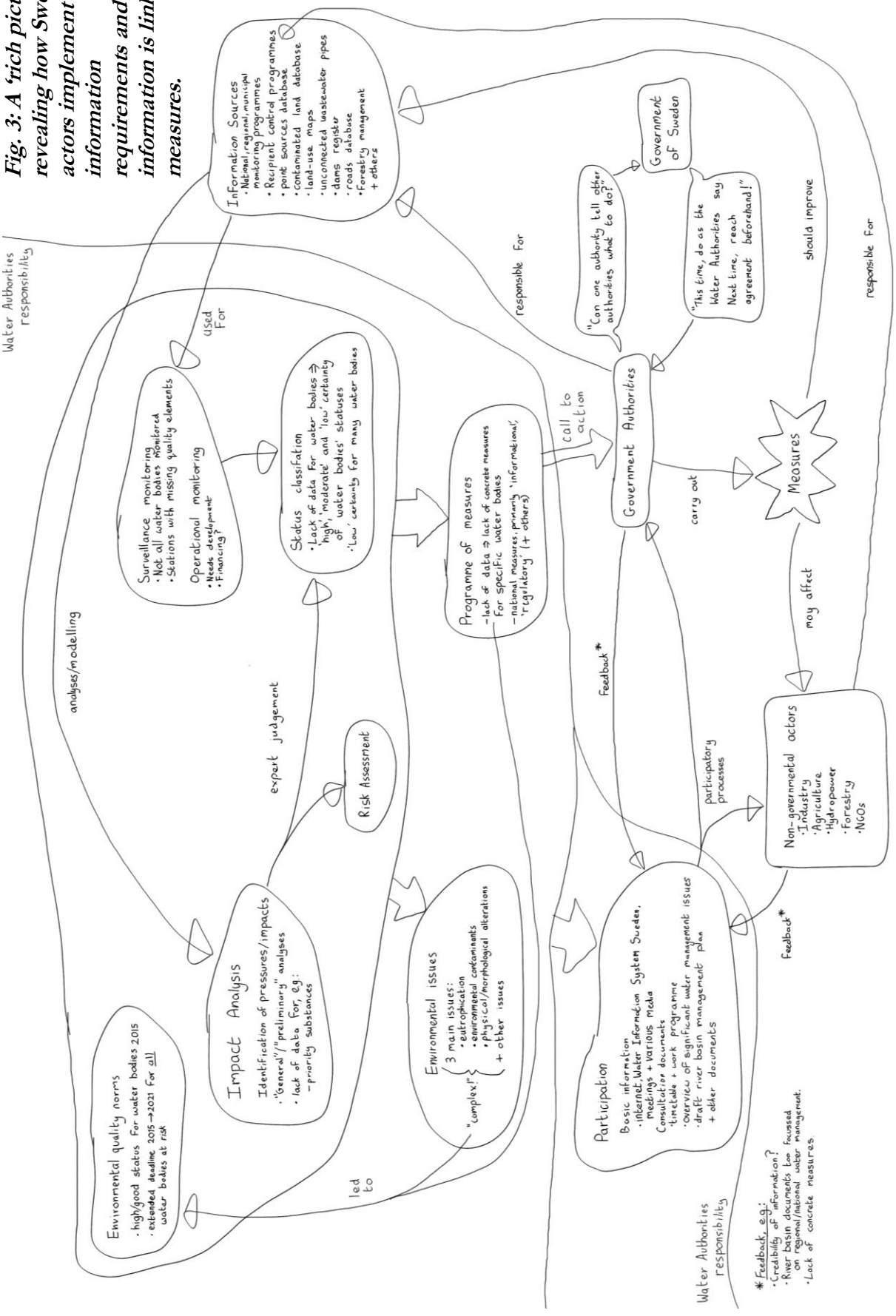

Fig. 3: A 'rich picture' revealing how Swedish actors implement WFD information requirements and how information is linked to measures.

4.2.3. Elements 3 and 4: Discourse and created meanings

The various actors engage in various forums in order to express their ideas and make sense of what is going on in the perceived world – discussing both the situation regarding water resources and the implications of the WFD. Depending on the opportunities available for participating in the discussion and their 'cognitive filters', the various actors perceive data, obtain information and build knowledge. The amount of information and knowledge gained vary greatly and in type depending on interests.

There are various formal occasions for discourse, in addition to ongoing informal discourse. Primarily, much of the formal discourse is established by the Water Authorities, together with the County Boards. Discourse occurs, for example, in RBD Water Delegations, who are responsible for making final decisions on the Swedish environmental quality norms (i.e. the WFD environmental objectives), the Programmes of Measures and the RBD management plans (each of these are prepared by the RBD Water Authority before being passed to the Water Delegation for approval). Water Delegations are made up of maximum eleven members. Members are actors brought together from various sectors, including politicians, government bodies, universities and other sectors. (Although members are supposed to be objective, and not represent their sectors, it would seem impossible to achieve this fully!) The County Boards also organise occasions for discourse, including, at the behest of the Water Authorities, WFD-required consultation meetings. In this case, the Water Authorities prepare documents and the consultation meetings provide an opportunity for a broad range of actors to discuss them. These occasions enable discourse and the formation of 'created meanings'.

Regarding created meanings, it appears there is agreement among actors as to what the problems are. For example, there is a general recognition that the problems of loss of ecosystem health and good water quality are growing problems and that this must be dealt with. However, given the particularly complex nature of the situation, there are many pertinent issues, such as: what measures are effective and should be undertaken, what the main sources of the problems are, who bears responsibility for carrying out action and who bears responsibility for costs. In Sweden, the WFD has been received with mixed emotions by the various actors involved. Nevertheless, the law stipulates that it must be implemented. In any case, the WFD forces a new start on dealing with the complex situation of water management.

4.2.4. Element 5: Intentions and accommodations

The various 'created meanings' should help actors to form intentions and accommodations (link 4–5, Fig. 1). However, due to the fact that created meanings include concerns over uncertainty and responsibility, intentions and accommodations are not so easy to arrive at. Furthermore, based on their power, position and influence, actors involved must accommodate the intentions of others. The main actor responsible for forming intentions is the RBD Water Authority. However, even their ability to turn intentions into action is severely limited – essentially, they have only been able to prepare a set of measures requesting other government authorities to carry out action (*Paper IV*). Apparently, Water Authorities lack the power to assign sector actors as responsible for undertaking measures. Additionally, the Water Authorities were unable to propose concrete measures for specific water bodies, perhaps since it would imply that sector actors would need to undertake measures. Consequentially, measures proposed were primarily directed at other government authorities and were, primarily, administrative measures, focussing on changing regulatory processes and improving information availability. A number of government authorities responded by sending a formal query to the central Swedish government, which questioned if the Water Authorities had the right to call on other authorities to carry out such action (Fig. 3). The government responded

that the authorities should, on this occasion, comply with the Water Authorities' call; and, in the future, the various authorities should reach agreement beforehand. Thus other government authorities have been compelled to accommodate the Water Authorities' intentions.

A group of government actors which have not been particularly involved in WFD water management are the municipalities. That this is the case is, in large part, due to the central government's decision to not provide extra funding for municipalities, when they requesting extra funding for implementing WFD water management. The response of the municipalities was to decide to stay out of WFD implementation and, essentially, only watch the process from the side-lines (*Paper IV*). This is a significant loss, since municipalities have many of the planning tools which are important for catchment planning (Balfors et al., 2012).

At this point in time, it is apparent that the Water Authorities are not ready to directly call upon sector actors to undertake measures. Thus, sector actors do not have to directly accommodate the intentions of the Water Authorities. However, sector actors are indirectly affected by the Water Authorities' Programmes of Measures, insofar as other government actors are required to develop regulatory processes; which should ensure that water bodies meet the environmental objectives within the WFD deadline (year 2027 at the latest). The effects of these regulatory measures are already beginning to be noticed, as sector actors are requested to account for the effects of new operations in environmental impact assessments.

4.2.5. Element 6: Purposeful action

Water management action should be defined in Programmes of Measures for RBDs. In Sweden, the Water Authorities' proposed measures primarily focus on informational and regulatory changes which are directed at other government bodies; no concrete measures were proposed (*Paper IV*). Numerous actors expressed disappointment with the lack of concrete, practical measures. Although some level of action occurs at County Board and municipal level, there is little integration of planning at and between levels (*Paper IV*). For example, on-going activities with impacts on water bodies are generally unaffected so long as they meet current regulations; however, newly proposed activities which may have an impact on water bodies may not be authorised. As already described, sector actors are generally not required to undertake action, though they might be affected indirectly by new regulatory measures.

4.2.6. Element 7: Organised IS

Ideally, organised IS (element 7, Fig. 1) for water management appears straightforward: identify the chemical and ecological status of water bodies in order to inform action to improve the status if it is lower than required. In reality, there are many complications with organised IS for water management in Sweden (*Paper IV*). Regarding data collection to help keep track of the 'perceived world' (link 7–2, Fig. 1), a large number of water bodies are not adequately monitored. Despite this, information regarding their status has been based on a process of 'expert judgement' (*Paper IV*). This throws into question the credibility of information, which limits actors' to 'create meanings' (link 7–4, Fig. 1). Also, the Swedish Water Authorities stated that the lack of information made it difficult to assess the need for concrete, practical measures (links 7–5 and 7–6, Fig. 1). This issue led the Water Authorities to propose measures related to improving data and information collection (links 4–7 and 5–7, Fig. 1). Since the 'purposeful action' proposed was primarily administrative reform (regulatory and informational), information has not provided a firm foundation for establishing practical measures in water bodies. That is, no concrete measures were proposed to help towards meeting the environmental objectives of water bodies, only administrative measures.

An additional issue, already described, is that while effective water management should likely require both government and sector actors to undertake measures, only government actors were identified in the *Programme*

of Measures. Farmers, in particular, felt uninformed and unable to affect water management, despite the fact that some desired both information and opportunities to affect water management (*Paper V*). It could be argued more generally that sector actors, who should be involved in water management as well as the corresponding information processes, are not fully involved.

5. DISCUSSION

The discussion is divided into two main parts. In the first part, the role of information support for water resources management is considered for the two cases. Drawing on the results, similar challenges affecting the use of information to support action are identified. The second part of the discussion reflects on the research approach, considering the use of Checkland and Holwell's (1998) generic model for the organisational processes which are supported by organised IS (Fig. 1), as well as the use of the SSM approach.

5.1. Information in support of water management

As has already been presented in the introduction (section 1), both the Ugandan case of M&E of rural water supply and the Swedish case of organising information for water management according to the WFD have some similar characteristics. The cases fall under the sphere of IWRM, and necessitate multi-level governance with involvement of numerous actors from the international to the local level. Thus, as will be argued here, there are similar challenges faced in providing information support for action and, as will be argued in sub-section 5.2, these challenges can be recognised and thus tackled with the help of appropriate models and methodologies.

In both cases, there has been international pressure on nation-states to carry out action in a specific area of concern, i.e. rural water supply in Uganda and sustainable management of water in Sweden. Furthermore, this international pressure also induced the countries to develop organised IS (element 7, Fig. 1) in order to support action; international donors required Uganda to implement M&E while the EU WFD requires European Members States to adopt a DPSIR-based approach to water management. Thus, in both cases, those ultimately responsible for ensuring that organised IS is implemented are nation-states. To achieve this, numerous government authorities at multiple levels need to partake in the development and carrying out of organised IS. Multiple sectors are affected in both cases, including private sector and NGO actors. Since many of these actors are likely to need to carry out action themselves, they should be involved in the organisational processes which lead to action (Fig. 1); thus, they should also receive information (Principle 10, Agenda 21; UN, 1993). It could also be argued that they should even be involved in the development of organised IS in order to help support action. Keeping these points in mind, we can now take a look at the challenges to implementing organised IS to support water management action.

According to Checkland and Holwell's (1998) model (Fig. 1), in order to support action, organised IS (element 7) should support the organisational processes which lead to action (elements 2, 4, 5 and 6). There were significant challenges with data collection, which should aid actors' creation of the 'perceived world' (link 7–2, Fig. 1); both cases revealed that the quantity and quality of data was insufficient. Furthermore, dissemination of information to certain actors can be somewhat limited. For example, district politicians in Uganda – who play significant, unintended roles in the rural water supply programme (*Paper I*) – may not always avail of rural water supply sector information for various reasons (*Paper II*). In Sweden, farmers felt that they were not sufficiently informed about water management (*Paper V*). The lack of provision of data sufficient in quantity and quality are important factors which limit the ability of actors to 'perceive' a situation (element 2, Fig. 1).

Together with 'discourse' (element 3, Fig. 1), organised IS (element 7) should help actors to 'create meanings' about a situation (links 3–4 and 7–4); i.e. organised IS should facilitate actors process data into information and knowledge. Additionally, from 'created meanings' there is a feedback to 'discourse' (link 4–3). Limitations which affected these processes and links were identified in both cases. Obviously, if some actors lack access to data for whatever reason, then their ability to develop information and knowledge about the situation is also limited. This may also be affected by the data lacking, for example, salience, credibility or legitimacy in the eyes of actors (McNie, 2007). With regard to salience, a DWO in Uganda felt that M&E data was not useful, since he felt that he already had the information he needed (*Paper II*). With regard to credibility, the indicators used in Uganda were based on data lacking in quantity and quality. Similarly in Sweden, WFD-required information was also based on data lacking in quantity and quality. Playing on (Ward et al., 1986) comment on the 'data-rich but information-poor' syndrome in relation to monitoring for water management, we could reasonably regard the above examples as 'data-poor but information-rich'; i.e. information is created from data which lacks quantity and quality. In both cases there appears to be tacit acceptance among central government authorities that the credibility of information is inadequate. For example, in Uganda only the indicator for access is currently linked to funding and one of the first responses to the recognition that water supplies had problems with functionality was to increase data collection. Similarly in Sweden, the Water Authorities proposed numerous measures related to improving data and information. Both of these are examples of where 'created meanings' led to the recognition that organised IS needed to be improved (link 4–7).

Actors form intentions and accommodations (element 5, Fig. 1) based on their 'created meanings' (element 4, Fig. 1); organised IS can also support the process (link 7–5). Considering the indicators in Uganda, not all enabled intentions to be formed given their lack of credibility. In Sweden, the Water Authorities admitted that it was difficult to plan for practical action due to the lack of data. The fact that not all actors were sufficiently involved in both cases also affected how intentions and accommodations were formed. In Uganda, district politicians' intentions sometimes forced DWOs to make accommodations which affected rural water supply negatively (*Paper I*). Importantly, some DWOs described taking district politicians on what they called 'political monitoring' visits to villages so that the politicians could learn about the problems that communities within the district were facing (*Paper II*). Hopefully such visits might encourage politicians to form new 'created meanings' and intentions. In Sweden, although sector actors were involved in various public information and consultation processes, there was lack of clarity regarding how their intentions should affect the Water Authorities' intentions, since the Programmes of Measures were only directed at government bodies (*Paper IV*). Farmers, in particular, felt that they could not affect water management (*Paper V*).

Regarding the support of 'purposeful action' by organised IS (link 7-6), an interesting result from the cases was that where information supported action, the action tended to be strategic and not operational action. For example, in Uganda the RWSSD distributed funding to districts based on the indicator for access – i.e. strategic action. In Sweden, the data which was collected revealed a set of significant water management issues and led the Water Authorities to identify, in Programmes of Measures, other government bodies as responsible for planning and carrying out strategic action. However, in neither case was operational (or local-level) action particularly well supported by the organised IS. Thus, it can be argued that there was a lack of integration of information support between the strategic and operational levels.

One of the objectives of this thesis was to consider how local actors might be better

included in the development of organised IS for water management (*Paper V*). For this particular objective, Swedish farmers were selected. The results indicated that at least some farmers were interested in receiving regional information and, also, desired improved local information. These results suggest that information for strategic planning levels might well be considered 'useful' (McNie, 2007) at the local level, but that there are challenges to sufficiently including actors in developing information and consultation processes by appropriate means. The challenges of organising information support over multiple governance levels implies the need for using models and methodologies which are capable of tackling the process (Timmerman et al., 2010).

5.2. Reflections on the research approach

The research presented in this thesis has been guided by Checkland and Holwell's (1998) model (Fig. 1), as well as SSM (Checkland, 1999; Checkland & Scholes, 1990; Checkland & Poulter, 2006). How their use enabled investigation of the cases is reflected upon here.

5.2.1. Reflections on the use of Checkland and Holwell's (1998) model

At a first glance, the processes that should be supported by Checkland and Holwell's (1998) model (Fig. 1) might not seem to be particularly striking. For example, that organised IS (element 7) should help actors to 'perceive' a situation is no extraordinary claim. However, an advantage with the model is that it combines key processes into a single model. This enables investigation of complex cases where information is used to support action. Conceivably, the model offers a coherent means of comprehending the 'whole'. For a given situation where information is used to support action, using the model can help with the identification of weaknesses or neglected processes; it also provides a framework for analysing the effect of weaknesses on other parts of the situation.

The focus on organisational processes (and not structure) helps not only to analyse how single organisations might use information support for action, but also helps to analyse situations involving multiple actors and, thus, multi-level governance. Water management is such a situation. Elaborating on the above, the model (Fig. 1) helps to assess if organisational processes (elements 2, 4, 5 and 6) are actually supported by organised IS (element 7). I.e. does organised IS help all actors to:

- perceive a situation (link 7–2);
- 'create meanings' (link 7–4);
- form intentions and accommodations (link 7–5); and,
- carry out purposeful action (link 7–6)?

This does not imply that the structure of a situation should be designed to match the model. Neither does it imply that the model is any sort of ideal case; rather, the model is supposed to be a defensible account of how organisational processes lead to action, supported by IS (Checkland and Holwell, 1998).

Regarding the organisational processes (elements 1–7, Fig. 1), and links between them, each of these are complex processes in themselves, encompassing whole research fields. Taking an example, one can consider how McNie's (2007) account of the credibility, salience and legitimacy of information fits in with the model (Fig. 1).[3] However, just as we should not lose sight of the forest for the trees, we should not lose sight of the 'whole' of a situation, where information is used to support organisational action. This point, for the context of information in support of organisational action, can be related to Ostrom's (2007) framework, which should help to structure research on social-ecological systems. Ostrom summarises the work of many researchers who have identified variables relevant to such social-ecological systems. While Checkland and

[3] A popular account – The Science of Why We Don't Believe Science (Mooney, 2011) – similarly covers this theme, summarising psychological research investigating how people reject facts in order to protect their values and beliefs.

Holwell's model is based on an interpretive approach, it could nevertheless provide an initial framework for establishing a relevant set of variables to help with understanding situations where information is used to inform action. With time, it might be possible to achieve something equivalent to that which is being developed for social-ecological systems. Given that social-ecological systems also incorporate information needs, some integration could also be possible, whereby variables relevant to information in support of action could be incorporated into the framework for social-ecological systems.

5.2.2. Reflections on the use of SSM

As previously pointed out, since SSM is a methodology, a researcher must adapt it to suit the situation being investigated; i.e. the researcher must develop an approach specific to the situation and the objectives of the research (see the Learning-User-Methodology-Approach-Situation model; Checkland and Poulter, 2006).

In both the Ugandan and Swedish cases, the systems for action were analysed first, followed by the information systems intended to support them – i.e. the *system to be served* was investigated before the *system which serves*. Appreciating the system for action helped with understanding how information processes in the two cases were intended to support action. Comparing conceptual models with the results of the 'finding out' stage helped to identify implementation challenges, as well as how the challenges affected other parts of the system. Similar to use of the IS model, a criticism of the SSM approach might be that it lacks depth. However, the approach offers an advantage in that it provides a coherent means of comprehending how processes are interconnected.

6. FUTURE RESEARCH

The research presented in this thesis can, in many regards, be seen as some first tentative steps towards developing a potentially useful approach for understanding the subject of information in support of water management action, and perhaps, other related fields of natural resources management. Further stages in applying the methodology could provide some potentially useful insights, as well as providing a practical means of tackling the challenges of information systems development for situations involving multiple actors distributed over multiple levels, from international to local.

For example, models of purposeful activity could be developed for various levels which represent the organisational action necessary to change some situation. In this case, such processes are already being adopted in Sweden for the strategic management of water according to the WFD. However, models could be formed which represent local catchment planning processes, involving relevant local actors. From such models, it is possible to identify information which is needed to carry out the action and to monitor the process (Checkland and Holwell, 1998). This could be carried out in conjunction with the involvement of relevant actors. Models and information needs could be compared within and across levels to improve integration. Based on such models and information needs, desirable and feasible changes to existing organisational processes could be identified and, ideally, lead to action to change the situation.

Could such an approach help to form an integrated information system which takes into account the multiple sets of values, 'appreciative settings' and worldviews which actors hold? Could such an information system contribute to social learning among actors? Also, while Checkland and Holwell (1998) have developed concepts within the field of information systems and their development, they appear to have developed their ideas independently of the growing field of knowledge management (Davenport and Prusak, 2000). Would integration between these fields and social learning provide some useful insights?

At the end of the day, many of the challenges related to successfully organising information to support water management (and other areas of natural resources management) are, ultimately, political questions – how much is society willing to spend

on obtaining accurate data and ensuring the involvement of all actors? Further research in developing a framework for information systems could help to reveal essential components that policy-makers should support in order to secure sufficient information to support action – how much organised IS is 'optimal'? Given limited budgets and resources, an information systems framework could help to establish the consequences of making trade-offs between the various organisational processes which lead to action and the organised IS to support them.

7. CONCLUSION

The cases from Uganda and Sweden reveal a number of challenges in using information to support action. Given that information was based on data lacking in quantity and quality, it could be argued that a 'data-poor, but information-rich' problem arose. Such a problem can jeopardise the credibility of information, affect how other actors perceive a given complex situation and lead to difficulties in using information to support action.

In both cases, the integration of information processes over multiple government levels, as well as ensuring the provision of information to non-governmental actors, was a particular challenge. It can be argued that if actors influence action (e.g. district politicians in Uganda, or should play a role in carrying out action (e.g. farmers in Sweden), then they should be included in information support processes (Principle 10, Agenda 21; UN 1993). It could even be argued that they should perhaps be involved in the development of information support processes. This might help actors to perceive information as useful, i.e. salient, credible and legitimate (McNie, 2007), and could further help actors to learn and develop knowledge about the situation in which they are involved. Taking the case of farmers in Sweden, some are interested in obtaining both strategic and local information. They are also particularly interested in seeing practical action which takes into consideration their needs at the local level. Farmers appear keen to see how strategic planning might affect them, as well as have access to local information in order to appreciate local catchment management. This implies that it is necessary to improve the links between strategic and local information and, also, to ensure that the links between information and action are made more clear. Given that strategic information processes could be better tailored to suit local information needs, as well as local action, the development of such information processes are likely to benefit from consultation with local actors.

Checkland and Holwell's (1998) model, which conceptualises how organised information systems support the organisational processes which lead to action, in combination with SSM, forms a useful approach for exploring the challenges of providing information support in water management situations. The approach cannot necessarily help with establishing precise reasons revealing why information and organisational processes and links might not be functioning as desired since the complexity of such situations impedes such detailed investigations. Various fields of research which focus on specific information system processes (e.g. how human cognitive processes affect the perception of data and its transformation into information) might help to provide valuable insights and even precise reasons for explaining poorly functioning processes in organisational contexts. However, the approach confers some advantages. For example, the model provides a holistic perspective which can further help to provide a coherent means of comprehending how information and organisational processes affect and interact with each other. Also, the model could offer a basis for establishing a framework for better understanding how information systems support organisational processes, which could bring together variables proven to affect such systems. Such a framework could be integrated with other existing frameworks – e.g. the framework for social-ecological systems suggested by Ostrom

(2007). Furthermore, the approach can offer a means of linking action, based on decision-making processes, to the information needs of actors operating at various levels in water management.

Today, we are more capable than ever of rapidly changing our environments and potentially destroying them – sometimes to the extent of threatening ourselves. In the past, societies which abused their environments sometimes collapsed by reducing the ability of the environment to sustain them (Diamond, 2005). Yet societies can adapt to changing conditions, often evolving cultural means of managing their environment over time. If we are to ensure that our culture evolves as rapidly as the changes we induce on the environment, then we will need to ensure that sufficient information is extracted and shared among those involved.

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