Grasping complexity: analysing risk for sustainable development

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Abstract: Sustainable development relies on our ability to make decisions today that will determine our tomorrow. Given that uncertainty is explicitly allowed to influence our view of what the future holds for us, most ex ante analyses of challenges for sustainable development can be viewed as analysing risk. Many frameworks for analysing risk exist today, but analysing risk for sustainable development entails different requirements. By applying a combination of traditional science and design science, this thesis presents six such requirements, informed by available theory and new empirical studies. The thesis also presents six criteria for scientifically developing frameworks for analysing risk for sustainable development.

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Summary

Sustainable development relies on our ability to make decisions today that will determine our tomorrow. Given that uncertainty is explicitly allowed to influence our view of what the future holds for us, most ex ante analyses of challenges for sustainable development can be viewed as analysing risk. Many frameworks for analysing risk exist today, but analysing risk for sustainable development entails different requirements.

By applying a combination of traditional science and design science, this thesis presents justifications for six key requirements, informed by available theory and new empirical studies. Although the empirical base for this thesis is facilitating capacity development for managing risk, it may hold broader implications for analysing risk for sustainable development in general. The identified key requirements comprise the ability to: (1) integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity (systemic); (2) accommodate different stakeholder values (multi-value); (3) incorporate a wide range of initiating events that may impact on what stakeholders value (multi-hazard); (4) integrate a multitude of factors and processes that contribute to the susceptibility of what stakeholders' value to the impact of the events (multi-susceptive); (5) involve various stakeholders across functional, administrative and geographical borders (multi-stakeholder); and (6) integrate several risk analyses performed by different groups of stakeholders (multi-analysis).

The thesis also presents six criteria for scientifically developing frameworks for analysing risk for sustainable development, namely a systematic and transparent design process in which: (a) the empirical and normative statements behind the framework's purpose and required functions are explicitly justified and stated; (b) the actual form of the developed framework makes it possible to utilise in practice; (c) the connections between purpose, functions and form of the framework are clear; (d) the framework is utilised in its intended contexts; (e) the utility of the framework is measured in how well its form fulfils the required functions to meet its purpose; and (f) the outcome of evaluating the framework guides further development.

Sammanfattning

Hållbar utveckling bygger på vår förmåga att fatta beslut i dag som avgör vår morgondag. Givet att osäkerhet tillåts påverka vår syn på vad framtiden har i sitt sköte, kan de flesta framåtblickande analyser av utmaningar för hållbar utveckling anses vara riskanalyser. Det existerar många ramverk för riskanalys idag, men att analysera risk för hållbar utveckling innebär särskilda krav.

Genom att tillämpa traditionell vetenskap och designvetenskap, presenteras i denna avhandling motiveringar för sex krav på riskanalyser för hållbar utveckling, baserade på tillgänglig teori och nya empiriska studier. Även om den empiriska grunden för denna avhandling är att underlätta utveckling av kapacitet för att hantera risk, kan dess resultat ha betydelse för att analysera risk för hållbar utveckling i allmänhet. Kraven är förmåga att: (1) integrera fenomen på olika skalor i rum och tid, samt strukturell och funktionell komplexitet (systemisk), (2) tillgodose olika värden (multi-värde), (3) innehålla många inledande händelser som kan påverka dessa värden (multi-hot), (4) integrera en mängd faktorer och processer som bidrar till sårbarheten hos dessa värden (multi-sårbarhet), (5) involvera olika intressenter över funktionella, administrativa och geografiska gränser (multi-intressent) och (6) integrera flera riskanalyser som utförs av olika grupper av intressenter (multi-analys).

Avhandlingen presenterar också sex kriterier för att vetenskapligt utveckla ramverk för att analysera risk för hållbar utveckling, nämligen en systematisk och öppen designprocess där: (a) de empiriska och normativa antaganden bakom syfte och funktion uttryckligen motiveras, (b) den konkreta utformningen av det utvecklade ramverket gör det möjligt att använda det i praktiken, (c) sambanden mellan syfte, funktion och form är tydligt, (d) ramverket används i dess avsedda kontext, (e) användbarheten av ramverket mäts i hur väl dess form uppfyller de funktioner som krävs för att uppfylla sitt syfte, och (f) resultatet av utvärdering efter användning vägleder ytterligare utveckling.

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Although I have spent my entire adult life dealing with risk or disaster-related issues in relation to sustainable development and pondering how to grasp their complexity, it was not until I started working at Lund University Centre for Risk Assessment and Management (LUCRAM) that I felt that I was getting somewhere. I am thus grateful to all my colleagues who have assisted me in this immense learning experience, both within Lund University and elsewhere. Especial thanks are due to my Head of Department, Robert Jönsson, for making it administratively possible to finalise a PhD while working as a Visiting Professor, and to my supervisor Professor Kurt Petersen for guiding me along the way. However, the biggest debt I owe is to Henrik Tehler, my co-supervisor and colleague, who through his great intellect and patience has supported the development of my understanding of risk, as well as my own intellectual development in general. Finally, I extend all my love to my wife, Anna, for always supporting me, and to my son, Noa, for inspiring me to continue to be as curious as he is.

Lund, October 18, 2010

Per Becker

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1. Introduction

"Unless we change direction, we are likely to end up where we are going" - Chinese proverb

This thesis is an attempt to facilitate sustainable development by articulating an argument for the need to integrate the notion and management of risk in development policy and practice. And more specifically by outlining initial ideas for a framework for analysing risk in this context, including potential negative impacts of climate change.

1.1. Background

The world economy has been estimated to have increased around 50 times and the population almost six times from the industrial revolution to the end of our last century (Maddison 2001:28). This development continues to place increasing strains on the world's natural resources and environment (Kalas 2000; Grimble *et al.* 2002; Komatsuzaki & Ohta 2007; Syvitski 2008; Gadda & Gasparatos 2009; Fan & Qi 2010), while vast inequalities persist and even deepen both between and within states (Rist 2006:18; Bywaters 2009; Gorringe *et al.* 2009; O'Brien *et al.* 2009a). Although the last century saw a global increase in life expectancy (Riley 2001) and a decrease in child mortality (Ahmad *et al.* 2000:1175) and adult illiteracy (Parris & Kates 2003:8070-8071), the economic development was highly unequal rendering the same wealth in the final decade of the century to the richest one percent in the world as to the poorest 57 percent (Milanovic 2002:50). In order to reduce poverty while striving towards a more viable use of natural resources, it is vital to make future development more sustainable.

Regardless of whether one focuses on economic growth or on more human-centred parameters, such as increased literacy or reduced child mortality, most uses of the concept of development have one thing in common. This is the fact that they project some sort of scenario into the future, in which the variables of interest develop over time along a preferred expected course. This scenario is, in modern society, not believed to be predestined or predetermined in any way, but is dependent on a wide range of human activity, environmental processes, etc. The complexity and dynamic character of the world is, instead,

continuously creating a multitude of possible futures (Japp & Kusche 2008:80), causing uncertainty as to what real development will materialise.

Being unable to see into the future, as well as being largely incapable of predicting it (Simon 1990:7-8; Taleb 2007/2008), modern individuals, organisations and societies resort to the notion of risk in order to make sense of their uncertain world (Zinn 2008:3-10). Risk is a contested concept, but to be able to talk about risk at all entails some kind of idea of uncertain futures as well as of their potential impacts on what human beings value (Renn 1998a:51). This use of risk also entails that risk must be defined in relation to some preferred expected outcome (Kaplan & Garrick 1981; Luhmann 1995:307-310; Kaplan 1997; Kaplan *et al.* 2001; Johansson & Jönsson 2007:12-14; Zinn 2008:4). If risk is related to potential deviations from a preferred expected future, stakeholders in development must endeavour to reduce such risk to safeguard their development objectives.

There are many courses of events and their underlying processes that may negatively impact development, in either the short or the long term. Abrupt changes in political leadership, global financial crises, algal bloom, epidemic outbreak, droughts, cyclones and outbreaks of communal violence are just a few examples of initiating events that may set off destructive courses of events. Behind these often dramatic courses of events lay processes of change which are less sensational, but may have far-reaching indirect impacts, such as globalisation (Beck 1999; Yusuf 2003; Murad & Mazumder 2009), demographic and socio-economic processes (Wisner *et al.* 2004:62-74; Satterthwaite *et al.* 2009:11-19), modernisation (Beck 1992), environmental degradation (Geist & Lambin 2004; Pimentel 2006; Lewis 2006), the increasing complexity of modern society (Perrow 1999b; Perrow 2008), the development of protracted low intensity armed conflicts (Kaldor 1999), and increased asymmetrical threats (Kegley 2003). In addition we have the mounting threats of climate change, not only potentially increasing the frequency and intensity of destructive extreme weather events (Webster *et al.* 2005; Nordhaus 2006; Syvitski 2008; von Storch & Woth 2008; Elsner *et al.*

2008; Gravelle & Mimura 2008; Kasei *et al.* 2010), but also changing everyday life for vast numbers of people.

These courses of events and their underlying processes rarely exist in isolation, neither from each other nor from the development activities and processes that they impact. It is thus not only vital to ensure that development gains are durable in the face of destructive courses of events and their underlying processes, but also that the means to reach the development gains do not augment, or create new, risks that hinder development for future generations (WCED 1987). Analysing risk is thus a requisite for sustainable development (Haimes 2004:101-106). There are many frameworks for analysing risk that have been developed over the last four decades or so (e.g. Haimes 1998; Aven 2003). However, analysing risk in a sustainability science context entails additional, and sometimes different, requirements.

The world is increasingly complex (OECD 2003:33-50; Calvano & John 2004:25-26; Renn 2008:5). Facilitating sustainable development requires the ability to integrate phenomena on a wide range of spatial and temporal scales, from local to global and from delayed to immediate (Kates *et al.* 2001:641). It also demands the ability to grasp structural and functional complexity (*ibid.*), which means not focusing on individual elements of the world in isolation but on how they are connected, interact with and depend on each other (Haimes 1998:104; Turner *et al.* 2003a:8077). This causes the consequences of an initiating event to propagate through the system (Rinaldi *et al.* 2001; Hollenstein *et al.* 2002:56-61; OECD 2003:44-45; Jiang & Haimes 2004:1215-1229; Dobson *et al.* 2007). To facilitate sustainable development, societies must have the capacity to manage a wide range of risks (Haimes 1992:415; Haimes 2004:101-106) to a complex set of elements that human beings value. It is vital to include a multitude of initiating events in the analysis and an even larger set of interdependent factors and processes, both social and biophysical (Kasperson & Kasperson 1996:96; Turner *et al.* 2003a), contributing to the susceptibility of these elements to the direct or indirect impact of the events. It is also vital to include a wide range of stakeholders (Renn *et al.* 1997:218-219; Haimes 1998:104; Renn & Schweizer 2009) representing legal, institutional,

social, political and economical contexts (Renn 2008:8-9), as well as experts, policymakers and the public at large (Renn 2001).

2. Research demarcation

"The most beautiful part of every picture is the frame" - Gilbert Keith Chesterton (1909/2008:105)

2.1. Presenting the context of the research

Sustainable development is, as will be presented later in this thesis, both conceptually and practically a broad and multifaceted issue (WCED 1987; Kates *et al.* 2001). It is an issue of paramount importance for the continued existence of the world as we know it. At its core lies the idea that in planning for the future, we must think about what to do and not to do today, in order to bring about that future (Simon 1990:11). An important part of sustainable development is, in other words, forward-looking. However, there may be many ways to envisage the future. A major distinction among these approaches is the extent to which uncertainty is explicitly allowed to influence the resulting view of what the future holds for us. This thesis is limited to concerning itself with frameworks for ex ante analyses of challenges for sustainable development that explicitly include uncertainty (Figure 1), i.e. frameworks for analysing risk for sustainable development.

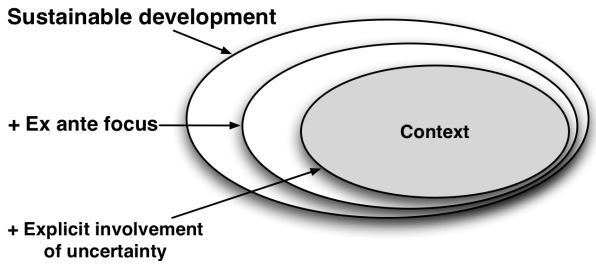

Figure 1. Demarcation of research context.

Analysing risk for sustainable development entails a broad societal focus, which limits this thesis to excluding analysing risk in more monomorphous contexts, e.g. restricted to one stakeholder (a company), one particular site (a chemical plant), one functional sector (power distribution), etc. The frameworks for analysing risk for sustainable development envisioned in this thesis are, in other words, for

stakeholders with interest of society as a whole, e.g. national, provincial or local governing bodies, public-private partnerships for regional development, civil-society organisations with broad social responsibility, etc.

2.2. Purpose, research question and process

The purpose of this thesis is to outline a framework for analysing risk for sustainable development, including negative impacts of climate change. To meet this purpose, the thesis intends to answer the following overall research question:

What criteria should guide the design of a framework for analysing risk for sustainable development, and how should such a framework be developed scientifically?

The scientific design of a framework necessitates a somewhat different approach than traditional science (March & Smith 1995; Abrahamsson 2009:20). Instead of being mainly concerned with the pursuit of knowledge (Weber 1949; Ravetz 1996; Checkland 1999:50), the focus must be placed on designing a framework that must meet some predefined purpose (Simon 1996:4-5, 114; Poser 1998:85-87; Cook & Ferris 2007:173; Abrahamsson 2009:20; Hassel 2010:14-15).

The normative focus of this endeavour poses a different challenge than for traditional descriptive research, as normative statements are inferred from value preference and not from empirical observation, a philosophical assumption presented in detail in Section *3.1.3 Axiological assumptions*. This challenge opens up the way for an infinite number of possible frameworks that could be considered to meet the stated purpose (Figure 2) (Simon 1996:119-120; Poser 1998:86). Just as it is unfeasible to identify all possible frameworks, it is also unfeasible to design the optimal framework (Simon 1996:119-120; Poser 1998:86; Hevner *et al.* 2004:88-89). The aim must instead be to design a framework that satisfies some predetermined design criteria (Simon 1996:119-121; Abrahamsson 2009:23; Hassel 2010:40).

To scientifically develop the framework, we must ensure transparency of both what underlies decisions about design criteria and of the design

process itself, so that they are open to scientific scrutiny (Abrahamsson 2009:22-24; Hassel 2010:42-47). Each decision about a specific design criterion may or may not have implications for other criteria, but the process to establish them can be seen as additive in the sense that each decision determines the path to take through this part of the design process (Figure 2). The set of design criteria is then what the framework is evaluated against.

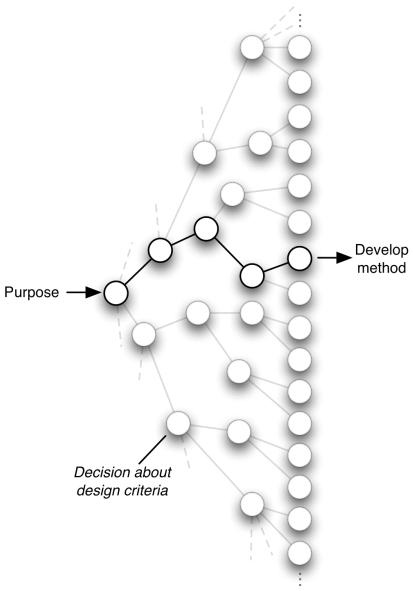

Figure 2. The additive process of establishing design criteria.

The research process of this thesis is to establish design criteria, to develop the framework, apply it in context and evaluate it against the established design criteria. This may seem like a rather linear process, but it is inherently iterative (Hevner *et al.* 2004:88). The design process is presented in full in Chapter *4.2 The design process*.

The framework for analysing risk for sustainable development that is outlined in this thesis is only applied and evaluated in one context. This may seem to limit the effectiveness and usability of the framework itself, as more applications most certainly are necessary to guide further development. However, the overall research question of this thesis is not focused directly on the outcome of the design process, which is the first embryo of a framework. Rather, it focuses instead on making a transparent argument for design criteria that should guide the design of such a framework, as well for how such framework can be designed scientifically. Such a focus is less limited by the few applications of the framework itself.

2.3. Appended papers

This thesis is based on a synthesis of six peer-reviewed journal articles. The first five (I-V) are descriptive in nature and are intended to empirically inform the normative argumentation behind the establishment of key design criteria. This connection between the descriptive and the normative is elaborated on in Section *3.1.3 Axiological assumptions*. The argumentation behind such criteria is also informed by available theory. The last paper (VI) is used to present initial ideas for a framework for analysing risk for sustainable development and to discern if the used design process can be scientifically rigorous. The setting for the studies described in the appended papers is international and their focus is on facilitating capacity development for managing risk or actual destructive courses of events. This represents one of many possible settings within the context of this research, but still, it forms the empirical basis for indicating potential generalisations in the final chapter of this thesis. The research contribution and implications of the papers are summarised in the table below (Table 1).

2.4. Outline of the thesis

This thesis consists of six chapters, a bibliography and six appended papers. Here follows a brief synopsis of the four remaining chapters:

Chapter 3. Philosophical and theoretical framework: This chapter starts by presenting vital assumptions about ontology, epistemology, axiology and complexity. The chapter continues by presenting a theoretical framework for informing the argumentation for key design criteria.

Chapter 4. Methodological issues: This chapter presents traditional science and design science as complementary, and equally essential, elements for the purpose of this thesis. It also presents the design process and similarities and differences between research methodologies and methods used during the thesis research.

Chapter 5. Research contribution: The first part of this chapter presents empirical studies which together with established theory are used to inform the argumentation for key design criteria that should guide the design of the target framework. The second part outlines initial ideas for

a framework for analysing risk for sustainable development, and presents how it is tested and evaluated against the design criteria. The chapter ends by elaborating on, and answering, the overall research question.

Chapter 6. Final remarks: The last chapter of the thesis includes a final discussion of implications for analysing risk for sustainable development in general, and presents ideas for future research.

Paper I	**Research question** What general results may come from focusing international development cooperation on specific factors influencing disaster risk without acknowledging interdependencies with other factors?	**Research methods** Observation Interviews **Research object** 4 projects in Tajikistan and Sri Lanka	**Research results** Ignoring interdependencies between factors relevant for meeting project purposes results in sub-optimisation problems and in reduced chances for monitoring and evaluation in all four studied projects. **Implications** As it is likely that these problems are general, it is vital to take into consideration interdependencies between factors when planning and implementing projects.
Paper II	**Research question** What do stakeholders in disaster risk reduction in Fiji express as valuable and important to protect?	**Research methods** Semi-structured interviews **Research object** 11 stakeholders selected from all levels of state and traditional leadership, important market sectors, and from civil society in Fiji.	**Research results** There is great variation in what the 11 included stakeholders express as valuable and important to protect. **Implications** As it is likely that there is variation in what stakeholders express as valuable in general, explicit discussions of what is valuable are vital for risk management initiatives, since the lack of such discussions may result in stakeholders pursuing irreconcilable goals.
Paper III	**Research question** What do groups of municipal and county council civil servants express as valuable and important to protect and what underlies these expressions?	**Research methods** Focus groups **Research object** 4 focus groups of 7-21 civil-servants each (3 with municipal and 1 with county-council employees) in Sweden.	**Research results** There is variation in what the four groups of civil-servants express together as valuable in their context, indicating a range of social, cognitive and contextual factors influencing the result. **Implications** Although it is likely that such variation in what groups express together as valuable is a general factor, the picture supplied is likely to be richer than the sum of individual accounts and could also provide a mutual framework for acting together towards common goals.

Paper IV	**Research question** How do women and men of from three municipalities in El Salvador rank hazards in their communities?	**Research methods** Structured interviews **Research object** 69 randomly selected respondents from 3 randomly selected municipalities in El Salvador.	**Research results** Although there are no statistically significant differences in the ranking of hazards between women and men in the study, variation in livelihood, level of education, locations of dwellings, age, etc, provide statistically significant differences. **Implications** As it is likely that demographic factors may influence how hazards are prioritised in general, a wide inclusion of people is vital for broad public commitment to specific risk management measures.
Paper V	**Research question** What are the similarities and differences in expressed flows of information and assistance regarding risk and disasters between different administrative levels involved in managing risks and disaster situations in Fiji?	**Research methods** Semi-structured interviews **Research object** 5 related stakeholders from all administrative levels potentially involved in risk and disaster-related activities in Fiji.	**Research results** There are substantial discrepancies between what the 5 respondents on different administrative levels express regarding most aspects of the flow of information and assistance between them. **Implications** As there may be considerable differences between what stakeholders express when describing their system for managing risk and disaster situations, it is vital to integrate information from different administrative levels when constructing one comprehensive view of that system.
Paper VI	**Purpose** To present justifications for key requirements for analysing risk for sustainable development, and to outline, test and evaluate initial ideas for a framework for analysing risk that meets these requirements.	**Research methods** Focus groups Transect walk **Research object** 3 focus groups of 7-10 civil-servants and a full day of transect walk.	**Research results** The paper presents justifications for six key requirements for analysing risk in the context of developing capacities for managing risk for sustainable development (systemic, multi-value, multi-hazard, multi-susceptive, multi-stakeholder, and multi-analysis). It also presents, tests and evaluates, based on ten questions, an initial framework for building human-environment systems and structuring risk scenarios, in terms of their different strengths and weaknesses. **Implications** Although the initial framework seems to meet the six stated requirements to a certain extent, there are still modifications that have to be made and additional applications are necessary. Representing the world as an explicit human-environment system, while involving a multitude of stakeholders, seems central to analysing risk in the complex context of sustainable development.

Table 1. Summary of research contribution.

3. Philosophical and theoretical framework

"Thoughts without content are empty, ideas without concepts are blind[1]*" - Immanuel Kant*

3.1. Philosophical assumptions

3.1.1. Ontological assumption

The world is dynamic and complex (Dewey 1922). Although parts of the world are determined by processes over which human action has little influence, e.g. tidal cycles or the movement of tectonic plates, human activity has increasingly become the most important determining factor of our future (Simon 1996:2-3). However, regardless of what our world is determined by, this thesis rests on the assumption that the world does exist no matter if I am around to observe it or not (Keat & Urry 1975; Blaikie 1991:121). Such realist ontology entails a distinction between the empirical, the actual, and the real domains, where the first covers our experiences of events through observation, the second covers events whether observed or not, and the third covers the real processes that generate events (*ibid.*). The world is in other words there, but not directly available to us (Hammersley 1992:69).

3.1.2. Epistemological assumptions

In a world that is not accessible through direct observation, where the empirical rests on our experiences of interaction with it, there can be no objective search for truth (Kuhn 1970). In other words, meaning cannot be discovered, but rather, must be constructed through social processes in which there is a constant struggle over what is considered to be true or false (Winther Jørgensen & Phillips 1999:11-12). The philosophical base for knowledge rests on social practice, and on the practical knowledge[2] of people acting and utilising artefacts in specific social contexts (*ibid.*:11-14). This argument follows John Dewey's pragmatic philosophy in which thought and action never can be separated (Dewey

[1] Author's translation from German "Gedanken ohne Inhalt sind leer, Anschauungen ohne Begriffe sind blind" (Kant 1787/1968:75).

[2] Theoretical knowledge is, in this view, also a kind of practical knowledge since it involves the social practices of producing and evaluating theories (Tanesini 1999:13-15).

1927/1991), as meaning and knowledge are forged in action (Dewey 1906:306-307). His philosophy of knowledge is also inclusive in the sense that everyone is a capable participant in generating knowledge (Greenwood & Levin 2007:61). But what then is knowledge?

Frank P. Ramsey, another pragmatic philosopher, distinguishes knowledge from belief by stating that belief is knowledge only if it is formed in a reliable process and never leads to mistakes (Ramsey 1931/2001:258). It is thus inadequate to believe something, regardless of the amount of empirical support for it, if that belief leads to errors (Sahlin 1990:4). This is much in line with Popper's idea of falsification in which a theory ceases to be theory when falsified through empirical observation (Popper 2002b). Falsification is, in this approach, the only genuine way for testing theory (Popper 2002a:48), which means that empirical observation may, at best, be consistent with a theory but can never prove it. Knowledge thus comprises beliefs in whose validity we are reasonably confident (Hammersley 1992:50).

Ramsey looks upon theory as being divided into existing entities (here, α, β, γ), axioms and a dictionary, which can be expressed as "$(\exists\alpha, \beta, \gamma)$: dictionary . axioms" (Ramsey 1929/1990:131) and is referred to as the "Ramsey Sentence" (e.g. Mellor 1980; Sahlin 1990). Here, the entities are the building blocks of theory, the axioms are the rules for how the entities function and interact with each other, and the dictionary is our ability to find the entities and axioms in the empirical domain of the world.

The "Ramsey Sentence" not only helps us to understand the relationship between the theoretical and the empirical (Sahlin 1990:140-158), but it also gives us a philosophical framework for managing the complexity in what we perceive when observing the real world. Ramsey (2000) distinguishes between the world, which is home of what we try to explain and understand, and our theoretical construction, which is a tool for making sense of the world. In other words, in order to grasp the complexity of reality, we need to implicitly or explicitly create models of it (Conant & Ashby 1970), or systems, as they commonly are referred to later in this thesis. The vital link between reality and our models is our capability to identify what is relevant for what we attempt to explain,

understand or solve, as well as our capability to test our hypotheses for that particular explanation, understanding and solution.

3.1.3. Axiological assumptions

Researchers involved in traditional science should primarily be concerned with the pursuit of knowledge (Weber 1949; Ravetz 1996), and be as neutral as they possibly can in relation to values (Hammersley 2000:12). Although it is impossible to be objective and value-neutral, according to the epistemological assumptions above, we are not destined to only produce subjective accounts from which only political processes can distinguish the successes from the failures (Blaikie 2000:56). For researchers to be as value-neutral as they possibly can, it is essential to strive to be reflexive and to identify, and get beyond, prejudices and biases. Value-neutrality is, in other words, an unreachable vision or ideal that researchers involved in the pursuit of knowledge must chase with great strength and stamina to be able to get as close as possible to the realities under study (Hammersley 2000:17-18).

The vision of value-neutrality is, however, only vital in the pursuit of knowledge itself. It is not required to attempt to abandon values when it comes to what is perceived to be significant in selecting the areas of inquiry (Keat 1981:38-58). Nor are normative values prohibited from being involved in the process of utilising results from traditional science in solving real-world problems. This may also be done with scientific rigour and is the focus of the complementary design science (Lee 2007:44; Wieringa 2009:2).

Traditional science is well equipped to deal with how things are in the world (Checkland & Holwell 2007:3-5), but less so in dealing with how things ought to be (Simon 1996:5). This distinction between “is” and “ought to be”, i.e. between the descriptive and the normative, has been problematic for scientists for centuries, as it is easy to stray over from the former to the latter if proper care is not taken. David Hume was the first to point out this problem and some scholars claim that Hume advocates a complete division between “is” and “ought to be”, which is rather theatrically illustrated by the principle’s common epithet “Hume’s Guillotine” (Black 1964:166).

Statements about "how things ought to be" cannot be empirically inferred from statements about "how things are", as these two are entirely different from each other (Hume 1739/1978:469). For instance, the normative statement "the authorities should lower the speed limit on all 90 km/h roads to 70 km/h" cannot be empirically inferred from the descriptive statement "the number of fatalities per car in accidents is 38% lower on 70 km/h roads compared to 90 km/h roads". Descriptive statements should, however, be allowed to inform normative statements, but the statement itself will always be essentially inferred from a value preference, i.e. if we value the potentially saved human lives higher than the costs and inconvenience of longer travel times. It is thus vital to be transparent in what values normative statements rest upon (Hammersley 1992:4).

3.1.4. Reductionism, holism and complexity

Contemporary science is concerned with the pursuit of knowledge of a wide range of phenomena, as well as with solving an equally wide range of problems. How these phenomena and problems should be approached has been debated for decades, mainly in the form of more or less fierce advocacy for two seemingly disparate standpoints; reductionism and holism (e.g. Malanson 1999:746-747).

When looking at this conflict, much appears to depend on the definition of reductionism (van den Bergh & Gowdy 2003:76). If reductionism entails the standpoint that a system is nothing but the sum of its parts (e.g. Polkinghorne 2010), it is irreconcilable with holism. However, if reductionism, instead, entails the idea that to address the whole requires a decomposition of it into its parts and examining relations between these parts, they need not to be fundamentally conflicting (van den Bergh & Gowdy 2003:76).

Reductionist approaches attempt to isolate fundamental parts of a phenomenon or problem, and to examine relations between some of these parts, while assuming others to be constant. Holistic approaches, on the other hand, advocate the view that more complex phenomena or problems as wholes cannot be explained, understood or solved by

studying parts in isolation[1] (Smuts 1926:86-87). There are at least two reasons for this. The first may be deducted from the famous statement that *the whole is more than the sum of its parts*[2], indicating that there may be observed regularities in the whole that cannot be obtained by aggregating the regularities of each part (Holland 1998:225). The second is related to the assumption of *ceteris paribus*, that all things that are not explicitly studied stay the same over time. This is refuted if relations between parts are non-linear and precludes attempts to hold selected parts constant (Ashby 1957:5; Anderson 1999:217). However, the vastness and sheer complexity of our universe make it impossible to research anything without reducing it to some extent (Churchman 1970:B43-44).

According to this view, the issue is not whether reductionism or holism is the best approach, but instead how much complexity is allowed to be involved in approaches to particular phenomena or problems (van den Bergh & Gowdy 2003:76). The guiding principles for finding a satisfactory approach regarding complexity are found in the Law of Requisite Variety (Ashby 1957:202-268) and Ockham's Razor[3] (Checkland 1999:35-36). The former states that a model of reality can only model something in reality if it has sufficient complexity to represent it, while the latter asserts that this complexity should be kept to a minimum and limited to only what is relevant for each particular phenomenon or problem (*ibid.*). The decisive feature in relation to how this phenomenon or problem may be approached is thus its complexity.

Although complexity is a contested concept with a wide variety of definitions and uses (see Backlund 2002), it is, in this context, commonly related to the number of involved parts; the number, significance and/or non-linearity of relations between parts and/or

[1] It is important to note that in order for any parts to be part of a whole they must coincide in space and time, and there must be some kind of causal dependence between them (Mellor 2006:140).

[2] A statement often given as a quote from Aristotle's "Metaphysics", but which the author could not find in any translation.

[3] Also referred to as the principle of parsimony (Sober 1981).

heterogeneity in space[1] and time[2] (e.g. Yates 1978:R201). However, if any theory or model of reality is a social construction and influenced by both descriptive and normative aspects, then the complexity of any phenomenon or problem must also be related to factors associated with the observer (Ashby 1973:1; Flood 1987:177-178; Wu 1999:3). Ashby's analogy of the brain demonstrates this with almost amusing clarity and simplicity:

> *"To the neurophysiologist, the brain, as a feltwork of fibers and a soup of enzymes, is certainly complex [...]. To a butcher the brain is simple, for he has to distinguish it from only about thirty other « meats »" (Ashby 1973:1).*

What is included and what is excluded when addressing a phenomenon or problem are vital considerations (Churchman 1970:B43-44; Midgley *et al.* 1998:467) which are often referred to as boundary judgements to underline their inherently subjective nature (Ulrich 1996:156-158; Ulrich 2002:41).

Boundary judgements, descriptive statements about what we know about the phenomenon or problem, and normative statements about the purpose, objectives, etc of addressing them, are all connected to each other in such a way that changing one automatically induces changes in the others (Ulrich 2000:251-252). It is thus crucial to scrutinise systematically what is included and excluded when addressing any phenomenon or problem, as well as what descriptive and normative statements on which those boundary judgements are based. This is especially so when there are multiple stakeholders in the process, who may agree neither on the boundary judgements nor on the descriptive and normative statements behind them. This systematic scrutiny of boundary judgements is often referred to as boundary critique (Ulrich 1996:171-176; Midgley *et al.* 1998:467-470; Ulrich 2000:254-266).

[1] What Yates (1978) refers to as broken symmetry.
[2] What Yates (1978) refers to as non-holonomic constraints.

3.2. Theoretical framework

3.2.1. Development, sustainable development and risk

Although the word development has been used for at least 250 years (Harper 2010), it was not until the end of the Second World War that it became an important concept (Thomas 2000b:3). Ideas about development have changed back and forth since then, e.g. the Soviet model of development (Smekal 1991:32-39), modernisation theories (Rostow 1960; Organski 1965), dependency theory (Dos Santos 1970; Frank 1967/2004), World Systems Theory (Wallerstein 1974), Another Development (Hettne 1995:160-206), Human Development (ul Haq 1995). This has spurred numerous and often competing definitions and has made it difficult to communicate about development. It has been suggested that this Babylonian confusion, to a great extent, is the result of the concept being used in three different ways: (1) as a description of a desired future state of society; (2) as a process of change over time; or (3) as deliberate efforts of various stakeholders aimed at improvement (Thomas 2000a:29).

Development may, in other words, refer to a desired state (goal), the process of getting there (change), as well as our efforts to get there (activities). Presenting a desired state of society implies some variable or set of variables (y) that human beings value and aspire to change from its current state. Development is, in other words, inherently normative (Seers 1969/1989). In this context, the process of change is the transformation of the variable or set of variables over time and our efforts refer to purposeful activities we carry out in order to drive or steer this change towards the desired state. The three parts are thus fundamentally related to each other (Thomas 2000a:29), enabling us to look at development as having five components:

1. A variable or set of variables (y) that human beings value and aspire to change.
2. A descriptive statement about the current state of "y".
3. A normative statement about the desired state of "y".
4. A normative description of a preferred expected scenario of change in "y" over time.
5. A set of purposeful activities aimed at driving or steering the change in "y".

Most definitions of development only include one or a few of these components explicitly (e.g. Seers 1969/1989:481; Todaro 1989:620; South Commission 1990:10-11; UNDP 1990:10-11; Chambers 1997; Rist 2006:13). However, these components can be seen as incremental in the sense that it is unfeasible to focus a definition of development on one without at least implicit involvement of the others before it. For example, it is impossible to define a desired state of something in the world without first defining that something and determining its current state that requires development, or to define development activities without expressing this desired state and the required change that the activities are designed to bring about (Örtengren 2003:9-15).

Hettne (1995) argues that development is contextual and therefore eludes any fixed and final definition. Because facilitating sustainable development requires emphasising the importance of human activity, the concept of development in this thesis includes all five components. Development is thus viewed as a preferred expected scenario of change in a variable or set of variables (y) over time from a current to a desired state and includes purposeful activities to drive or steer this change (Figure 3).

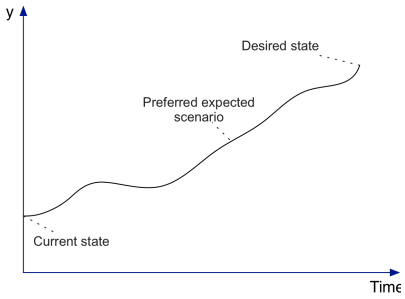

Figure 3. Development as a preferred expected scenario of change in "y" over time from a current to a desired state, including purposeful activity.

Sustainable development is commonly defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43). Looking more closely into the term "sustainable", one sees that it is defined as something that is "able to be upheld or defended" (The New Oxford American Dictionary 2005). The first part of this definition indicates that sustainable development is development that can be maintained over time, while the second part indicates that sustainable development is development that can be safeguarded from the impact of negative

courses of events and their underlying processes. These two parts are closely related, as it is not only negative courses of events that may impact development, but the means for development may also increase or create new courses of events and underlying processes that in turn make it difficult to maintain development over time. Hence, sustainable development is development that can be maintained over time and be safeguarded from the impact of negative courses of events and their underlying processes.

An important example of the connection between the two meanings of sustainable development is our dependency on burning fossil fuels for energy. This seems to be the main cause behind the climate change that threatens the development of our society. These threats are manifested both through increasing extreme weather events (Webster *et al.* 2005; Nordhaus 2006; Syvitski 2008; von Storch & Woth 2008; Elsner *et al.* 2008; Gravelle & Mimura 2008; Kasei *et al.* 2010) and through the gradual degradation of entire aquatic and terrestrial ecosystems, on which society depends (Folke & Rockström 2009; Rockström *et al.* 2009). Regardless of whether they are sudden and dramatic, or gradual and obscure, negative courses of events and their underlying processes may cause deviations from our preferred expected development scenario (Figure 4), limiting the sustainability of our development.

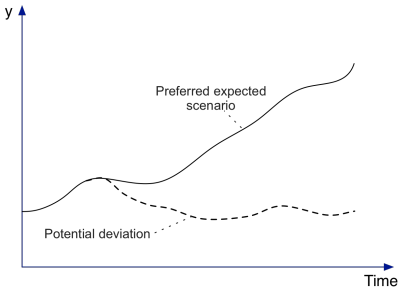

Figure 4. Potential deviation from the preferred expected scenario.

As the future is uncertain (Japp & Kusche 2008:80) and human beings are fundamentally incapable of predicting it (Simon 1990:7-8; Simon 1996:147-148; Taleb 2007/2008), there is not only one but a multitude of possible scenarios that deviate to various degrees from our preferred expected scenario (Figure 5) (Abrahamsson *et al.* 2010:22-23; Hassel 2010:29). Human beings have the ability to design their future by structuring these uncertain scenarios and use them as mental tools to anticipate consequences of different courses of action and then select

activities that appear to lead to our desired state or goal (Simon 1990:11; Renn 2008:1). It is in this context that sustainable development can be viewed as requiring the ability to manage risk (ISDR 2004:18-30; UNDP 2004:9-27).

Risk is a contested concept with numerous definitions, creating the potential for miscommunication and misunderstandings (Fischhoff *et al.* 1984; Rosa 1998; Aven & Renn 2009a). In everyday language, the term "risk" stands for a destructive incident that may or may not occur (Sjöberg & Thedéen 2003:16). Researchers use the term more precisely, but the exact definition of the concept varies (Nilsson *et al.* 2000:21; Renn 2008:12-45; Aven & Renn 2009a:1-2). Nevertheless, these definitions have three aspects in common. First they all distinguish between reality and possibility, as the concept of risk makes no sense at all if the future is predetermined or independent of present human activity (Renn 1992:56; Renn 2008:1; Zinn 2008:3-4). The future must, in other words, be uncertain (Renn 1998a:51; Renn 1998b:51; Japp & Kusche 2008:80) and any future event must at least be perceived as being amenable to alteration (Zinn 2008:4), i.e. there would be no risk in gambling if the game were 100 percent rigged. Secondly, all definitions of risk explicitly or implicitly entail that these uncertain futures must have the potential to impact[1] what human beings value (Renn 1998a:51; Renn 1998b:51; Renn 2008:2), or at least be so perceived (Slovic *et al.* 1982; Slovic 1987). In other words, there would be no risk in gambling, even if the game were not rigged, if the stake is a grain of sand and it takes place in a desert. Finally, and closely related to the previous aspect, risk must be defined in relation to a preferred expected outcome (Kaplan & Garrick 1981; Luhmann 1995:307-310; Kaplan 1997; Kaplan *et al.*

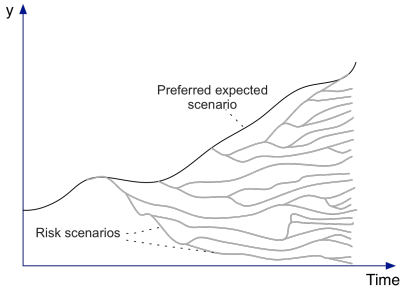

Figure 5. Potential deviations as risk scenarios

[1] Risk is here assumed to relate to negative outcomes (Renn 2008:2), while opportunity denotes positive outcomes.

2001; Johansson & Jönsson 2007:12-14; Zinn 2008:4). This means that there would be no risk in gambling, even if the game were not rigged and the stakes were high, if the participant has no preference for winning or losing. Taking these three aspects of risk together means that risk is a representation of potential negative deviations in any variable or set of variables representing what human beings value (y) from its preferred expected development over time (Figure 5), making risk analysis into the practise of structuring unwanted scenarios, risk scenarios, and compare them against the preferred expected scenario.

The notion of risk depends, in other words, on values and preference, is socially constructed and does not exist ontologically (Slovic 1992:119; Renn 2008:2-3; Aven & Renn 2009a:8-10). However, what does exist ontologically is the complex combination of events and their underlying processes that determine what actually happens (Aven & Renn 2009a:8-10). The actual course of events that produce consequences that human beings experience, interpret and include when making sense of the present as well as structuring scenarios for envisaging the future. These direct or indirect experiences create a link between risk as a social construction and reality (Renn 2008:2), making it vital not to mix ontology and epistemology (Rosa 2010), since these are entirely different philosophical assumptions.

The realist ontology presented in Chapter *3.1 Philosophical assumptions* does not require the epistemological realism of viewing risk as real and objective (Slovic 1992:119; Kunreuther & Slovic 1996:119; Renn 2008:2-3; Aven & Renn 2009a). Nor does the social-constructivist epistemology require an ontological constructivism that reduces risk to only subjective issues of power and interest (Renn 2008:3; Aven & Renn 2009a:9). Instead, the ontology and epistemology presented in this thesis form a philosophical foundation for highlighting this link between risk, as socially constructed, and the real world. It is important to note that all human beings take part in experiencing and interpreting the world, making the social construction of risk rooted equally in science and in public values and preferences (MacGregor & Slovic 2000:49; Renn 2008:3-4; Aven & Renn 2009a:8-9).

This conceptual approach to development, sustainable development and risk indicates that all three concepts are essentially connected to each other. Facilitating sustainable development entails purposeful human activity to make sure that any potential deviation from the preferred expected development scenario is avoided or minimised. Anticipating potential deviations, or risk scenarios, is therefore vital for managing risk. Hence, analysing risk is a requisite for sustainable development (Haimes 2004:101-106).

Since analysing risk, according to this approach, is the practise of structuring risk scenarios and comparing them with the preferred expected scenario, a risk analysis is the answer to three questions (Kaplan & Garrick 1981:13): (1) What can happen?; (2) How likely is it to happen?; and (3) If it happens, what are the consequences? Answering these questions, often referred to as "set of triplets" (Kaplan & Garrick 1981; Kaplan 1997; Kaplan *et al.* 2001) or "risk triplets" (Kaplan 1982; Garrick 2002), entails a systematic analysis of what human beings value, the initiating events that can have a negative impact on those valued elements, and how susceptible they are to the impact the initiating events.

3.2.2. Values and what is expressed as valuable

Values may be seen as "desirable trans-situational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" (Schwartz 1994:21). In other words, values are what people care about (Keeney 1992:3). To grasp what human beings value in relation to analysing risk, it is important to understand how values come to be ascribed to whatever is declared to have value.

"No man is an island, entire or itself" (Donne 1624:415). This timeworn quote by a 17-century English poet indicates that human beings are social beings, functioning together in society. Giddens takes this idea further by stating that how human beings experience their social context influence how they perceive and understand it, and therefore also how they will act in that social context (Giddens 1984). These actions in turn produce and reproduce social structures, which guide and restrict the actions human beings may take (*ibid.*:25-26).

Human actions are thus fundamentally linked to social structures, which are representations of established patterns of behaviour and have the purpose of keeping order while coordinating stable activities (Hardcastle *et al.* 2005:224). What human beings value is, in other words, socially constructed in context, where prolonged human action creates social structures that direct human beings in what value to ascribe to objects. It is however rare that society is totally homogenous, granting room for individual variation as there may be several social structures competing for dominance. Indicating that the more heterogeneous the society, the more individual variation is possible in what human beings value. Values may thus be seen as acquired "both through socialization to dominant group values and through the unique learning experience of individuals" (Schwartz 1994:21).

Values are notoriously difficult to measure (Slovic 1995:369) and the methods used are predisposed to biases (Payne *et al.* 1992:121-122; Hassel *et al.* 2009:36-37) regardless of the assumptions upon which the value elicitation is based (Fischhoff 1991). However, for the purpose of analysing risk it is not the values themselves that we need to elicit, but what human beings express as valuable and as important to protect.

In order to understand what people express in particular contexts, it is important to consider that "we can know more than we can tell" (Polanyi 1966/1997:136). What people know can be divided into explicit knowledge and tacit knowledge (Nonaka 1994:16). Explicit knowledge consists of concepts, information and insights that are possible to specify, store and directly transmit to others (Connell *et al.* 2003:141). Tacit knowledge, on the other hand, is not directly transmittable and consists of knowledge that makes up our mental models for creating meaning to our experiences, as well as our know-how and skills to apply in specific contexts (Polanyi 1967; Nonaka 1994:16; Polanyi 1966/1997:139-140). Explicit and tacit knowledge are, however, closely connected, as "explicit knowledge must rely on being tacitly understood and applied" (Polanyi 1966:7).

Tacit knowledge is comprised of subsidiary awareness and focal awareness, where the phenomenon in our focal awareness is made identifiable to us by subconsciously assembled clues in our subsidiary

awareness which are not identifiable in isolation (*ibid.*:2-7). An example of this is the psychiatrist showing his students a patient having a seizure. After letting the students discuss if it was an epileptic or a hystero-epileptic seizure, he settles the argument by stating "you have seen a true epileptic seizure. I cannot tell you how to recognize it; you will learn this by more extensive experience" (Polanyi 1961:458). The statement that the seizure was a true epileptic seizure is possible to transmit across to the classroom and is an example of explicit knowledge. The knowledge that the psychiatrist uses for diagnosing the patient is, however, tacit knowledge and is less straightforward to share with the students. It is then only the diagnose itself that is in his focal awareness and accessible to him, as he is only subsidiary aware of each of the many clues and indicators that he more or less subconsciously had observed.

What is in our focal awareness is not only determined by individual characteristics, knowledge, etc, but is constantly changing depending on context. Each situation gives us a sense of what is relevant for what we are doing. Our experience of similar situations, our idea of what the situation calls for or demands, our sense of aim or direction, etc, all combine in supplying us with this "relevance structure" (Marton & Booth 1997:143). What we have talked about recently, what roles the people around us have, what goals we think they have, etc, are thus crucial for how we understand, interpret and remember incoming information. These mental structures or processes are referred to in cognitive science as "schemata" and are constantly amendable (Bartlett 1932/1995:208). The current schemata of an individual guide her interpretation of the incoming situation as well as her expectations of, and attention to, it (Boland *et al.* 2001:394). Our tacit knowledge comprises, in other words, a part of our schemata (Nonaka 1994:16). Another closely-related cognitive tool that we utilise to get by in our complex world is called "script". Scripts are cognitive chains of expectations of actions and effects in particular situations (Schank & Abelson 1977; Abelson 1981), which assist individuals in their reaction in those situations without focusing much of their focal awareness on their actions. A main function of schemata and scripts is to facilitate

coherence in our perception and experience of a situation by filling in gaps in the actual information available.

What stakeholders consider valuable and important to protect is usually not explicitly stated when analysing risk, but instead relies on an implicit assumption that all stakeholders agree on this issue (Nilsson & Becker 2009). The theoretical framework presented makes such assumptions appear dubious at best and flawed at worst. Paper II and III investigate further the validity of such assumptions.

To summarise, what individuals express as valuable in any given situation is socially constructed in context, and is determined by their values and by what they have in their focal awareness at that time. This takes into account the functions of their current schemata and scripts, and it indicates that human beings construct their own mental models of reality through active selection and interpretation of information around them (Vennix 2001:14). It may then be argued that it is of no use to discuss what is valuable and important to protect, as each account is destined to be subjective and fragmented. However, explicit dialogue may facilitate the integration of individual mental models, each of which giving a limited perspective on the world, into one shared model, which is vital for creating a common understanding of the challenge at hand (*ibid.*). It is probably true that each individual account is unlikely to give a complete picture of what is considered valuable on their own. But it is likely, in a dialogue between several individuals, that what is mentioned triggers additional scripts and amends schemata, thus activating additional knowledge by moving it from their subsidiary awareness to their focal awareness. What the group comes up with is however also highly contextual, but it is still likely to be a richer picture than the sum of each individual account. And more importantly, it is their common picture of what is valuable, making it achievable for the stakeholders involved to formulate and pursue common goals when analysing risk. Without such an explicit common picture, there is a grave danger that the stakeholders might unwittingly impede each others' work by focusing on protecting different things, e.g. the ministry of agriculture focusing on securing state revenues by promoting the production of cash

crops, while the Red Cross Society might focus on working to reduce the risk of famine by increasing diversity of food crops.

3.2.3. Expanding risk scenario space

The more common contemporary approach to analyse risk starts with identifying and selecting a set of hazards (Coppola 2007:31). Establishing the initiating events that can have a negative impact is important but generally subjective, as it is determined by human beings' values and perceptions of risk. Various demographical factors have been identified as influencing risk perception (Slovic 1987:281; Flynn *et al.* 1994; e.g. Bontempo *et al.* 1997; Sjöberg 1998:86-87; Hermand *et al.* 1999; Fordham 2000; Sjöberg 2000:7-8; Johnson 2004:111; Lam 2005; Armaş 2006; Chauvin *et al.* 2007), but how these differences influence the way hazards are ranked has not been as well researched. Paper IV investigates this further.

This crucial step of identifying and selecting a set of hazards is sometimes referred to as hazard analysis (e.g. Coppola 2007:34-39) and is aimed at establishing necessary spatial, temporal and magnitudinal aspects of each initiating event included in our risk analysis. A clear definition of the location and spatial extent of each initiating event, its speed of onset and duration, its magnitude or intensity, as well as its frequency or likelihood are requisites for this part of the analysis (*ibid.*:31-39). The more specifically each initiating event is defined, the easier it is to construct risk scenarios. That said, it is impossible to include all possible initiating events in a risk analysis, which calls for categorising such events and allowing one specific initiating event to represent a number of them. This is referred to as partitioning the risk scenario space (Kaplan *et al.* 2001:810-811).

Having identified a relevant initiating event, it is important to analyse the factors that contribute to it, as these may be connected to, and amplified by, processes related to human activity (e.g. Hewitt 1983:25; Kates *et al.* 1990; Renn 2008:5). Examples of such connections are mining and pollution, logging and flash floods, irrigation for agriculture and sinkholes, etc. It is also important to note that a specific initiating

event can impact on contributing factors for other initiating events, e.g. earthquakes or heavy rain may trigger landslides.

Given that sustainable development demands the capacity for managing a wide range of risks (Haimes 1992:415; Haimes 2004:101-106), it is vital to include a wide range of initiating events in the analysis. More dramatic, and often sudden, initiating events may give rise to highly destructive courses of events, often referred to as catastrophes (Scawthorne 2000; Freeman *et al.* 2002; Perrow 2008), disasters (Campbell 1990; Coppola 2007; Fordham 2007) or emergencies (Hernandez & Serrano 2001; Condorelli & Mussumeci 2010; Korf 2010). Most scholars use these terms more or less synonymously or to signify quantitative differences in scale, while others assign qualitatively different meanings to them (Quarantelli 2000). Regardless of label, these are well understood as posing major threats to sustainable development[1] (Humphreys & Varshney 2004; UNDP 2004:9-27; Sachs 2005; Schipper & Pelling 2006:20; Fordham 2007:339-340; Becker 2009:12).

Our predisposition for the spectacular, however, should not make us forget the many smaller courses of events, which on their own might seem relatively trivial, but whose cumulative impact on society in many ways vastly surpasses the few and dramatic. For instance, in 2004, the Indian Ocean tsunami raised the total global death toll in disasters to around 250,000[2] people (CRED 2010), while armed conflict directly killed more than 180,000 people (WHO 2008:58). This is obviously terrible enough, but consider then that it is estimated that almost 900.000 people died from malaria, 1.2 million in road traffic accidents, 1.5 million from tuberculosis, 2 million from HIV/AIDS and 2.2 million from diarrhoeal diseases that same year (*ibid.*:54-58). Still, these horrific numbers do not even come close to the top three global causes of death in 2004, namely, lower respiratory infections (4.2 million), cerebrovascular disease (5.7 million), and ischaemic heart disease (7.2

[1] Less acknowledged is that such scenarios may be beneficial to development for some groups in society, e.g. women or previously marginalised ethnic groups, as they may increase access to vital resources for short or long term (Delaney & Shrader 2000; Enarson 2000; Bradshaw 2002).
[2] EM-DAT: The international disaster database (www.emdat.be), search for the total number of deaths in all countries and all disaster types for 2004.

million) (*ibid.*:54-58). All such less significant courses of events may impact on what human beings value like water drops eroding stone. It is thus vital to be prepared to expand the risk scenario space when analysing risk for sustainable development.

3.2.4. The susceptibility of impact

Simon (2002) states that "[t]he reading of history persuades me that the most dangerous villains we will encounter along the way will rarely be the forces of nature". Regardless of whether an initiating event derives from natural, technological or antagonistic processes, it will not result in unwanted consequences unless it occurs in a conducive setting (Wisner *et al.* 2004:3-16). Such a setting is one determined by factors from all spheres of society (ISDR 2004:16; Wisner *et al.* 2004:49-84; Bolin 2007:114-129; Coppola 2007:146-161), and is primarily a result of human activity (Hewitt 1983:24-29; Oliver-Smith 1999). This further explains the idea, forcefully put forward already in the mid 1980s by Wijkman and Timberlake (1984), that most disasters stem from unresolved development issues[1]. Destructive courses of events, set off by any type of initiating event, are therefore not discrete, unfortunate and detached from ordinary societal processes, but are intrinsic products of everyday human-environment relations over time (Hewitt 1983:25; Hearn Morrow 1999; Oliver-Smith 1999; Ariyabandu & Wickramasinghe 2003:33-37; Fordham 2007:338-339; IRP 2007:10).

This susceptibility to harm is often referred to as vulnerability[2], and is never a general attribute, but must always be defined in relation to the impact of a specific initiating event (Blaikie *et al.* 1994:9-10; Salter 1997:61-62; Dilley & Boudreau 2001:232; Hollenstein *et al.*2002; Twigg 2004:13; Wisner *et al.*2004:11-13; Gallopín 2006:294; Aven 2007:747; Coppola 2007:146-149; Johansson *et al.* 2007:6; Jönsson 2007:61-63; Cannon 2008:351; Aven & Renn 2009b:588-589).

[1] An idea that later has been emphasised by many (Stephenson 1994; Yodmani 2001; UNDP 2004:9-10; Shultz *et al.* 2005; Schipper & Pelling 2006; Fordham 2007:338). However, Wisner(2001) reminds us of the importance, when considering connections between development and disasters, of specifying what development we have in mind.

[2] O'Keefe, Westgate and Wisner (1976) introduced the concept of vulnerability to risk and disaster-related research in the mid-1970s.

However, vulnerability is not only associated with potential consequences, but also with uncertainties in determining these consequences (Aven 2007:747; Aven & Renn 2009b:589). Such uncertainties multiply the potential risk scenarios, making a vulnerability analysis into the answer to three questions: (1) What can happen, given a specific initiating event?, (2) How likely is that to happen, given that initiating event?, and (3) If it happens, what are the consequences? (Jönsson 2007:63; Hassel 2010:35).

When analysing vulnerability it becomes clear that it is not only structural issues, in the sense of a complex combination of physical and environmental, social and cultural, political and economical factors, that determines susceptibility to harm. Human agency also plays a vital role (Renn 2008:xiii), as purposeful human activity influences the answers to the three questions. This might be directly, through reactive activities that influence the course of events in a specific risk scenario (Jönsson 2007:81; Jönsson *et al.* 2007), e.g. recognising the need to evacuate before flood waters reach a critical level, the actual evacuation to safer grounds, rapid salvation of damaged food crops, or indirectly, by proactive activities influencing what risk scenarios are feasible altogether, e.g. constructing permanent levees to protect settlements from flood water, awareness-raising campaigns clarifying when and where to evacuate in case of flood, analysing risk to inform the location of temporary shelter. It is thus important to include the capabilities of individuals and organisations to take actions in the risk scenario to limit the impact.

Although activities with more indirect influence on risk scenarios are vital for managing risk to facilitate sustainable development, they are, to a large extent, already set at the beginning of the time period that we want to analyse and are thus less feasible to incorporate directly when analysing risk. This is not at all to say that analysing and reducing risk, as well as preparing for effective response and recovery, only takes part before an initiating event has triggered some destructive course of events. On the contrary, these activities must be ongoing even in the midst of calamity to protect what human beings value.

While capability and capacity may be considered synonymous in a purely linguistic sense, they are used deliberately in this thesis to separate capabilities to act in and influence specific risk scenarios from other capacities relevant for managing risk in general. Analysing capability is the answer to three questions (*ibid.*:7): (1) What can happen when an actor is performing a specific activity, given a specific scenario?, (2) How likely is that to happen?, and (3) If it happens, what are the consequences?

3.2.5. Participants in analysing risk for sustainable development

Managing risk for sustainable development requires the involvement of various stakeholders (Haimes 1998:104; Renn 2008:8-9; Renn & Schweizer 2009). The complexity of risk in this context requires the integrated knowledge and effort of stakeholders from most functional sectors and all administrative levels of society. Unfortunately, efforts to manage risk and development losses have had a tendency in the past to reduce the problem into parts that fit functional sectors and organisational mandates[1] (Fordham 2007). This is likely to represent a major weakness as it clouds the bigger picture of risk (Hale & Heijer 2006:139). However, there is a deficiency of research into what general challenges may arise if one focuses on individual functional sectors or administrative levels in isolation. Paper I and Paper V investigate these issues further.

Managing risk for sustainable development is thus not about dividing the issue into parts that fit the agenda or mandate of specific stakeholders, but rather is about grasping the dynamics and non-linear interdependencies in the complex system of factors determining risk (Hollnagel 2006:14-17). Geographical borders are also complicating factors, as their delimitations are geopolitical, impeding collaboration between stakeholders to various degrees, but rarely limiting the geographical spread of calamity. Analysing risk for sustainable development therefore requires the participation of various stakeholders across functional, administrative and geographical borders.

[1] As well as academic disciplines.

There has also been prolonged debate on whether it should be up to the public to decide about matters concerning risk or if this should be the sole domain of experts (e.g. Cole & Withey 1981; Slovic *et al.* 1982; Slovic 1987; Keren 1992; Shanteau 1992; Rowe & Wright 2001; Sjöberg 2001). Much of this debate has the appearance of a clash between two seemingly incompatible positions. However, influential accounts present a persuasive alternative way forward, arguing for the need for as broad participation as possible, from experts, the public, decision makers, and other stakeholders (Fischhoff *et al.* 1982; Renn 2001). According to this view, it is not only formal expertise that is vital, as the educated common sense of other stakeholders can be rather effective in this process and render some degree of moral force and political influence to the results (Ravetz 1999:651). Vickers (1968) takes this even further when claiming that:

> *"Over many decades, things which used to be regarded as "acts of God" - war, famine, pestilence; or as part of the nature of things - crime, destitution, ignorance, have come to be regarded as controllable and are hence assumed to be somebody's responsibility. They can all be "fixed"; it is just a matter of know-how. It is true and welcome that the degree of our control is slowly extending but the assumptions based on this extension are false and dangerous. Not everything can be fixed; and fixing is never just know-how. It is always decision, made at the cost of not fixing something else. Until both governors and governed have a common and realistic view of what can be controlled and how far and at what cost, the relations between them are bound to be disturbed; and these disturbances may be as dangerous to the system as any"*

It is, in other words, not only for reasons of effectiveness that analysing risk for sustainable development necessitates a wide participation of stakeholders, but also for pre-empting public discontent by distributing responsibility and facilitating realistic expectations. Public discontent that seems to be increasing in the wake of recent examples of calamity (Renn 2008:1).

As a result of the complexity of risk and of the functional, administrative and geographical disjointedness of stakeholders, multiple risk analyses are often performed, with various purposes and by various stakeholders. For instance, there may be several municipal risk analyses and a detailed risk analysis of a chemical plant in a province, all with different purposes

and based on different assumptions, which the provincial administration needs to combine to make an overall analysis of risk for their jurisdiction. Hence, analysing risk for sustainable development requires ability to integrate the results of several risk analyses performed by different groups of stakeholders.

3.2.6. The world represented as a human-environment system

The five preceding sections all emphasise from different perspectives that risk and analysing risk for sustainable development are complex issues. This is however not the only area in which complexity constitutes a daunting challenge for scientific inquiry. Living organisms, the brain, culture, society, climate, and ecosystems are only a few examples, all with something in common. Living organisms are made up of the complex interaction of myriads of cells, the brain is a vast network of neurons transmitting signals, society is made up of individuals and organisations, etc. In short, they can all be approached as wholes made up by complex sets of parts[1]. In attempts to manage and learn from this complexity, some scholars find it helpful to look at the entity under study as a system, as did von Bertalanffy (1960) in regarding the living organism, Ashby (1960) in regarding the brain and Buckley (1968) in regarding society. These approaches, so-called systems approaches[2], span various disciplines, all having "a particular set of ideas, systems ideas, in trying to understand the world's complexity" (Checkland 1999:3). A system is here defined as "a group of interacting, interrelated, or interdependent elements forming a complex whole" (American Heritage Dictionary 2000).

As indicated in earlier sections, risk is determined by structural factors from all spheres of society, as well as by human agency. However, it is not only the multifarious nature of conducive factors that make risk complex, but the intricate relations between these factors (Turner *et al.*

[1] Even Franz Boas (1927) argues in his now classical anthropological writings that culture cannot be reduced into parts but must be studied as a whole or as a system of many interrelated parts.

[2] E.g. General Systems Theory (e.g. von Bertalanffy 1968), System Dynamics (e.g. Forrester 1969), Systems Thinking (e.g. Checkland 1999; Senge 2006), Cybernetics (Rosenblueth *et al.* 1943; e.g. Ashby 1957) etc.

2003a). This is indicated by the influential Pressure and Release (PAR) model (Wisner *et al.* 2004:51), and highlighted by the productive research community around the recurring *Symposium on Resilience Engineering* (e.g. Dekker 2006; Hollnagel 2006; Leveson *et al.* 2006; Hollnagel 2009; Woods *et al.* 2009).

Destructive courses of events that threaten sustainable development are, in this view, not results of linear chains of events, like dominos falling on each other (Hollnagel 2006:10-12), but are instead non-linear phenomena that emerge within complex systems themselves (Perrow 1999a; Hollnagel 2006:12). They thus limit the effectiveness of frameworks for analysing risk that focus on linear combinations of discrete events, since they fail to represent risk sufficiently by their ignoring of complexity (Hollnagel 2009:125-127), and by indicating that frameworks for analysing risk in more complex contexts must be systemic in the sense of relating to a system, as opposed to particular elements. Ignoring interdependencies may not only result in inadequate representations of risk. Paper I investigates the other negative results that may arise in general from focusing on specific elements without acknowledging interdependencies between elements.

The PAR model is not only instrumental in illustrating how various factors interact to create unsafe conditions, but also in emphasising that risk emerge in the intersection between the social and the environmental. Renn (2008) takes this relation further and states that risk is largely a by-product of how human beings transform the natural environment into a cultural environment for the purpose of serving human needs and wants. Such a transformation has brought about immense changes in the world over the last 300 years, and continues to do so at an ever-increasing pace (*The Earth as transformed by human action,* 1990). It is in this nexus of the social and the environmental that sustainability science has risen to address the core challenges of humankind (Kates *et al.* 2001; Clark & Dickson 2003; Olsson & Jerneck 2010). This is done by increasing our understanding of the complex and dynamic character of our world and by supporting the capacity of society to guide its development through avoiding or minimising deviations from its preferred and sustainable future (Kates *et*

al. 2001). One way of managing this complexity and dynamic character is to approach our world as a complex human-environment system (Turner *et al.* 2003a; Turner *et al.* 2003b; e.g. An *et al.* 2005; Haque & Etkin 2007; Metzger *et al.* 2008; Reenberg *et al.* 2008) and to view both the risks of, as well as the actual destructive courses of events, as rooted in the same complex human-environment system that supplies human beings with opportunities (Haque & Etkin 2007).

In order to facilitate the much-needed shift towards sustainable development, sustainability science states that we must be able to: (1) span the range of spatial scales of various phenomena; (2) account for both urgency and temporal inertia; (3) manage functional complexity; and (4) recognise a wide range of perspectives as usable knowledge from both society and science (Kates *et al.* 2001:641; Ness *et al.* 2010:479).

The five preceding sections stress that analysing risk is about structuring risk scenarios based on explicit information regarding what human beings value, on the events that can have a negative impact on that, and on how susceptible that is to the impact of each event[1]. In order to be able to do that in this complex setting, we need to construct a model of the world (Conant & Ashby 1970), i.e. a human-environment system. Any framework for analysing risk for sustainable development should therefore be systemic.

3.2.7. Constructing human-environment systems

There are many ways to construct human-environment systems. Jackson (2003) specifies four incremental methods for modelling systems: (1) causal loop diagramming; (2) system archetypes; (3) stock-and-flow diagramming; and (4) microworlds. The two former are qualitative and the two latter are quantitative.

The basic building blocks for constructing a human-environment system are elements and directional relations between elements that can be

[1] Including the capabilities that are available in a particular scenario to limit the impact of the event

either positive or negative[1] (Maani & Cavana 2000:26-27; Boardman & Sauser 2008:67). These relations cause a change in one element to spread to associated elements, creating a branching chain of causal relations through which any impact on the system could propagate to distant parts of it (Rinaldi *et al.* 2001; Hollenstein *et al.* 2002:56-61; OECD 2003:44-45; Jiang & Haimes 2004:1215-1229; Dobson *et al.* 2007). The propagation of a change between each pair of elements may be immediate or delayed to various degrees, making the time period over which to analyse risk important, as the timescale of appearance of adverse effects is important when linking risk to sustainable development (Renn 2007:15). These delays, often indicated by two parallel lines crossing the relations (Figure 6), are also major contributors to the complexity of the system (Maani & Cavana 2000:33; Senge 2006:88-91). It is therefore not only the number of elements that determine complexity, often referred to as detail complexity (Senge 2006:71), but also the relations between elements (Yates 1978:R201; Flood 1987:180). This leads to what Senge (2006) refers to as dynamic complexity by the separation of cause and effect in both space and time.

The chains of causal relations sometimes create loops, causal loops, feeding back the propagating changes to elements earlier in the chains (Figure 6) (Ashby 1957:53-54; Maruyama 1963/1963; Maani & Cavana 2000:28; Senge 2006:73-79; Boardman & Sauser 2008:67). Such causal loops are prevalent in our world (Senge 2006) and are yet another source of complexity (Yates 1978:R201; Flood 1987:180), as they give rise to nonlinear dynamics.

These causal loops can be either reinforcing, i.e. resulting in either continuous growth or to a decline in the element of interest, or balancing, i.e. resulting in stability, through dampening or negating changes in the element or in meeting a set target (Maani & Cavana 2000:28-33; Senge 2006:79-88). It is however important to note that growth, decline and stability may all be positive or negative depending

[1] A positive relationship means that a change in one element leads to a change in the same direction for the associated element, while a negative relationship means that a change in one leads to an opposite change in the other (Leveson *et al.* 2006:107-108).

on values and perception. Balancing loops that drive systems to meet set targets for specific elements are rather easy to identify, as they attempt to reduce gaps between the actual and the desired state of the elements in question (Senge 2006:83-88). However, balancing loops without such explicit targets are not always as intuitively obvious to distinguish from reinforcing loops, as this distinction depends on which element one focuses on. For example, if one focuses on the element marked by "α" in Figure 6, any change in "α" will continuously reinforce itself since the change propagating from "α" has the same polarity as the subsequent change coming in to "α" (Maani & Cavana 2000:32). If one focuses on the element marked by "Ω", on the other hand, any change in "Ω" will be dampened as the change propagating from "Ω" has an opposite polarity to the subsequent change coming in (*ibid.*).

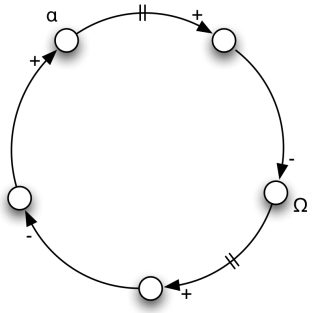

Figure 6. A causal loop of elements, directional relations and delays.

When constructing qualitative models using causal loop diagramming, for which the output is a more or less complex system of causal loops, it is at times possible to identify systems archetypes. A systems archetype in this case is a set of elements and relations that can be generalised and used in analysing systems behaviour or in guiding the construction of the human-environment system. In constructing quantitative models, on the other hand, key elements and relations are transformed into what are referred to as stocks and flows[1], but are still part of the causal loops (Figure 7) (Forrester 1994). A stock in this context is some variable that

[1] Or levels and rates (Forrester 1994).

is increased or decreased over time, and a flow (inflow or outflow) is what changes a stock over time. Thus, the name stock-and-flow diagramming.

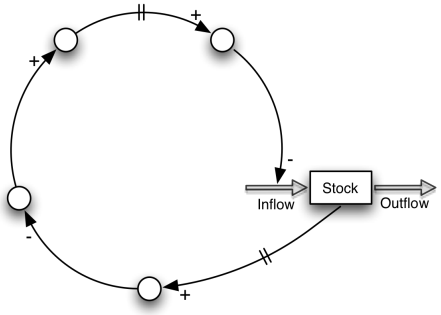

Figure 7. A causal loop including a stock and flows.

Once a quantitative model has been developed, it can be extended into a microworld by providing an interactive and user-friendly interface for users to experiment with the model (Wolstenholme 1999; Cavana & Maani 2000). In complex systems, it may be challenging to mathematically model all the relationships between the elements that appear on the surface to be involved in what the system does. However, it is still possible to "determine the most important structural aspects that lie behind system viability and performance" (Jackson 2003:21). This means that qualitative methods can also elicit information on both structural and functional aspects for the human-environment system, which is central for analysing risk in this context.

3.2.8. Wholeness, hierarchy and multiplicity of descriptions

The challenge when building a human-environment system for enabling the construction of risk scenarios is to find a balance between including enough information to sufficiently capture the complexity of the context of the analysis as a whole (referred to as the principle of wholeness) while limiting it to include only what is relevant in light of the purpose of the analysis and the resources available. Section 3.1.4 in Chapter *3.1 Philosophical assumptions* presents the principles behind finding such a balance. In short, the primary issue for making boundary judgements is

relevance to what we address and to what we want to accomplish (Simon 1990:7-13).

Parts of the world that are not directly a part of the human-environment system, but still influence or are influenced by it to a degree deemed relevant, may be referred to as belonging to the surrounding of the system (Ingelstam 2002:19). What distinguishes these elements in the surrounding from the elements within the system itself is that it is only their transboundary relations with the system that are of interest, and not the relations amongst themselves. For instance, it may be relevant to include how changing global weather patterns may impact floods in our municipality, but it is probably not relevant to include the global causal factors of climate change into the municipal risk analysis. In short, it is the purpose of our analysis and the resources available that determine how the human-environment system is demarcated. However, all elements on the outside that influence it to a degree deemed relevant for the functioning of the system, in light of the purpose and available resources, should be included.

Because building a human-environment system to facilitate the structuring of risk scenarios is likely to result in a web of elements and relations that is complex and essentially impossible to grasp, it is necessary here to introduce the principle of hierarchy. This principle states that human-environment systems are hierarchical in the sense that the system of interest is part of a system on a higher level and is made up of systems on a lower level (Simon 1962:468; Simon 1996:184; Blanchard & Fabrycky 2006:5). Most systems in our world are of this type (Simon 1962:477-482; Simon 1996:186-188). This hierarchy plays a vital role in assisting the management of complexity as it makes it possible to simplify the system by aggregating sets of interdependent elements into subsystems (Simon 1962:473-477; Simon 1990:12; Simon 1996:197-204). This enables us to describe and explain the behaviour of an element/subsystem at any particular level with no need for a detailed representation of, and with only moderate concern for, the structures and behaviour on the levels above and below (Simon 1990:12).

In addition to the principles of wholeness and hierarchy, large complex systems require a third principle when building our human-environment system; the principle of multiplicity of descriptions (Blauberg *et al.* 1977:132). This principle states that to represent sufficiently any large and complex part of our world requires constructing a range of different descriptions, each of which only covers certain aspects of the wholeness and hierarchy of the human-environment system. The principle of multiplicity of descriptions becomes particularly important since analysing risk for sustainable development entails involving a wide range of stakeholders and often integrating various risk analyses. This requires the human-environment system to be explicit, since effective collaboration depends on having a shared vision of what to accomplish together (Jackson 2003:22; Senge 2006:187-197).

Hierarchical Holographic Modeling (HHM) builds on the idea of this third principle and supplies a basic framework for understanding complex systems. This is done by merging these complementary descriptions into one multidimensional picture (Haimes 1981; Haimes & Li 1991; Haimes *et al.* 1995; Haimes 1998; Haimes 2001; Lambert *et al.* 2001; Jiang & Haimes2004; Haimes 2004; Lian & Haimes 2006). However, HHM focuses on multi-objective settings in which many stakeholders may vary but a number of them are kept constant. This is unlikely to be the case in the wider context of analysing risk for sustainable development, which complicates things even further.

3.2.9. Risk- and vulnerability analysis as sustainability science tools

An interesting survey of tools for analysing sustainability issues presents its most complex category, called integrated assessment tools, as tools used for supporting decisions related to a project or policy in a specific location (Ness *et al.* 2007:503-505). These integrated assessment tools include conceptual modelling and systems dynamics; multi-criteria analysis; risk analysis and uncertainty analysis; cost-benefit analysis; and environmental impact assessment[1]. These are all established categories of tools used for different purposes and often by different groups of

[1] Impact assessment in original.

stakeholders, but with large overlaps opening up for further categorisation.

Ness *et al.* (2007) indicate the first overlap themselves when stating that many of the six categories of integrated assessment tools are based on systems approaches. In the context of sustainability science, all applications of these categories of tools must be able to integrate relations between elements in human-environment systems. Conceptual modelling and systems dynamics may, in this context, thus be viewed as an integrated part of the other five categories and not as a stand-alone category of tools for integrated assessment.

Ness *et al.* (2007) also state that in the context of sustainability science, the categories of integrated assessment tools have an ex ante focus on supporting decisions that have impacts on the future. Assuming that there are uncertainties in what may happen in the future and that these uncertainties, at least to some extent, are included in the analyses, the decision situation becomes limited to decisions under uncertainty based on one criterion or multiple criteria (Keeney & Raïffa 1976). The three questions to answer when analysing risk[1] or when analysing vulnerability[2] indicate that risk is uncertainty about what could happen and what the consequences would be (Aven 2007:747; Aven & Renn 2009a; Aven & Renn 2009b:588). On the other hand, vulnerability is uncertainty about what could happen and what the consequences would be, given a specific initiating event (Aven 2007:747). Both risk and vulnerability analysis may focus on one or several variables that human beings value, resulting in two main categories of tools for integrated assessment: (1) risk analysis, also covering multi-criteria analysis and cost benefit analysis; and (2) vulnerability analysis, also covering environmental impact assessment.

[1] (1) What can happen?, (2) How likely is that to happen?, and (3) If it happens, what are the consequences? (Kaplan & Garrick1981:13).

[2] (1) What can happen, given a specific initiating event?, (2) How likely is that to happen, given that initiating event?, and (3) If it happens, what are the consequences? (Jönsson 2007:63; Hassel 2010:35).

Hence, given that uncertainties are involved to some extent in multi-criteria analyses, these tools can be viewed as risk analyses focusing on more than one variable representing what human beings value. Cost benefit analyses can also, under these circumstances, be considered a special case of multi-criteria risk analysis, as they, by definition, entail at least one selected variable and another variable representing the cost of implementing different activities somehow influencing the selected variable(s). Similarly, environmental impact assessment may be seen as a special case of vulnerability analysis, where the initiating event not only is clearly defined but also controlled by purposeful human activity. Consequently, different types of systemic risk analyses and vulnerability analyses could be viewed as the two main categories of tools for ex ante assessments to support decisions related to sustainable development. There are several examples of sustainability science approaches to vulnerability analysis (e.g. Turner *et al.* 2003a; Turner *et al.* 2003b; O'Brien *et al.* 2009b), but this thesis attempts only to supply justifications for key requirements for sustainability science approaches to analysing risk.

4. Methodological issues

"How does one determine scientifically what science is?" – Bent Flyvbjerg (2001)

4.1. The sciences of the complemental

The philosophical assumptions presented in Section *3.1.3 Axiological assumptions* portray traditional science and design science as different in their relation to values. This difference is however neither unambiguous nor pitting the two against each other. Even if traditional science demands the pursuit of the unreachable vision of value-neutrality in the production of knowledge about how the world is, its relevance can only be judged in relation to normative values. This relevance generally refers to the utility of the scientific knowledge for solving problems affecting humankind, even if traditional science is mostly satisfied by simply assuming that the knowledge produced will be used at some point in the future (Lee 2007:44). Describing how the world is, however, is not appropriate for solving problems on its own, as that entails normative statements about how the world ought to be. Design science, on the other hand, is equipped for solving problems (Simon 1996), but not for describing how the world is, which also is necessary for defining the problem and for anticipating the results of potential activities (Ness *et al.* 2010:479). It is important to note that problem-solving can also be scientifically rigorous, even if based on principles other than traditional science (Checkland & Holwell 2007:3-4). Traditional science and design science are thus complementary parts in facilitating sustainable development (Figure 8).

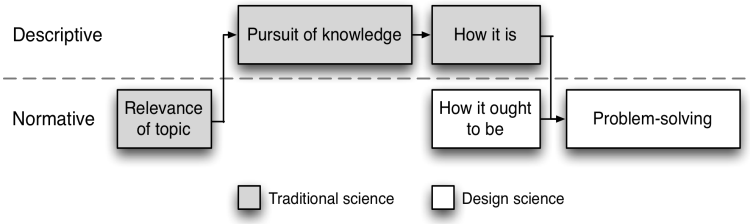

Figure 8. Traditional science and design science as complementary.

Solving problems entails changing something from a current state, that at least one human being perceives as unsatisfactory, to a desired state (Ackoff 1962:30). This signifies intentional and purposeful activities to change the world to suit human purposes (Wieringa 2009:1). However, the changes that human agency can cause in the world are limited to what our activities can influence[1]. Purposeful products of intentional human activities are referred to as artefact (Hilpinen 1993) and it is through designing and utilising these artefacts that human beings shape their present and as well as their future (Simon 1996). Artefacts that can be either physical (tools, constructions, etc) or conceptual (symbols, methods, etc) (Hilpinen 1993; Simon 1996).

Building on Rasmussen's (1985) work on functional hierarchy, Brehmer (2007) suggests that every artefact has purpose, function and form. The purpose answers the question why the artefact exists, the function what it must do to meet that purpose, and the form how the function is fulfilled in the real world (Brehmer 2007:212-214; Brehmer 2008:5-6; Brehmer 2009:2-3; Brehmer 2010:4). The purpose is, in other words, the highest level of abstraction while the form is the most concrete (Rasmussen 1985). As an artefact is evaluated on the relationships between its purpose, intended character, and its actual character (Hilpinen 1995:140), evaluation means assessing how well the form fulfils the required functions to meet the purpose when utilised.

The main activities of traditional science are to theorise and justify, while the main activities of design science are to build and evaluate (March & Smith 1995). The purpose and overall research question of this thesis require both sets of activities, as design science supplies the structure for designing the framework scientifically, while traditional science informs the argumentation for the purpose and design criteria that are defined to guide the development of the framework.

4.2. The design process

Recent applications of design science in similar contexts supply us with comprehensive design processes (Abrahamsson 2009:22-24; Hassel

[1] Which according to Simon (1996) is much more than we cannot.

2010:42-47). This argues persuasively for an increase in scientific rigour in designing artefacts when applying a systematic and transparent design process in which normative assumptions regarding purpose and design criteria are explicitly stated, and the choices directed by those assumptions are justified through logical reasoning (Abrahamsson 2009:22-24; Hassel 2010:42-47). The scientific design process used in this thesis is developed from these innovative examples (Figure 9).

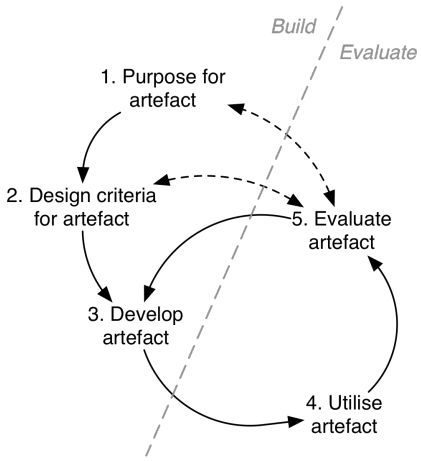

Figure 9. A scientific process for designing artefacts(developed from Abrahamsson 2009:22-24; Hassel 2010:42-47).

The first step in this process is to clearly define the purpose (or purposes) of the artefact (Simon 1990:13; Simon 1996:4-5,114; Cook & Ferris 2007:173-174; Abrahamsson 2009:22; Hassel 2010:43). This purpose is generally described in rather abstract terms and acts like an overall guiding principle for the rest of the design process (Hassel 2010:43). The second step is to define the design criteria that the artefact must meet (Abrahamsson 2009:22; Wieringa 2009:1-2). These design criteria are normative assumptions about the required function (or functions) of the artefact, which must be appropriately justified through logical reasoning informed by established theory or new empirical research (Hassel 2010:43-44). The third step of the design process is to develop the actual form of the artefact, based on our initial judgements regarding what is needed to meet the design criteria and purpose. The word develop is here used to signify that there may already

exist artefacts to improve or build upon. The fourth step is to utilise the artefact in the intended context, or in a setting that is designed to approximate that context (*ibid.*:45). Utilising the artefact in the intended context is vital, as there may be various contextual factors that influence the performance of the artefact (March & Smith 1995:254; Simon 1996:5-6). Moreover, it provides an opportunity to test theories about the context (March & Smith 1995:255). The application of the artefact can therefore cause learning that may inspire modifications in purpose and in design criteria. The fifth step of the design process is to evaluate the performance of the artefact against its design criteria and purpose. If the result of this evaluation is unsatisfactory, either the artefact must be further developed or the purpose and design criteria adjusted. Such adjustments of purpose and design criteria may be constructive if spurred by increased understanding of the context, but not if caused solely by demands to show improvement by reducing the gap between the artefact's actual and desired state (Senge 2006:107-108).

4.3. Research methodologies and methods

Both descriptive research, to further inform the justifications behind the establishment of key design criteria, and normative research, to build and evaluate initial ideas for the framework, involve scientific research methodologies and data collection methods with different strengths and weaknesses.

4.3.1. Reliability, validity and workability

The methodologies applied in the appended papers are case study research, survey research and design research. The most fundamental divide among these three methodologies is the divide between the two former and the latter. The purpose of case study research and survey research is to increase our understanding of phenomena, which makes them part of traditional science, while the purpose of design research is to develop artefacts to address problems affecting humankind, which makes it part of design science. This distinction in purpose entails differences in the principles for assessing the quality of the research.

The quality of traditional science is commonly assessed in terms of the reliability and validity of the result (Kirk & Miller 1986:20). Reliability refers to the degree of consistency of empirical results between different researchers, or by the same researcher on different occasions (Hammersley 1992:67). In other words, it refers to the degree to which these results are independent of unintentional circumstances (Kirk & Miller 1986:20). Validity, on the other hand, refers to the accuracy with which an empirical description of a particular phenomenon represents the theoretical construction that it is intended to represent and captures the relevant features of this phenomenon (Hammersley 1992:67). In other words, it refers to the degree to which the empirical results are interpreted in an adequate manner (Kirk & Miller 1986:20).

Reliability depends essentially on transparently describing the research procedures, making it possible to distinguish at least three types reliability (*ibid.*:41-42): (1) reliability as a single research method continually yielding an invariable result[1], (2) reliability as stability of a result over time[2], and (3) reliability as similarity of results within the same time period using different data[3]. The first two types of reliability are not particularly useful in assuring quality when researching complex human-environment systems. The first suffers from the fact that it allows a single flawed method to continuously generate erroneous results (Kirk & Miller 1986:41) and the second for the fact that the world is constantly changing (Dewey 1922; Keynes 1938/1994:287) and the elements and relations under study are impossible to isolate (Anderson 1999:217; Checkland & Holwell 2007:5-6). What is left is reliability in the sense of corresponding results by different research methods, which is commonly called triangulation (Webb *et al.* 1966:3; Mikkelsen 1995:31; Buckle *et al.* 2003:83; Pelling 2007:383-384; Denzin 1970/2009:297-313). Blaikie (1991; 2000:262-270), however, warns us that the use of the metaphor of triangulation often connotes naïve ontological and epistemological assumptions that it is possible to pinpoint reality by applying multiple research methods in the same way

[1] What Kirk and Miller (1986) refer to as 'quixotic reliability'.
[2] What Kirk and Miller (1986) refer to as 'diachronic reliability'.
[3] What Kirk and Miller (1986) refer to as 'synchronic reliability'.

that a surveyor pinpoints a geographical location. Although the metaphor itself is misleading, diverse data that lead to similar conclusions may still render us a little more confident as different data have different biases (Atkinson & Hammersley 2007:183). This assumes, of course, that the methods used do not share the same bias (Blaikie 2000:263).

With no direct access to reality, we cannot know for certain whether, or to what extent, a theoretical construction is valid (Hammersley 1992:69) regardless of the quantity and quality of the empirical data (Atkinson & Hammersley 2007:11). However, we must still assess the validity of such a theoretical construction in relation to the adequacy of the collected empirical data (Hammersley 1992:69). Assessments of validity are thus based on judgements about (1) the compatibility of the theoretical construction, or the empirical data supporting it, with our assumptions about the world that are presently taken to be beyond reasonable doubt[1], and/or (2) the likelihood of error, given the conditions in which the theoretical construction was made[2] (Hammersley 1992:51; Hammersley 2002:73). These are judgements whose own validity never can be established (Hammersley 1992:78). Validity is thus related to the collective judgement by the scientific community (Bernard 1995:43), which Kuhn (1970) refers to as a paradigm and Said (1978) calls "an academic-research consensus".

In short, the purpose behind the ideas of reliability and validity is to provide grounds for someone to trust the research results. This makes Ramsey's (2001) idea of a reliable process central, as it becomes vital to be transparent in how data are collected, analysed and presented in order for others to be able to assess the reliability and validity of the results. It also becomes vital to be transparent in what judgements and assumptions about the world are included in the research itself, as well as in the assessment of the quality of the research.

Although design science has a similar need to have people trust the research results, and reliability and validity do play roles here as well,

[1] What Hammersley (1992; 2002:73) refers to as plausibility.
[2] What Hammersley (1992; 2002:73) refers to as credibility.

solving problems involves an additional way of assessing the quality of the research. When the purpose of the research is to address a problem, instead of understanding a phenomenon, the quality of the results can be assessed in terms of the workability of the proposed solutions (Olsen & Lindøe 2004:372). Workability can be assessed by whether or not the proposed solution resolves the identified problem (Greenwood & Levin 2007:63-64), or, in design science terminology, whether or not the form of the artefact generates a result that fulfils the required functions, as specified in the design criteria, to meet the purpose when utilised in the intended context.

To summarise, the three research methodologies selected to meet the purpose of this thesis by answering its research question, entail different principles for assessing the quality of the research. Both the more traditional empirical studies, to inform the justifications for key design criteria for the initial version of the framework, and the process of collecting and analysing data for evaluation while utilising it in practice, involve promoting reliability and validity by ensuring transparency in process, assumptions and values. The quality of the actual framework itself is however assessed by judging its workability.

4.3.2. Statistical and analytical generalisations

The next fundamental divide among the three methodologies is the divide between survey research and the pair of case study research and design research. This divide concerns the basis for making generalisations of the theoretical constructions or solutions to problems produced through the use of the methodologies.

Although there are many data collection methodologies, called surveys, that are not quantitative (Fowler 2002:1-2; Punch 2003:1-2), survey research is commonly related to the methodology of collecting quantified data from a collection of items under consideration. This activity is usually for purposes of description or to identify causal relationships or predictive patterns of influence between variables (Sapsford 2007:3). The quantitative character of survey research may have limitations (Babbie 2007:276-277; Weisberg 2008:223-231), but it still provides a potent means for making generalisations. The use of such

a technique for providing statistical generalisations depends however on the sample (size in relation to total population, and how it was selected) and how precise one needs to be in the generalisations (significance or confidence level, and confidence interval). The result is that survey research is anything but simple. However, by carefully navigating the well-described strengths and weaknesses of the methodology, statistical generalisations can shed light on many interesting research questions.

Case study research, on the other hand, is often criticized for providing little basis for generalisations (Yin 1994:10; Flyvbjerg 2001:66). This is undoubtedly correct for statistical generalisations, as not even the best possible selection of a small number of cases would give us a compelling representation or a reliable statistical base (Stake 1998:101). Case study research is nonetheless well suited for providing analytical generalisations (Flyvbjerg 2001:73-77). The selection of cases is, in other words, not a sample of a bigger population, but more like the cases chosen for making experiments. Studying cases in this sense is like doing experiments to base the analytical generalisations on (Yin 1994:31). However, knowledge developed in one case cannot be generalised "through abstraction and loss of history and context", but may be transferred to other situations through "conscious reflection on similarities and differences between contextual features and historical factors" (Greenwood & Levin 2007:70). This fundamental focus on context is shared by design science in the sense that to develop a specific artefact, it must be utilised in its intended context (March & Smith 1995:254; Simon 1996:5-6). As this context expands, the artefact must be utilised in the new context, evaluated and further developed. This potentially expands the applicability of the artefact if the changes made do not lower its workability in the previous contexts.

To summarise, the three methodologies used in this thesis differ in their basis for generalisations. Survey research allows for statistical generalisations, while case study research provides for analytical generalisations regarding phenomena and design science regarding the applicability of its artefacts. Although Paper I, II III and V involve case study research, Paper IV involves survey research, and Paper VI, design research, none of them claim to be directly generalisable outside the

contexts of the studies. As Paper I-V are used to empirically inform the argumentation for key design criteria, the results are used more to support the argument that the parameters under study may play important roles in other contexts as well and should thus be included. The application of the initial ideas for the framework in Paper VI is indicative of how well it fulfils the required functions, as specified in the design criteria, to meet the purpose in that particular context. However, the more the results of utilising the framework indicate satisfactory performance in several contexts in the future, the bolder the analytical generalisations that are possible to justify.

4.3.3. Quantitative structure and qualitative depth

As the three methodologies used in this thesis have different purposes, ways of assessing quality, and bases for making generalisations, they require different research methods for collecting data. The data-collection methods used in the thesis are structured interviews, semi-structured interviews, focus groups, transect walk and observation. These methods differ in several ways, and of these, two will be elaborated on in this thesis.

First of all, the type of data collected by the different methods ranges from quantitative to qualitative, where the former refers to data that can be captured in numbers, or transformed into numbers, while the latter refers to data that can be captured in, or transformed into words (Blaikie 2000:185-187; Bernard 2006:24-25). I will not go into the perennial debate over which type of data is most valuable in social inquiry, as both contribute in different ways and are equally important (Bernard 2006).

The second difference between the research methods is the level of structure in how the data are collected. The more standardised the data collection method is, the easier it is to compare and analyse between respondents, contexts, researchers, etc. On the other hand, less structure allows for flexibility to go further in-depth or to explore wider the basis of the information collected. Furthermore, less structure is more appropriate if the focus is not just to collect specific information, but also for input on potential reasons behind that specific information. Less structure in interviews also allows for more two-way communication,

which may facilitate in building trust between researcher and respondent regarding sensitive questions, as it resembles more of a dialogue (IFRC 2007:61).

The choice of method is therefore not a simple choice of the best research method, but is rather an informed choice guided by the purpose, research question and, ultimately, the selected research methodology. Survey research requires a method that can collect highly structured quantitative data, i.e. the structured interviews in Paper IV, while case study research and design research generally are more flexible in type and structure of data. However, the applications of case study research and design research in Paper I-III, V and VI involve mainly qualitative data, even if the data are to some extent analysed quantitatively in Paper II and III. Semi-structured interviews are used in Paper II and V to collect mainly qualitative data, guided by set interview themes to provide enough structure to enable one to compare and contrast the results from different respondents. The focus groups of Paper III and VI are similar to the semi-structured interviews, with themes to guide the dialogues between respondents. However, the interaction between respondents makes the focus groups more difficult to control, which at times results in less structure. Transect walk is used in Paper VI to collect qualitative data from a specific geographical location (a part of a township). The transect walk itself is structured in the sense that the route and the main elements to look for are predetermined, but it still allows for flexibility to adapt or expand the walk while underway when interesting data emerge. Last but not least, Paper I involves observation, which is used to collect qualitative and highly unstructured information. The differences in type and structure of data collected in these applications of the different research methods are summarised in the figure above (Figure 10).

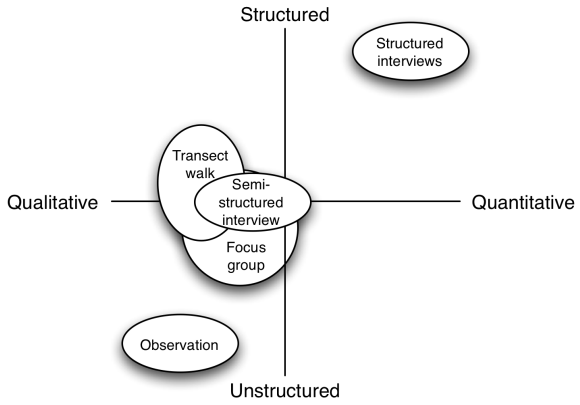

Figure 10. A comparison of level of structure and type of data of how the methods are applied.

5. Research contribution

"Our task is not to predict the future; our task is to design a future for a sustainable and acceptable world, and then to devote our efforts to bringing that future about" - Herbert A Simon (2002:601)

5.1. Empirically informing justifications for key design criteria

5.1.1. The importance of acknowledging interdependencies (Paper I)

The argumentation for the need to represent the world as a human-environment system presented in Chapter *3.2 Theoretical framework* is based on the notion that risk is a complex issue involving all spheres of society (ISDR 2004:16; Wisner *et al.* 2004:49-84; Bolin 2007:114-129; Coppola 2007:146-161). It is suggested that this complexity is a major challenge for effective risk management (Perrow 2008:164-165) and that sustainable development requires the ability to grasp such complexity (Kates *et al.* 2001:641), generally by not focusing on individual elements of the world in isolation but on their interdependencies (Haimes 1998:104; Turner *et al.* 2003a:8077). It is also suggested that more holistic approaches to risk are needed to overcome this challenge (McEntire *et al.* 2002; Cochard *et al.* 2008; Marvin *et al.* 2009), but no indications are given regarding what general negative results may arise if vital interdependencies are not taken into account. Paper I thus examines the need for acknowledging interdependencies of factors related to risk in international development cooperation. The research question of Paper I is:

What general results may come from focusing international development cooperation on specific factors influencing disaster risk without acknowledging interdependencies with other factors?

The limited study looked at two post-tsunami housing reconstruction projects in southern Sri Lanka and two capacity development projects with Tsentrospas (Search and Rescue Unit) in Tajikistan. The data were collected during three missions for the Swedish Red Cross (SRC) and Swedish Rescue Services Agency (SRSA). The methods used for collecting the data were observation and qualitative interviews (both

formal and informal). The respondents included potential beneficiaries, national authorities and civil society organisations, and international organisations. The respondents among the beneficiaries were selected out of convenience (Bernard 1995:96), while all other respondents were selected through purposive sampling to obtain informants from as wide selection of stakeholders as possible (*ibid.*:95-96). The data were analysed to extract indications on the purpose, results and actual effects of the four studied projects.

The study reveals that new and well-constructed houses were erected in both projects in Sri Lanka, but one of these newly established communities was not equipped with a sewage and waste water system while the other was constructed inland, far from the majority livelihood base of fishing, and was composed of houses that were too small for the average family-size. The correct number of houses was built according to plan in both projects, but the intended beneficiaries could not live in them due to the unsanitary state of the former and the lack of livelihood opportunities and comfort of the latter.

The study reveals similar results for the two capacity development projects in Tajikistan. The first project equipped Tsentrospas with much needed hydraulic equipment for rescuing people trapped in collapsed buildings and crashed vehicles. However, no activities were implemented to ensure lasting capacities for how to use and maintain the equipment. This resulted in the fact that Tsentrospas still had not used the equipment several years after obtaining it. The second project in the knowledge and skills base for the unit, which faded away as soon as the international support ended due to staff turnover and to the fact that the training was never institutionalised into the domestic training system.

It is clear in all four examples that crucial factors for reaching the purposes of the projects were ignored and left out. The ineffectiveness of these projects illustrates what systems approaches call sub-optimisation problems (Boland & others 1981:115; Liu & Leung 2002:341), in which the specific issue of giving shelter to tsunami affected families in Sri Lanka and developing the technical capacity of Tsentrospas in Tajikistan became the overriding focus, while losing sight

of the overall picture and what real effects the projects were intended to have. Without an understanding of what other factors were needed to reach the intended purposes, it did not matter how well specific project activities were implemented.

The four projects also illustrate that if there is no understanding of the relations between the purpose, efforts (costs) and actual effects of a project, it is difficult to monitor and evaluate its effectiveness. This is a second general outcome stipulated by systems approaches when interdependencies are ignored (Davies 2004; Davies 2005). It is clear in the four examples that the focus of the monitoring and evaluation of the projects was on the implementation of individual project activities and not on their complete intended effects.

Hence, the study indicates that ignoring interdependencies may (1) result in sub-optimisation problems where the desired outcome is not reached as the factor focused on and/or the desired outcome are dependent on other factors that are ignored, and (2) make it difficult or impossible to monitor and evaluate the actual effects of international development cooperation for managing risk.

5.1.2. The importance of explicit dialogue of what is valuable (Paper II-III)

What human beings value is at the core of any notion of risk (Renn 1998a:51; Renn 1998b:51; Renn 2008:2). However, there is rarely an explicit dialogue among stakeholders regarding what is to be considered valuable and important to protect when managing risk, thus indicating an inherent assumption that all stakeholders implicitly agree on this matter. Such an assumption may hold with only a few of the individuals involved, but the question is whether it is valid in the context of analysing risk for sustainable development with a multitude of stakeholders. Paper II and III are attempts to examine the need for an explicit dialogue among stakeholders about what is valuable and important to protect when managing risk. Paper II explores what various stakeholders in Fiji express as valuable and important to protect individually, while Paper III investigates what groups of Swedish civil-

servants express as valuable and important to protect together. The research questions for Paper II is:

What do stakeholders in disaster risk reduction in Fiji express as valuable and important to protect?

And the research questions for Paper III is:

What do groups of municipal and county council civil servants express as valuable and important to protect and what underlies these expressions?

In order to answer the research question of Paper II, 11 semi-structured interviews were conducted with stakeholders from all relevant administrative levels in Fiji, all possible levels of the traditional leadership, the most important market sectors, and from civil society. The interviews were divided into two themes in which the respondents were asked to give their opinions on what they considered to be valuable and important to protect in everyday life, as well as in disaster situations. The length of the interviews varied between thirty minutes and two hours, but the majority of them were about one hour long. Paper III, on the other hand, is based on four focus groups with 7-21 municipal or county council civil-servants in Sweden, who were asked to identify what they regarded as valuable and important to protect in their organisational contexts. What was elicited was captured on a whiteboard and the conversation was recorded in three of the focus groups. Each focus group lasted for 30-60 minutes.

The study in Fiji indicates that there may be great variation in what stakeholders express as valuable and important to protect. This may not be surprising, as each respondent has her or his own roles, responsibilities, goals, experiences, values and sets of cognitive abilities. The variation in itself is nonetheless enough to raise a serious question about the validity of any approach to risk that is built on the assumption that all stakeholders implicitly agree on what is valuable and important to protect. This point to the need for explicit dialogue regarding this issue, given the assumption that stakeholders need to pull in the same direction for effective risk management. However, the study in Sweden indicates similar variation in what is expressed as valuable and important

to protect between groups of stakeholders. This may again not be surprising considering the range of social, cognitive and contextual factors that may influence the dialogue among the stakeholders. However, an explicit dialogue seems to be vital for the formulation of common goals within the group and is likely to generate a rich picture of what is considered valuable. The objective of such dialogue is not to list and prioritise individual elements, but instead to build a system of what is valuable and how these elements relate to each other. This way of eliciting what stakeholders together view as valuable is likely to facilitate consensus among stakeholders, as most of what each one expresses individually may be included in the system. The final result of the dialogue can then be used as a tool for guiding risk analyses as it visualises and specifies in practice what is valuable and important to protect in that particular context.

Therefore, explicit dialogue of what is valuable is vital for analysing risk for sustainable development, as stakeholders initially may have different opinions on what to protect, which may result in them pursuing irreconcilable goals. The outcome of such dialogue is unlikely to give a complete picture of what is valuable and important to protect, and there may still be variation in outcome between groups of stakeholders. However, the picture supplied is likely to be richer than the sum of individual accounts and to provide a mutual framework for acting together towards common goals.

5.1.3. The importance of including various demographic groups (Paper IV)

The perception of risk is suggested to be central to any effort to manage risk (Paton & Johnston 2001). Several factors have been identified as influencing risk perception, e.g. culture (Slovic 1987:281; Bontempo *et al.* 1997; Lam 2005), gender (Flynn *et al.* 1994; Fordham 2000; Armaş 2006), age (Sjöberg 1998:86-87; Hermand *et al.* 1999), income level (Johnson 2004:111), education (Sjöberg 2000:7-8), personality traits (Chauvin *et al.* 2007), etc. It is also important to study how such factors influence the internal order in which individuals rank hazards in their communities, as potential differences could mean that any risk

management measure might focus on the priority risks of only part of the population.

Women are generally viewed to be more averse to risks and men to be more tolerant to risks (Flynn *et al.* 1994; Fordham 2000; Armaş 2006), so paper IV is an attempt to investigate if women and men rank the hazards within their communities differently. However, the study includes a wide range of factors in addition to gender that are also included in the analysis. The research question of Paper IV is:

How do women and men of three municipalities in El Salvador rank hazards in their communities?

To answer the research question, 69 randomly selected respondents from three randomly selected municipalities in El Salvador were included in a questionnaire survey. The questionnaires were answered using face-to-face structured interviews. The sample was generated through a field PPS method (Probability Proportionate to Size) (Bernard 2006:160-162), using grid systems and with randomisation using dice. The questionnaire included various demographic variables and a hazard ranking exercise. The data were statistically analysed using SPSS. Pearson's χ^2 (chi-square) was used for nominal variables, γ (gamma) between ordinal variables, paired-sample t-test for analysing differences in the mean between hazards within each group, and independent-sample t-test for analysing equality of mean values for each hazard between groups.

Statistical analysis of the survey data indicates that there are no significant differences between the ranking of hazards by women and men in the studied communities. This is a somewhat surprising result considering the large volume of peer-reviewed literature on gendered differences in risk perception. However, the findings do not constitute a criticism of the view that women and men perceive risks differently, but rather, they indicate that, regardless of how different women and men may view hazards, there is a possibility that they still rank them in a similar order. The analysis shows, nevertheless, a range of other variables as having statistically significant associations with how hazards are

ranked, e.g. type of livelihood, location of household, level of education, etc.

Hence, the short answer to the research question is that the participating women and men rank hazards in similar order. There are nonetheless a number of other factors that seem to influence how hazards are ranked. This indicates that regardless of whether there are gender differences in risk perception or not, hazards may be ranked in similar order. It also indicates that there are dividing lines other than gender that may influence priorities of risk management initiatives. It is thus vital to communicate with, and to include, as wide group of people as possible to participate in analysing risk. This applies not only to women and men, but also to representatives with various livelihoods, income levels, level of education, ethnic background, locations of their dwellings, etc. If not, there is a danger that vital needs and opinions might be left out and community commitment to risk management measures reduced. The process may take longer, but even if risk perceptions may differ between different people, there is still a chance that risk management measures can focus on the priority of several different groups, without conceding precedence to any one group over another.

5.1.4. The importance of integrating multiple administrative levels (Paper V)

The destructive impacts of disastrous courses of events are not evenly distributed in the world. Developing countries are bearing the brunt of the suffering and devastation (UNDP 2004), and the international community is urging more affluent countries and international organisations to assist these countries in developing their capacities for managing risk, including adapting to climate change. Capacity assessment has been identified as a vital tool to pursue this capacity development agenda (Lopes & Theisohn 2003; UNDP 2008b; UNDP 2008a; UNDP 2009).

Influential guidelines clearly state that capacity assessment can be conducted at various administrative levels (e.g. UNDP 2008a:5), but most assessments focus only on one level. This can potentially skew the foundation for effective development of capacities for managing risk.

Paper V is thus an attempt to explore the need for integrating information from multiple administrative levels when analysing risk and capacities for managing risk. This can be done by investigating similarities and differences between what stakeholders on different administrative levels express regarding their system for managing risk and disaster situations in Fiji. The research question is of Paper V is:

What are the similarities and differences in expressed flows of information and assistance regarding risk and disasters between different administrative levels involved in managing risks and disaster situations in Fiji?

The data were collected through semi-structured interviews with five respondents holding successive posts, from the village, to the national, level, in the system for managing risks and disaster situations in Fiji. The interviews focused on what type of information and assistance regarding risks and disaster situations the respondents give, or are requested to give, to stakeholders on other administrative levels and what information and assistance they receive or request, in everyday circumstances as well as during disaster situations. The total length of the interviews varied between thirty and eighty minutes, but most of them were about one hour long.

The focus of the analysis is on identifying potential similarities and differences between the individual accounts regarding information and assistance passed up and down between administrative levels. The data are analysed by categorising it according to the six guiding principles of risk management in Fiji[1] (DISMAC 2000) and searching for similarities and differences in what respondents express in their descriptions of the same flow of information and assistance between administrative levels.

The analysis indicates substantial discrepancies between what respondents at different administrative levels express regarding most issues not directly regulated by the Natural Disaster Management Act and the National Disaster Management Plan. For instance, the

[1] Which are clearly drawn from the Hyogo Framework for Action and its regional framework for the Pacific.

respondents at the national and divisional levels state that the provincial level initially manages any disaster situation, but when such situations are beyond the provincial capacities, the divisional level is activated, and when beyond the divisional capacities, the national level is activated. The respondent at the provincial level, on the other hand, states that regardless of disaster, the province have to deal with it on their own with no external support.

Similarly, the respondents at the national level state that they regularly request and get risk and vulnerability analyses from the divisional level, identifying all risk areas and what vulnerable people and infrastructure are located in those areas, and that the divisional level requests and get the same from the provincial level. However, the respondent at the divisional level, after initially more or less concurring with that, admits that reports are only written and submitted to the national level after disaster has struck. The respondent at the provincial level describes that they never document and submit anything regarding risk and vulnerability to the divisional level. The respondent at the municipal level states that they are not a central part of reducing risk and managing disaster situations at all, which is indirectly confirmed by the other respondents as none of them ever mentioned the municipal level during the interviews. The respondents at the divisional and provincial levels both describe that they are active in public awareness and education, independently of each other, but that these activities are neither known to the respondents at the administrative levels below, nor were visible in any of the villages visited during the field research. Interestingly enough, it is only the respondent at the municipal level who express that their administrative level plays a role in reducing underlying risk factors, e.g. working to maintain storm water drainage in urban areas, inspecting buildings against building codes, etc. Hence, even if the focus is claimed to be shifting to reducing risk, the system for managing risk and disaster situations in Fiji still seems to be highly focused on response to, and recovery from, disaster situations.

The differences between the respondents at the national level and the others regarding the expressed focus in disaster risk reduction is likely to be the result of the top-down approach of the implementation of the

Hyogo Framework for Action 2005-2015. This is a process that is trickling down slowly to lower administrative levels in most countries around the world (GNCSODR 2009). A more general explanation of the differences between the accounts of the respondents may be that some respondents' answers relate to how it is in practice, while others, to how it ought to be, or they extrapolate a few good examples to make them appear general. Other explanations could be that the respondents' roles, responsibilities, goals, experiences, values and sets of cognitive abilities altogether interact with the context of the interview situation, influencing what was elicited at that particular time. Alternatively, the interviewer could have just misunderstood what was said entirely. Regardless of reason, the results entail substantial discrepancies regarding how the system for managing risks and disaster situations in Fiji functions.

In summary, Paper V illustrates that there may be substantial discrepancies between what stakeholders on different administrative levels express when explaining how their system for managing risk and disaster situations functions. This demonstrates a potential for bias if a capacity assessment would have included only one administrative level in the process. The paper does not claim that this is always the case, but only that there may be a possibility for it. Analysing risk would, in other words, benefit from efforts to include information from different administrative levels in attempting to construct one comprehensive view of the current capacities and future capacity needs.

5.2. Designing a framework for analysing risk

5.2.1. Building and evaluating a framework for analysing risk (Paper VI)

In the context of developing capacities to manage risk, any organised efforts are unfeasible without having a clear idea of what risks to manage in the first place. Analysing risk is thus a requisite for any capacity development effort in this context. There are many frameworks for analysing risk developed over the past four decades or so (e.g. Haimes 1998; Aven 2003). However, Paper VI presents justifications for six key requirements for analysing risk for sustainable development, which are

based on normative arguments informed by established theory and the empirical investigations of Papers I-V. Paper VI attempts to outline, test and evaluate initial ideas for a framework for analysing risk that meets these requirements through applying the design process presented in Chapter *4.2 The design process*.

The purpose of the desired framework is to guide the analysis of risk aimed at informing efforts to develop capacity for managing risk to facilitate sustainable development. In order to meet that purpose, the framework must fulfil at least six key requirements concerning the ability to:

1. Integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity (systemic);
2. Accommodate different stakeholder values (multi-value);
3. Incorporate a wide range of initiating events that may impact what stakeholders value (multi-hazard);
4. Integrate a multitude of factors and processes contributing to the susceptibility of what stakeholders' value to the impact of the events (multi-susceptive);
5. Involve various stakeholders across functional, administrative and geographical borders (multi-stakeholder);
6. Integrate several risk analyses performed by different groups of stakeholders (multi-analysis).

The initial ideas of the framework are to facilitate analysing risk by constructing explicit models of the world, or human-environment systems, and to use these models to guide the structuring of risk scenarios. The explicit model is constructed using causal loop diagramming, including elements of the world that are deemed relevant, as well as directional relations between these elements which indicate how any changes would propagate through the system.

As argued in Paper II and III, analysing risk starts by explicitly establishing what is valuable and important to protect. This is done with broad participation from various stakeholders. Also important is the facilitating of dialogue by mapping what stakeholders express as

valuable, as well as how these valuable elements are related to each other. The result is a system of interdependent elements, which not only guides us in what to have in mind when identifying relevant initiating events but also in how their consequences would spread between elements. Questions 1-3 below are used to guide this part of the analysis (Table 2).

Establish what is valuable and important to protect	1. What is valuable and important to protect? 2. Why is it valuable? 3. Which other elements are valuable in securing that valuable element?
Establish which events can have a negative impact on these valuable elements	4. Which events may happen that can have an impact on what human beings value? 5. Which factors contribute to these events occurring? 6. How likely is each event to occur?
Establish how susceptible these valuable elements are to the impact of the events, including the capability to act to reduce the impact where relevant	7. What can happen to what human beings value, given a specific event, considering actors performing tasks that may influence the outcome where relevant? 8. Which factors contribute to their susceptibility? 9. How likely is that to occur? 10. If it happens, what are the consequences for what human beings value?

Table 2. Ten questions for building human-environment systems and structuring risk scenarios.

The second step in the analysis is to establish what initiating events are capable of having a negative impact on what has been established as valuable and important to protect. After identifying potential initiating events, it is time to define necessary spatial, temporal and magnitudinal aspects of each. This is done by allowing a definite number of initiating events to represent the entire known collection of possible initiating events. For each selected initiating event, the contributing factors are identified and included in the system, potentially connecting it to what

stakeholders have expressed as valuable and important to protect. Finally, the likelihood of each initiating event is estimated. Questions 4-6 are used to guide this second part of the analysis (Table 2).

The final part of the analysis is to establish how susceptible each valuable element is to the direct or indirect impact of each initiating event. Therefore, for each initiating event that has been identified, it is vital to define how such an event would impact each identified valuable element, including purposeful human activity to reduce the impact where relevant. For each valuable element that may be impacted by a specific initiating event, any contributing factors for its susceptibility, which has not been included in the previous steps, are identified and included in the system. As there is uncertainty in determining what would happen exactly, even given a specific initiating event, it is important to define different potential courses of events and estimate the likelihood of each one happening. After having established the direct consequences of the impact of a specific initiating event on a specific element, it is time to analyse how this consequence would impact the elements dependent on it. Tracing the impact trough the system. Questions 7-10 are used to guide this part of the analysis (Table 2).

This initial version of the framework was applied in a district municipality in North-West Province, South Africa. The data were collected through focus groups at the district municipal and local municipal levels, and through transect walk, including informal interviews, at the ward level. The method was also applied at the district municipal level in the Western Cape, South Africa, in order to initiate exploration of possibilities for generalisation of the higher levels of the human-environment systems.

Focus groups were selected as the primary method since they provide opportunities for dialogue, which facilitates the formation of an explicit, comprehensive and shared mental model of the world among stakeholders. The three focus groups included between 7-10 members, who represented different municipal departments and other organisations having roles in the institutional structures for managing risk in their respective areas. The focus groups were recorded, generating 6 hours 49 minutes of recorded discussions from which elements and

relations are elicited. A full day transect walk in one ward was then used as reference to verify the information given at the higher administrative levels.

The application of the framework in this limited South African example generates a lot of data. Around 100-120 elements and 200-250 relations are elicited from each focus group, making the raw data cumbersome to use in their original form. The elements and relations are therefore aggregated into subsystems on different hierarchical levels, with increasing level of abstraction the higher the level. It is important to restate that the resulting human-environment system is not in any way an objective picture of reality, as both the raw data collected and the system and subsystems are constructed.

Paper VI indicates that the approach of building an explicit human-environment system is beneficial in grasping the complexity of risk in relation to sustainable development. The framework in its current form makes it possible to qualitatively analyse how a change in the system may propagate, reinforce or balance itself, and combine with other changes, creating nonlinear dynamics that may have eluded or even deluded stakeholders in more traditional risk analyses. The focus on relations between elements in the human-environment system, together with the integration of delays, also make it possible to track indirect consequences of a change to spatially and temporally distant parts of the system. Allowing for analysis over multiple time periods and facilitating the integration of long-term or delayed consequences of an immediate impact, as well as pressing consequence of gradual changes. The framework also seems to facilitate the integration of various spatial scales, as the human-environment system is possible to organise hierarchically.

Although the framework would benefit immensely from the quantitative modelling of stock-and-flow diagramming and microworlds, such approaches may still be somewhat distant as there are many complex relations that remain difficult to quantify. Systems archetypes (e.g. Jackson 2003:70-73), on the other hand, may be a more feasible step in the development of the framework.

Paper VI also indicates that the framework can accommodate different stakeholder values and thus reduce the potential for debate and conflict around these issues. Explicit dialogue also seems to mobilise stakeholders who may not usually consider themselves important for risk management. As they realise that their input is vital for analysing risk in their context, it may reinforce their awareness of the importance of managing risk in general, as well as their interest in supporting such activities.

Specifying what is considered valuable and important to protect also seems to facilitate the incorporation of a multitude of different initiating events in the analysis. This is also facilitated by including multiple stakeholder values which provides a wide range of elements that different initiating events can impact. Furthermore, bringing each specific element systematically to mind facilitates their identification.

Paper VI indicates that the initial framework not only emphasises the analysis of the susceptibility of specific elements to the impact of specific initiating events, but also demands more detailed descriptions of these factors and processes. It also provides a systematic approach to integrating them into the analysis. The framework also emphasises that the capability of individuals, organisations and societies to act in specific scenarios is vital in such analysis. Since the framework allows for multiple stakeholder values, it also allows for multiple types consequences in the analysis of risk. Similarly, multiple time periods for analysis generate different sets of these consequences for each specific time period. The main challenge in using the framework lies therefore in managing the vast amount of information in both input and output. Although the development of systems archetypes may somewhat reduce this problem by providing a scaffold for more systematic construction of human-environment systems, the optimum solution is to integrate the framework into some tool for information management, e.g. Geographical Information Systems (GIS).

Paper VI indicates that the framework is well designed for involving various stakeholders. The explicit dialogue of what is to be considered valuable and important to protect demands direct interaction between stakeholders across functional boundaries and opens up opportunities

for involving the public if the resources are available. Such a broad range of stakeholders can also be involved in identifying initiating events that can impact what they value, as well as experts who may be more capable of adding scientific insight into the dynamics of the initiating events and their contributing factors. The initial framework also seems to facilitate the involvement of stakeholders across administrative and geographical borders, as the hierarchical structure of human-environment systems makes them possible to aggregate and disaggregate. However, the multifarious nature of our world generates challenges with aggregation that need further attention in the development of the framework.

It is not possible to evaluate sufficiently the requirement of integrating several risk analyses performed by different groups of stakeholders, as this application of the framework does not include multiple risk assessments performed by different groups of stakeholders. However, Paper VI outlines reasons for further emphasising the importance of this design criterion.

Finally, although the initial framework seems to meet the six stated requirements to certain extent, there are still modifications and more applications that can be added if necessary. However, representing the world as an explicit human-environment system, while involving a multitude of stakeholders, seems central to the task of analysing risk in the complex context of sustainable development, and appears to be an appropriate path to follow for further research.

5.3. Discussing and concluding the research contributions

The setting for the studies in Paper I-VI is facilitating capacity development for managing risk and actual destructive courses of events. Since this is only one of many possible settings within the context of analysing risk for sustainable development, it is vital to keep in mind that the empirical foundation for the discussion and conclusion in this chapter is limited to this particular setting. The potential for more general implications is presented in Chapter *6.1 Implications for analysing risk for sustainable development in general.*

5.3.1. Discussing the six key design criteria

Risk analysis is a requisite for guiding decisions today that will determine our tomorrow. It is our major instrument for attempting to manage the contingent nature of our future and constitutes, together with vulnerability analysis, the two main categories of sustainability science tools for ex ante assessment of issues concerning sustainable development, given that uncertainty is explicitly involved in the analysis. However, all frameworks for analysing risk do not automatically qualify to fill the purpose of facilitating sustainable development. For that purpose, there is a range of specific requirements needed, of which this thesis presents and justifies six. The justifications for these six key design criteria are based on logical reasoning informed by established theory and, where necessary, by new empirical research (Paper I-V).

Sustainable development is about being able to maintain and safeguard the development of society from a current to a desired state and includes purposeful activities to drive or steer this change. Analysing risk in this context requires the ability to accommodate various stakeholder values in the analysis (multi-value). It is therefore not only uncertainty that is common to all approaches to analyse risk for sustainable development, but also the process of involving multiple criteria for measuring direct and indirect consequences and integrating these in the evaluation of risk in relation to development goals. Having diverse stakeholders involved in the process increases the likelihood that these stakeholders differ in what they consider valuable and important to protect (Paper II). There is a real potential for undermining the effectiveness of managing risk for sustainable development if what stakeholders value makes them pursue irreconcilable goals. Explicit dialogue about what is valuable is thus vital for analysing risk in this context (Paper II and III). What stakeholders express as valuable and important to protect in the studied contexts is rarely conflicting, but may, in fact, be related to each other. This serves to create a system of valuable elements representing what is relevant to protect over time in the particular contexts (Paper VI). A range of social, cognitive and contextual factors can still create variation in what groups of stakeholders express together as valuable and important to protect (Paper III). However, the picture supplied is likely to be richer than the

sum of individual accounts and could also provide a framework for acting together towards common goals.

Because of this holistic approach to what human beings value in society, analysing risk for sustainable development may also require the ability to incorporate a wide range of initiating events in the analysis (multi-hazard), or what Kates *et al.* (2001) call multiple stresses, as well as various factors and processes contributing to the vulnerability of what stakeholders' value to the impact of these events (multi-susceptive). Including various initiating events in the analysis is particularly important as representatives from different demographic groups may rank different initiating events in different order (Paper IV). This has the potential for limiting the commitment to specific risk management activities to only certain parts of the community.

Although the world is dynamic and complex with more or less immeasurable interdependent connections between elements directly or indirectly determining risk, human beings seem to have an almost relentless fixation with dividing this issue into parts that suit functional sectors, organisational mandates and academic disciplines. This is disruptive to sustainable development, since focusing on one functional sector, while ignoring interdependencies with other sectors, is likely to result in sub-optimisation problems and challenges for monitoring and evaluating the actual effects of specific activities (Paper I). Similarly, including only one administrative level in the analysis may produce a biased view of the challenges at hand, as there may be differences in how stakeholders at different levels describe their system for managing risk and disaster situations (Paper V). Sustainability science provides a clear break from this fruitless pattern, as it attempts to provide a basis for collaboration between global and local, poor and affluent, society and science, etc. In short, analysing risk for informing efforts to develop capacity for managing risk to facilitate sustainable development requires the ability to involve various stakeholders across functional, administrative and geographical borders (multi-stakeholder).

Accommodating multiple stakeholder values and involving a variety of stakeholders also introduces the requirement of being able to integrate several risk analyses performed by different groups of stakeholders

(multi-analysis). The application of the initial ideas of the framework (Paper VI) does not allow the fulfilment of this requirement to be sufficiently evaluated. Nevertheless, the implications of this requirement is that each risk analysis must include an explicit systems model, must clearly state what are considered negative consequences in the analysis, and the risk scenarios that have been identified must be clearly described together with estimates of their respective likelihood of occurrence and consequences.

Finally, the complexity of our world separates cause and effect in space and time, thus making it futile to analyse risk in the context of sustainable development without at least attempting to grasp this structural and functional complexity. This core challenge is the main focus of sustainability science and can be considered the foundation for all five requirements previously presented. Hence, analysing risk for sustainable development requires ability to integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity (systemic).

5.3.2. Presenting the developed framework

The purpose of the actual framework developed in this thesis is to guide the analysis of risk for informing efforts to develop capacity for managing risk to facilitate sustainable development. It is in order to meet this purpose that the framework must fulfil at least the six key requirements, or design criteria, presented above[1]. The actual form of the framework can then be summarised as three principles, two tools and a description of how the three principles and two tools are utilised in practice (Figure 11).

5.3.3. Discussing the scientific development of frameworks

The initial ideas for a framework for analysing risk for sustainable development presented in this thesis is not enough to lay claim to having a functioning framework ready for general use. For that, more

[1] (1) systemic; (2) multi-value; (3) multi-hazard; (4) multi-susceptive; (5) multi-stakeholder; and (6) multi-analysis.

development work is necessary. However, the overall research question of this thesis is not to present the developed framework per se, but to explore how such a framework can be developed scientifically. This can be done by using a combination of traditional science and design science, involving different research methodologies and principles for assessing scientific rigour, in a systematic and transparent design process. The application of the initial ideas for the framework thus supplies simply the context for exploring the scientific rigour of the design process used.

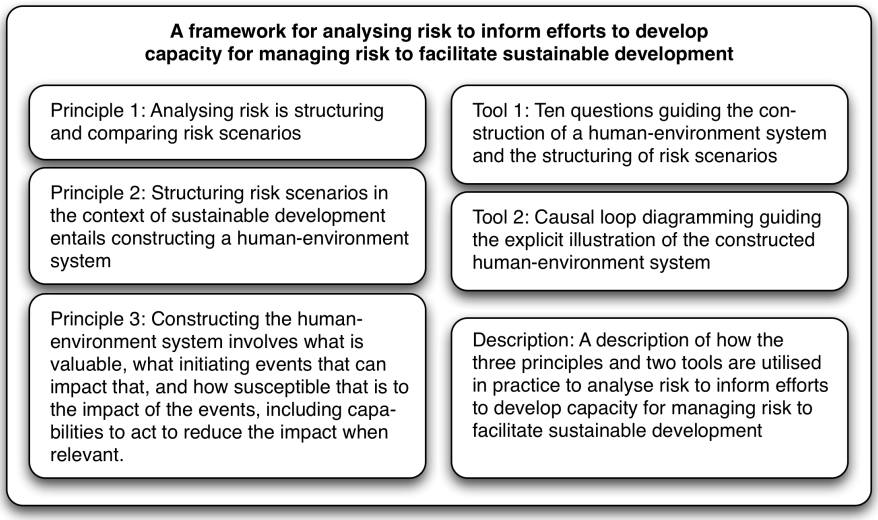

Figure 11. Summary of the initial framework for analysing risk to inform efforts to develop capacity for managing risk to facilitate sustainable development.

Design science supplies us with the principle of workability, in addition to the principles of reliability and validity of traditional science. However, the scientific rigour of the design process is determined by the degree to which the scientific community trusts its results. As in all scientific work, this trust relies to a large extent on the possibility for outsiders to see and understand what the researchers involved have done during the course of the project.

To scientifically develop a framework for analysing risk for sustainable development therefore demands full clarity and transparency in all steps

of the design process. This is particularly vital when justifying the purpose and required functions (design criteria) of the framework, since not only empirical statements usually are allowed to influence these core assumptions, but also, and more importantly, normative statements based on value preference. These are all assumptions that guide the development of the framework, as well as serving as references against which the framework is evaluated to judge its sufficiency. It is thus vital to not only explicitly state and justify the purpose and the required functions, but also to make sure to show clearly how these assumptions are related to each other, as well as to the actual form of the framework developed. Such transparency is also of fundamental importance as it is impossible to list all potential design criteria, and by having a systematic and transparent design process, one can allow and invite not only scientific scrutiny but also further scientific development.

The scientific development of the framework also has a practical side, as it is impossible to evaluate the performance of any framework if it is not possible first to apply it in practice. It is therefore necessary to make sure that the actual form of the developed framework makes it possible to utilise it in practice, in its intended contexts. Finally, to judge the workability of the framework, its sufficiency must be assessed in terms of its utility to fulfil the required functions to meet its purpose, and the outcome of this evaluation must be used to guide further development. Neglecting any of these requirements automatically reduces the scientific rigour of the design process.

5.3.4. Answering the overall research question

So, what criteria should guide the design of a framework for analysing risk for sustainable development, and how should such a framework be developed scientifically?

As stated above, it is obviously unfeasible to list all design criteria that could potentially guide the development of such a framework. However, in response to the first part of the overall research question above, this thesis suggests, and provides justifications for, six key design criteria that should be included in such endeavour. These design criteria demand

that a framework for analysing risk for sustainable development should be able to:

1. Integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity (systemic);
2. Accommodate different stakeholder values (multi-value);
3. Incorporate a wide range of initiating events that may impact what stakeholders value (multi-hazard);
4. Integrate a multitude of factors and processes contributing to the susceptibility of what stakeholders' value to the impact of the events (multi-susceptive);
5. Involve various stakeholders across functional, administrative and geographical borders (multi-stakeholder);
6. Integrate several risk analyses performed by different groups of stakeholders (multi-analysis).

In response to the second part of the overall research question, concerning how to scientifically develop such framework, this thesis emphasises the importance of three scientific principles: the principles of reliability and validity of traditional science, and the principle of workability of the framework itself in its intended contexts. Developing such framework scientifically thus requires a systematic and transparent design process in which:

a. The empirical and normative statements behind the framework's purpose and required functions, as specified in the design criteria, are explicitly justified and stated;
b. The actual form of the developed framework makes it possible to utilise it in practice;
c. The connections between purpose, functions and form of the framework are clear;
d. The framework is utilised in its intended contexts;
e. The utility of the framework is measured in how well its form fulfils the required functions to meet its purpose;
f. The outcome of the evaluation of the framework guides further development.

6. Final remarks

"Never look down to test the ground before taking your next step; only those who keep their eye fixed on the far horizon will find their right road" - Dag Hammarskjöld

6.1. Implications for analysing risk for sustainable development in general

Although the empirical base for this thesis is facilitating capacity development for managing risk for sustainable development, it may hold broader implications for analysing risk for sustainable development in general.

First of all, sustainability science requires the ability to integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity, in all descriptive and normative aspects of sustainable development. It is therefore plausible that analysing risk for sustainable development would benefit from following that requirement in general. Especially since it is likely that not taking vital interdependencies into account may cause sub-optimisation problems and problems in monitoring and evaluating the actual effects of our activities in general.

The requirement of being able to accommodate different stakeholder values is also likely to be a general one for analysing risk for sustainable development in a broader sense, given that multiple elements may be expressed as valuable in such contexts. This is especially the case since it is reasonable to believe that multiple stakeholders are necessary in such contexts, both to shed light on, and facilitate, a mutual understanding of the challenges at hand, as well as to generate broad commitment to reach common goals. The requirement of being able to involve various stakeholders across functional, administrative and geographical borders is also likely to be valid for analysing risk for sustainable development in general. Explicit dialogue about what is considered valuable in these contexts may thus be of vital importance, since it is probable that different stakeholders initially may have different ideas about this issue.

A broad societal focus in general, involving various stakeholders and multiple values, is also likely to entail the requirement of being able to

incorporate multiple initiating events in analysing risk for sustainable development, as well as that of integrating a multitude of factors and processes contributing to the susceptibility of what stakeholders' value to the impact of these events. This is because it is implausible that only involving one or two potential courses of events that may reduce the sustainability of our society would give a comprehensive enough picture to base today's decisions on in order to achieve our preferred tomorrow. In view of the complexity of having a broad societal focus when analysing risk for sustainable development in general, it is likely that obtaining the required comprehensive picture may necessitate the ability to integrate several analyses performed by different stakeholders.

Finally, the six conditions for scientifically developing a framework for analysing risk to inform efforts to develop capacity for managing risk to facilitate sustainable development (a-f) are likely to be of general application for developing frameworks for analysing risk for sustainable development. This is because the design process presented in this thesis builds on general design science that is, and has been, applied to solve a multitude of problems in various contexts.

6.2. Ideas for future research

Although a couple of centuries of unsustainable development have set the world in this grave state and there are unfortunately few signs of any major change of direction, let us hope that Simon's (2002:605) heartening prophecy comes true:

> *"Perhaps our very salvation will come from the severity of the problems we will have to solve: finding an ecologically sustainable state for the Earth and all its living inhabitants, injecting far stronger criteria of fairness into the allocation of available resources and their products, and disarming the vicious competitions that now take place between every imaginable sort of 'we' and 'they'."*

Researchers have important roles in facilitating such a dramatic and critical change in the transactions of humankind (Kates *et al.* 2001). Such a change is necessary for the survival of the world as we know it. Most disciplines have a role to play, but the transdisciplinary approach of sustainability science is imperative in this context as it brings together

"scholarship and practice, global and local perspectives from north and south, and disciplines across" all sciences (Clark & Dickson 2003:8060).

The most immediate need for future research in relation to this thesis is more applications of the framework in order to develop it further. More applications of the framework would also allow for researching the possibility of developing archetypes for the higher hierarchical levels of the human-environment systems constructed. This will serve in making the framework more efficient and user friendly by guiding the search for the more detailed and context-specific information needed. Such a process of systematic mapping of sub-systems can also be done independently of the framework itself, inviting various disciplines to contribute parts in order to construct a comprehensive whole: The core function of sustainability science.

More descriptive transdisciplinary research is thus needed to advance our understanding of the dynamics of complex human-environment systems in which a multitude of interdependent conditions and processes of change generate courses of events that undermine sustainable development. For instance, systemic mapping of factors behind why human beings live in dangerous locations, investigating the relations between land use, water resource management and sinkholes, etc. The more we learn, the more comprehensive our modelling of such systems can be, facilitating a merging of qualitative and quantitative tools in the future. In addition to understanding these phenomena, there is also a need for more normative transdisciplinary research to address these sustainability problems by designing better processes, methods and tools for managing risk for sustainable development. Examples of this are: a framework for analysing capacity in societies to manage risk, an add-on to Logical Framework Approach to facilitate its use for capacity development for risk- and disaster management, etc. When understanding phenomena and having artefacts to address problems, researchers need to focus more on innovation activities, on supporting the design, implementation and evaluation of projects that promote sustainable development in practice. This by applying their research results in collaboration with relevant partner communities (policy, management, practitioner, or beneficiary).

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Appendix: The Papers

Paper I Becker, Per (2009). 'Grasping the hydra: The need for a holistic and systematic approach to disaster risk reduction'. *Jàmbá: Journal of Disaster Risk Studies*, 2(1), 12-24.

Paper II Becker, Per (2009). 'The importance of explicit discussions of what is valuable in efforts to reduce disaster risk'. submitted to *Asian Journal of Environment and Disaster Management*

Paper III Nilsson, Jerry and Becker, Per (2009) 'What's important? Making what is valuable and worth protecting explicit when performing risk and vulnerability analyses'. *International Journal of Risk Assessment and Management*, 13(3/4), 345-363.

Paper IV Becker, Per (2010) 'Whose risks? Gender and ranking of hazards'. forthcoming in *Disaster Prevention and Management, An International Journal*

Paper V Becker, Per (2010). 'The importance of integrating multiple administrative levels in capacity assessment for disaster risk reduction and climate change adaptation'. forthcoming in *Australian Journal of Emergency Management*

Paper VI Becker, Per and Tehler, Henrik (2010). 'Risk informed capacity development for managing risk to facilitate sustainable development'. submitted to *Journal of Contingencies and Crisis Management*

I

Grasping the hydra: The need for a holistic and systematic approach to disaster risk reduction.

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ABSTRACT

This article stresses the significance of recognising interdependencies between factors determining disaster risk in any attempts to integrate disaster risk reduction in international development cooperation. It bases its arguments on the case studies of four past projects in Sri Lanka and Tajikistan, which are scrutinised using a theoretical framework based on systems approaches. It appears that the results of ignoring interdependencies may (1) cause sub-optimisation problems where the desired outcome is not reached as the factor focused on and/or the desired outcome are dependent on other factors, and (2) make it difficult or impossible to monitor and evaluate the actual effects of international development cooperation projects in disaster risk reduction.

KEYWORDS

Disaster Risk Reduction, Systems Approaches, Complexity and Interdependence.

Introduction

Disasters cause horrible consequences in human lives and suffering. The majority of the fatalities and instances of devastation occur in the developing parts of the world, posing a major threat to sustainable development and to the Millennium Development Goals (UNDP, 2004:9-27; UN Millennium Project, 2005). A growing number of donor agencies are recognising connections between disaster risk and poverty, and are currently drafting policies on how to further integrate disaster risk reduction into their official development assistance (e.g. DFID, 2006; Danish Ministry of Foreign Affairs, 2007).

Disaster risk is a complex issue involving all spheres of society, i.e. the physical and environmental, the social and cultural, the political and the economic (ISDR, 2004:16; Wisner *et al.*, 2004:49-84; Coppola, 2007:146-161; Boin, 2007:114-129). This complexity of interdependent factors determining risk has been identified as a major obstacle to effective disaster risk reduction (Perrow, 2008:164-165). One way to overcome this obstacle is to apply more holistic approaches that include a wider range of factors of disaster risk (e.g. McEntire, 2002; Cochard *et al.*, 2008; Marvin *et al.*, 2009). However, advocates of more holistic approaches to disaster risk do not give many indications of what the negative results are that may come if such approaches are not adhered to, which in turn could limit their persuasive influence on policy-makers for international development cooperation.

This article is an attempt to examine the need for holistic approaches to disaster risk in international development cooperation, by studying four recent projects in Sri Lanka and Tajikistan. The research question that the article attempts to answer is:

> *What general results may come from focusing international development cooperation on specific factors influencing disaster risk without acknowledging interdependencies with other factors?*

The investigation starts with drawing up a theoretical framework asserting the complexity of disaster risk, introducing systems approaches as tools for grasping complexity and studying how these theoretical findings resonate with international guiding documents for integrating disaster risk reduction into international development cooperation. The following sections introduce the research methodology and methods used to answer the research question, as well as presenting the empirical findings. The article ends with a discussion of the findings and a presentation of its conclusions.

The complexity of disaster risk

Disasters are not discrete unfortunate events detached from everyday societal processes, but constructed over time and are closely linked with the development of society (Fordham, 2007:338-339). Irrespective of whether a disaster is triggered by a specific hazard, there are various interdependent factors influencing the hazard's frequency, intensity, location, duration, speed of onset, etc (Coppola, 2007:31-39). The susceptibility for being destructively affected by the hazard is also determined by a complex set of interdependent factors (Hearn Morrow, 1999; ISDR, 2004:16; Wisner *et al.*, 2004:49-84; Coppola, 2007:146-161; Boin,

2007:114-129), as is the capacity of individuals, organisations and societies at risk, to anticipate, avoid, cope with and recover from the disaster (Leveson *et al.*, 2006). Disasters can thus rarely be sufficiently explained as results of linear chains of events, like dominos falling on each other, but are better understood as non-linear phenomena which emerge in complex systems of interrelated and interdependent conditions and events (Hollnagel, 2006:10-12). A disaster is here defined as a severe disruption of the functioning of a society causing extensive human, material, economic or environmental losses that exceed the ability of the affected society to manage using its own resources (ISDR, 2004:16). To substantially reduce disaster losses it is important to increase focus on reducing the risk of future disasters. There exists a multitude of expressions all describing risk in different ways. This article does not intend to use or produce such expressions, but states instead that risk is the answer to (1) what can happen, (2) how likely is it that that will happen and (3) if it does happen, what are the consequences (Kaplan and Garrick, 1981:12-13), regardless of what expression is used. However, the three components of hazard, vulnerability and capacity are often viewed as the building blocks of risk (e.g. Heijmans and Victoria, 2001:52-63; Cannon *et al.*, 2003; Vermaak and Niekerk, 2004; Chen *et al.*, 2007; Saldaña-Zorrilla, 2008) and need to be included in attempts to answer the three questions mentioned above.

Efforts to explain and understand, as well as to reduce disaster risk have had a tendency in the past to reduce the problem into parts that fit academic disciplines, professional sectors, organisational mandates, etc (Fordham, 2007). Such reductionist strategies may be effective when dealing with specific and well-bounded problems, but not with the complexity of real-world problems (Checkland, 1999:59-74; Senge, 2006:68-73). This kind of fragmented problem solving is instead likely to be a major weakness as it clouds the bigger picture of risk (Hale and Heijer, 2006:139). The challenge in reducing risk is thus not to find a way to divide the issue into parts that fit the mandate or agenda of specific stakeholders, but instead to grasp the dynamics and non-linear interdependencies between all parts in these complex systems of factors determining risk (Hollnagel, 2006:14-17). In other words, disaster risk is a complex issue not only because it includes factors from all spheres of society, but also because many of these factors are interdependent on each other. This complexity makes such systems difficult to understand (Cebulla, 2004:87), which is believed to be a main reason for why so few researchers have applied such multi-sectoral approaches in the past (Twigg, 2004:271). It is obviously impossible to understand such systems completely

(Skyttner, 2005:100), but the goal must be to obtain as holistic a picture as possible (McEntire, 2002).

Systems approaches and results when ignoring interdependencies

Disaster risk is complex. However, it is not the only area in which complexity constitutes a daunting challenge to scientific inquiry. Living organisms, the brain, society, the climate, ecosystems and computers are only a few other examples. What scholars in these areas have in common is that they are focusing on something functioning as a whole but made up of a multitude of parts and processes. Living organisms are made up by the complex interaction of a myriad of cells, the brain is a vast network of neurals transmitting signals, society is made up by individuals and organisations, etc. Some of these scholars find that one way of managing and trying to learn from this complexity is to look upon their entity under study as a system, as von Bertalanffy (1960) did regarding the living organism, Ashby (1960) regarding the brain and Buckley (1968) regarding society. A system is here defined as "a group of interacting, interrelated, or interdependent elements forming a complex whole" (American Heritage Dictionary, 2000). Systems approaches are thus not only focusing on the elements per se, but also on the relationships between the elements, which are crucial in order to understand the system as a whole (Checkland, 1999; Skyttner, 2005).

There are many examples where systems approaches have been applied in the area of risk and disasters (e.g. Haimes, 1992; Haimes *et al.*, 1995; Hollnagel, 2004; Dekker, 2006; Hale and Heijer, 2006; Hollnagel, 2006; Leveson *et al.*, 2006; Perrow, 2008; Petersen and Johansson, 2008). However, it is hard to find any direct guidance regarding the research question in this specific literature. It turns out to be more fruitful to look at applications of systems approaches in other areas in the search for general results when focusing on specific factors without recognising interdependencies with other factors.

If efforts focus on specific factors in a system, but there is limited understanding of interdependencies within that system, there is a grave risk of sub-optimisation problems (Boland, 1981:115; Liu and Leung, 2002:341). A sub-optimisation problem can be described as a situation where a change in one factor does not generate the desired outcome in the system as the factor and/or the desired outcome are dependent on other factors that are not changed or even counterbalance the intended change. Sub-optimisation problems may even generate counterproductive results due to lack of recognition of interdependencies (e.g. Wisner *et al.*, 2004:57-59).

It is not only sub-optimisation problems that may arise with a lack of understanding of the interdependencies in systems, but also problems with monitoring and evaluating the actual effects of a deliberate change in the system. Monitoring and evaluation are vital for system effectiveness (Skyttner, 2005:53-54), but not if focused solely on the implementation of the project activity per se and not also on what effects it has in the system in total (Davies, 2004). Davies (2004; 2005) goes even further by indicating that it is difficult, if not impossible, to monitor and evaluate actual effects of projects without attempting to understand interdependencies within the system.

Integrating disaster risk reduction in development cooperation

When donor agencies are attempting to integrate disaster risk reduction into their official development assistance, it is important to acknowledge that risk is determined by a complex system of interdependent factors from all spheres of society. Guiding documents for such integration (i.e. ISDR, 2005; 2007; 2008) include a wide range of factors to address and activities to include in international development cooperation projects. However, these documents do not emphasise the importance of identifying and understanding the interdependencies between the different factors and activities. In the light of the two previous sections of this article, this lack of emphasis on interdependencies may decrease the potential effectiveness of stakeholders' efforts to reduce disaster risk. It may even be questionable whether any approach can be called holistic without acknowledging interdependencies.

Methodology

There are several methodologies that could be used to empirically answer the research question, but taking into consideration its context-dependent outline and the contemporary framework of the research, case study research stands out as particularly suitable (Flyvbjerg, 2001:67-73; Yin, 1994:4-9). The selected cases are four past international development cooperation projects, two post-Tsunami housing reconstruction projects in southern Sri Lanka, and two capacity development projects with Tsentrospas in Tajikistan. Tsentrospas is a governmental elite unit for all types of rescue operations.

The data were collected during three missions, one for the Swedish Red Cross (SRC) and one for the Swedish Rescue Services Agency (SRSA) to Sri Lanka and one for SRSA to Tajikistan. The methods for collecting data were observation and interviews (both formal and informal). A wide range of informants were

selected for the purposes of the missions, some part of which was relevant to this study. The selection included potential beneficiaries of the projects, such as representatives of the local communities targeted by the housing reconstruction projects and local communities and local and regional authorities (mainly in the Kulyab and Kurgan Tube areas) potentially affected by disasters and in need of Tsentrospas assistance. It also included representatives of involved national authorities, UN agencies, the national Red Cross (Sri Lanka) and Red Crescent (Tajikistan) societies, the International Federation of Red Cross and Red Crescent Societies (IFRC), the International Committee of the Red Cross (ICRC, only in Sri Lanka), as well as international and national Non-Governmental Organisations. The interviews were qualitative and included many aspects of which only a part was related to the selected international development cooperation projects. The interviews with beneficiaries and with most other informants in Sri Lanka were informal, while the mission in Tajikistan allowed formal interviews. The informants among the beneficiaries were selected on the basis of convenience (Bernard, 1995:96), while all other informants were selected through purposive sampling to obtain informants from as wide a selection of stakeholders as possible (Bernard, 1995:95-96).

The data collected were then analysed qualitatively in order to obtain indications of the purpose, results and actual effects of the four projects being studied. Interviewing a wide range of informants gives an equally wide range of opinions, each with its own point of view. This cannot be called triangulation as such, but it still provides a qualitative increase in the possibility of producing a rich picture of the projects under investigation.

Housing reconstruction in southern Sri Lanka

After the Indian Ocean tsunami in 2004, the affected region experienced an unprecedented inflow of international assistance (Telford *et al.*, 2006). The number of national and international relief and recovery organisations in the region proliferated and massive funds were not only available but had to be spent promptly (Telford *et al.*, 2006). The Red Cross and Red Crescent Movement rapidly increased its resources to deal with the immense needs in various sectors, including sending livelihood experts to Sri Lanka in order to support the integration of livelihood issues into the overall programming (IFRC, 2008).

The researcher was sent to support livelihood programmes, mainly in the south and southeast (Kalutara, Galle and Matara) and in the capital of Colombo.

The researcher later came back on a second mission to Sri Lanka, managing the initiation of a capacity development project together with the Road Development Authority (RDA), for the purpose of strengthening the then over-used capacity for post-disaster reconstruction of bridges. However, this time the focus of the work was put on the inland district of Kurunegala and in Colombo. During both periods in Sri Lanka many housing reconstruction programmes were visited. Most of the International Federation of the Red Cross and Red Crescent Societies' (IFRC) programmes functioned well, providing viable housing to tsunami affected families. Other organisations did not however always include an element of more comprehensive analyses to guide their programming, which in several cases resulted in interesting but rather unfortunate outcomes. Two of these ill-planned examples constitute the case studies in Sri Lanka. New and well-constructed houses were erected in both cases, but one of these newly established communities was not equipped with a sewage and waste water system. The correct number of houses was built according to plan, but it would obviously have been insanitary to live there without large additional investments.

The other case had a sewage system, but many of the houses were designed without consulting the future occupants, resulting in inadequate size for the typical family in that area. There was also another challenge resulting from the benevolent idea of protecting people from future tsunamis by establishing the community inland, where land was more readily available. The problem here was that a large number of these families were headed by fishermen and had their entire livelihood base at the coast, resulting in many of them moving back and leaving or renting out the house provided.

Capacity development in Tajikistan

In March 2006, the UN system launched a team to assess the disaster response preparedness of Tajikistan. The purpose of the mission was to assist the authorities to develop the response preparedness of Tajikistan by assessing the national capacities to respond to natural and environmental disasters (OCHA, 2006). During this mission the researcher was in contact with and visited a wide range of stakeholders relevant to disaster preparedness in Tajikistan.

The researcher was received by the Tsentrospas, the elite unit for all types of rescue operations in Tajikistan, which is located in the capital of Dushanbe. During the time at Tsentrospas and in the discussions with representatives of the unit it became clear that they were very committed and proud to serve the people of

Tajikistan. What also became apparent were the very limited capacities of the unit due to several reasons that will not be elaborated on here. However, Tsentrospas had been supported by several international organisations during the years before this study. An Austrian organisation had donated hydraulic equipment for rescuing people trapped in collapsed buildings and crashed vehicles, and an international Non-Governmental Organisation had supported a training programme for the staff. These two projects constitute the case studies in Tajikistan.

In the case of the hydraulic equipment, there was an obvious need for such support. However, it was equally obvious that not sufficient focus had been placed on identifying what other capacities were needed for the equipment to have any actual effect on the capacities of Tsentrospas. The equipment was donated without any attempt to ensure lasting capacities regarding how to use and maintain the equipment. The actual result of the efforts was that Tsentrospas, several years after obtaining the equipment, still had not used it. One may also question the actual effects of such a donation of hydraulic tools considering the lack of effective means and resources to transport the tools to the scenes of accidents, or of a robust system of notifying the unit to bring the equipment, etc. The list of interdependent conditions can be seen to be very long. Hence, the donated equipment did not generate any increased capacity for managing disasters, but only frustration among the devoted Tsentrospas staff.

Similar results came from the support for the training programme. The training programme was never institutionalised into the wider context of the training system in Tajikistan and died as soon as the international support ended. Therefore, even if the unit included individuals with better training for a while, it did not have any lasting effects due to the lack of refresher training and staff turnover. Both projects together with Tsentrospas had good intentions and required investments in financial and human resources. However, neither project had any real sustainable effect on the capacity of Tsentrospas as the activities focused on factors that were dependent upon other factors that were ignored.

Discussion

It is clear in all four cases that crucial factors for reaching the purposes of the projects were ignored and left out. The ineffectiveness of these projects illustrates what systems approaches call sub-optimisation problems, in which the specific issue of giving shelter to tsunami affected families in Sri Lanka and developing the technical capacity of Tsentrospas for heavy rescue in Tajikistan became the

overriding focus, losing sight of the overall picture and what real effects the projects were intended to have. Without an understanding of what other factors were needed to achieve the intended purposes, it did not matter how well specific project activities were implemented.

The four projects also illustrate that if there is no understanding of the relations between the purpose, efforts (costs) and actual effects of a project, it is difficult to monitor and evaluate the effectiveness of the project, which is a second general outcome stipulated by systems approaches to complex cases where interdependencies are ignored. Going back to the examples from Sri Lanka and Tajikistan, it is quite clear that the focus of the monitoring and evaluation of these projects was on the implementation of the individual project activities and not on their intended effects.

With sub-optimisation problems and possibilities for monitoring and evaluation in mind, it appears that acknowledging interdependencies is a central requirement for the success of international development cooperation projects in disaster risk reduction. It is important to note, however, that these four projects were selected because of their ineffectiveness and there are obviously positive examples of international development cooperation around the world as well. It also seems that systems approaches may supply a useful analytical framework for grasping the complexity of interdependent factors determining disaster risk, which would benefit from further inquiry.

Conclusion

So, what general results may arise from focusing international development cooperation on specific factors influencing disaster risk without acknowledging interdependencies with other factors? This study is obviously insufficient to claim to have an absolute answer to such a complex question. However, it seems that the results of ignoring interdependencies can be categorised into at least two general categories:

1. Not acknowledging interdependencies may cause sub-optimisation problems where the desired outcome is not reached as the factor focused on and/or the desired outcome are dependent on other factors that are ignored.
2. Not acknowledging interdependencies makes it difficult or impossible to monitor and evaluate the actual effects of international development coopera tion in disaster risk reduction.

It is recommended that emphasis be given to the significance of analysing and

understanding interdependencies between factors determining disaster risk in any attempts to integrate disaster risk reduction in international development cooperation. A starting point would be to emphasise this in future international guiding documents for such integration, further facilitating holistic and systematic approaches to disaster risk reduction.

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II

THE IMPORTANCE OF EXPLICIT DISCUSSIONS OF WHAT IS VALUABLE IN EFFORTS TO REDUCE DISASTER RISK

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This article argues for the importance of explicit discussions of what is valuable as a foundation for any disaster risk reduction initiative to be effective. It does so by stating that it is impossible to talk about risk at all if not having some notion of uncertain potential impacts on something that humans value. What is assumed as valuable and important to protect is then determining what hazards that are relevant in this context etc. However, this is rarely explicitly debated in contemporary disaster risk reduction, indicating a common assumption that all stakeholders implicitly agree in this matter. Such assumption may hold with only a few involved individuals, but is shown in an empirical study in Fiji as unlikely to be valid in any more participatory approaches to disaster risk reduction. In order to facilitate effective disaster risk reduction in such contexts it is important to start by involving the stakeholders in an explicit discussion of what is valuable in their specific context. Without such discussion there is a risk that stakeholders unintentionally impede each other's efforts by pursuing different goals.

Keywords: risk; disaster; disaster risk reduction; value; valuable.

1. Introduction

The contemporary global trend in disaster losses seems daunting [1-4]. The developing parts of the world bear the brunt of the death toll and human suffering, as well as the largest relative economic losses [5]. Many organizations within the international community are striving to assist efforts to reduce disaster risk, but not always with real and sustainable results [6]. There may be several reasons behind less effective results. However, the purpose of this article is to argue for the importance of explicit discussions of what to be considered valuable as a foundation for any disaster risk reduction initiative.

To be able to talk about risk at all entails some notion of a possibility for courses of events that would have an impact on something humans value [7]. Without such notion of value it makes no sense to talk about risk. Keeping in mind this central role of what humans consider valuable, it is interesting to note that this is rarely explicitly debated when analyzing risk [8, 9]. A reason may be that many influential guidelines for reducing disaster risk instead are advocating to start by identifying potential hazards [e.g. 4]. However, identifying relevant hazards automatically implies some unspoken idea of what is to be considered valuable in each specific context. E.g. drought is a relevant hazard in Botswana if you have the protection of human lives and livelihoods in mind, but not if you are focusing on a functioning road transport infrastructure. The research problem of this article is that such approaches to disaster risk reduction rely on an assumption that all stakeholders implicitly agree on what is to be considered valuable. This may be the case if only including a small number of experts in the process, but is it really valid when looking at any broader participation of stakeholders? This article is an attempt to shed light on this problem by trying to answer the following research question:

What do stakeholders in disaster risk reduction in Fiji express as valuable and important to protect?

The article starts by drawing up a theoretical framework for why values and what people consider valuable is central for disaster risk reduction, as well as for what may influence what stakeholders express as valuable and important to protect. Thereafter follows a presentation of the methodology used to answer the research question as well as the results of the study. The

article ends with a discussion of the empirical findings and a presentation of the conclusions of the study.

2. Theoretical framework

Risk is a contested concept with numerous definitions creating a fertile ground for miscommunication and misunderstandings [10]. However, to be able to talk about risk at all entails some kind of idea of uncertain futures as well as of their potential impacts on what humans value [7]. In other words, if I rig a lottery in order to know that I will win the price, there is no risk in gambling. Nor is it a risk if the cost for the lottery ticket is a grain of sand and I live on a beach. The first of these two requisites comes automatically in the context of disaster risk, as our complex world makes the future highly unpredictable. The second requisite, however, is somewhat more intricate to grasp.

Values may be seen as "desirable trans-situational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity [11]. In other words, values are what people care about [12]. A key distinction between values is the distinction between intrinsic values and instrumental values. Where intrinsic values are values that something has in itself or "for its own sake", and instrumental values are values that the something has that lead to or cause intrinsic values [13]. It is important to note that nothing is regarded in this article as having intrinsic value in the sense that the value is inherent in the object itself. Value is instead considered as being ascribed to the object through the projection of human sentiments or emotions [14, 15] in a complex and constantly changing world [16]. Nevertheless, an object can have an intrinsic value in the sense that the ascribed value is a value in itself, such as human life, and not leading to other values, such as the value of drinking water which is instrumental for human life [9]. These two categories of values are connected to what influential scholars of decision making call fundamental objectives and means objectives in any decision situation [12]. Intrinsic or instrumental, in order to reach the purpose of this article it is important to understand how values come to be ascribed to whatever is declared to have value.

"No man is an island, entire or itself"[17]. This timeworn quote by a 17-century English poet indicates that humans are social beings, functioning together in society. Giddens takes this idea further by stating that how humans experience their social context influence how they perceive and understand it, and therefore also how they will act in that social context [18]. These actions in turn produce and reproduce social structures, which guide and restrict what actions humans may take [18]. Human actions are thus fundamentally linked to social structures, which are representations of established patterns of behavior and have the purpose of keeping order and coordinating stable activities [19]. What humans value is in other words socially constructed in context where prolonged human action creates social structures that direct humans in what value to ascribe to each object. There was for example never a law or any formal decision made beforehand that specified that women and children should be saved first on a sinking ship, but yet the casualties among women and children were much lower than among men in all categories of passengers and staff on the Titanic [20]. It is however rare that society is totally homogenous, granting room for individual variation as there may be several social structures competing for dominance. In other words, the more heterogeneous society the more individual variation in what humans value is possible. Values may thus be seen as acquired "both through socialization to dominant group values and through the unique learning experience of individuals [11].

Values are notoriously difficult to measure as they are constructed in context [21]. This renders the methods used liable to self-inflicted biases [8, 22] regardless of what assumptions the value elicitation is based upon [23]. A factor that may be part of the explanation behind this scientific challenge is the influence of social pressures on respondents taking part in such study [23]. Either from the interaction with the researcher, or with other respondents present. Another part of the explanation may have its roots in peoples' cognitive abilities [9].

In order to understand what people express in particular contexts it is important to consider that "we can know more than we can tell" [24]. What people know can be divided into explicit knowledge and tacit knowledge [25]. Explicit knowledge consists of concepts, information and insights that are possible to specify, store and directly transmit to others [26]. Tacit knowledge, on the other hand, is not directly transmittable and consists of knowledge forming our mental models for creating meaning to our experiences as well as our know-how and skills to apply in specific contexts [24, 25, 27]. Tacit knowledge may in other words be seen as consisting of tools to identify the problem as well as the elements comprising the solution [28]. This type of knowledge can thus only exist in intelligent systems, such as human beings [29], and affects decisions in ways that are very difficult to describe or generalize [30]. Explicit and tacit knowledge are however closely connected, as "explicit knowledge must rely on being tacitly understood and applied" [31]. "Hence all knowledge is either tacit or rooted in tacit knowledge" [31].

Tacit knowledge comprises in turn of subsidiary awareness and focal awareness, where the object or phenomenon of our focal awareness is made identifiable to us by subconsciously assemble clues in our subsidiary awareness which are not identifiable in isolation [31]. An example of this is the distinguished psychiatrist showing his students a patient having a seizure. After letting the students discuss if it was an epileptic or a hystero-epileptic seizure, he settles the argument by stating "you have seen a true epileptic seizure. I cannot tell you how to recognize it; you will learn this by more extensive experience" [32]. The statement that the seizure was a true epileptic seizure is possible to transmit across the classroom and is an example of explicit knowledge. The knowledge that the psychiatrist use for diagnosing the patient is however tacit knowledge and less straightforward to share with the students. And then it is only the diagnose itself that is in the focal awareness of the psychiatrist and accessible to him, as he is only subsidiary aware of each of the many clues and indicators that he more or less subconsciously had observed. It is however possible to communicate tacit knowledge between individuals by establishing a shared understanding between them [33], but that is not further elaborated in this article.

What is in ours focal awareness is not only determined by individual characteristics, knowledge, world view etc, but constantly changing depending on context. Each situation gives us a sense of what is relevant for what we are doing. Our experience of similar situations, our idea of what the situation calls for or demands, our sense of aim or direction, etc, all combine into supplying us with this relevance structure [34]. What we have talked about recently, what roles the people around us have, what goals we think that they have, etc, is thus crucial for how we understand, interpret and remember incoming information. These mental structures or processes are in cognitive science referred to as schemata and are constantly amendable [35]. The current schemata of an individual is then guiding the individual's interpretation of the incoming situation as well as her expectations of and attention in it [36]. Our tacit knowledge comprises in other words partly of our schemata [25]. Another closely related cognitive tool that we use to get by in our complex world is called script. Scripts are cognitive chains of expectations of actions and effects in particular situations [37, 38], which assist individuals in how to act in those situations without focusing much of their focal awareness on these actions. Scripts that are based on few experiences of a specific type of situation are likely to be unstable and comprise of concrete information, while many experiences tend to make the scripts more stable and based increasingly on general information [37]. A main function of schemata and scripts is to facilitate coherence in our perception and experience of a situation by filling in gaps in the actual information available.

What individuals express as valuable in any given situation is socially constructed in context and determined by their values and what they have in their focal awareness at that time through the functions of their current schemata and scripts. It may then be argued that there is no use discussing the issue, as each account is destined to be subjective and fragmented. However, my opinion is rather the opposite. It is correct that each individual account is unlikely to give a complete picture on their own of what they consider valuable.

But it is likely in a dialogue between several individuals that what is mentioned triggers additional scripts and amends schemata activating additional knowledge by moving it from their subsidiary awareness to their focal awareness. What the group comes up with is however also highly contextual, but it is still likely to be a richer picture. And more importantly, it is their common picture of what is valuable. Making it achievable for the involved stakeholders to formulate and pursue common objectives in assessing and reducing disaster risk. Without such explicit common picture there is a grave danger that the stakeholders unwittingly impede each others' work by focusing on protecting different values, e.g. the ministry of agriculture focusing on securing state revenues by promoting the production of cash crops, while the Red Cross Society is working to reduce the risk of famine by increasing diversity of food crops.

There has been a prolonged debate on whether in should be up to the public to decide about matters concerning risk or if this should be the sole domain of experts [e.g. 39-45]. Much of this debate has the appearance of a clash between two seemingly irreconcilable standpoints. However, there are influential accounts presenting an alternative way forward, which is particularly persuasive in the context of international efforts for disaster risk reduction. These accounts argue for neither side, but instead for the need for as broad participation as possible, from experts, the public, decision makers, and other stakeholders [46, 47].

3. Methodology

Case study research is applied in order to meet the purpose of this article. Case studies are often criticized for their lack of rigor in that biases are allowed to influence their conclusions [48]. This is not a weakness of case study methodology as such, as biases must be treated properly regardless of methodology. Another common criticism is that case studies provide little basis for generalizations [48, 49]. This holds for statistical generalizations, but not for analytical generalizations for which case studies have proven well suited [49]. Knowledge developed in one case cannot be generalized "through abstraction and loss of history and context", but may be transferred to other situations through "conscious reflection on similarities and differences between contextual features and historical factors" [50].

To select the case for this study it is important to get a case with a wide variety of potential hazards as well as a complex social and political context, facilitating for variation of stakeholders. Keeping in mind the limited scope of this study, it is also important that the case is of limited size to make it possible to grasp using the available resources. According to this rational, Fiji appears to be particularly suitable. It is an island state of limited size in both land mass and population. It includes a wide range of hazards from earthquakes, tsunamis and landslides to cyclones, floods and droughts, as well as from dengue and other biological hazards to tense ethnic relations and political instability. Fiji also has a complex social and political set-up, with parallel power structures between the formal state structures and the continuously strong traditional structures. It's market is vastly dominated by its traditional revenue producer the sugar industry and its now even bigger tourism industry. Regardless of its political instability and current political repression, Fiji has still an relatively active civil society with Non-Governmental Organizations (NGOs) active in a wide range of fields.

In order to answer the research question, semi-structured interviews are conducted with a wide range of stakeholders from all relevant administrative levels of state, all possible levels of the traditional leadership, the most important sectors of the market and from civil society. Qualitative interviews are suitable to attain in-depth information to increase understanding[51]. Semi-structured interviews are particularly suitable as the selected respondents often have demanding agendas and cannot be interviewed more than once and then only under restricted time limits. This kind of interviews is flexible enough to let the informants open up and express themselves in their own terms, but structured enough to enable the interviewer to get what he wants during restricted time [52]. Interviewing each respondent on their own is assumed to be a valid method to elicit what they express as

valuable as individuals. The sources for the semi-structured interviews are presented in table 1, below.

Table 1. The sources for the semi-structured interviews.

Role	Level	Sector
Director of the National Disaster Management Office	National	State
Commissioner of division	Divisional	State
Provincial administrator	Provincial	State
Chairman of provincial council	Provincial	State/Traditional
Headsman of village (Turaga ni koro)	Village	State
Paramount chief of tribal confederacy	Tribal confederacy	Traditional
Chief of province (yasana, not interviewed)	Provincial	Traditional
Chief of district (tikina, deceased)	District	Traditional
Chief of village (koro)	Village	Traditional
Representative of sugar industry	National	Market
Representative of tourism industry	National	Market
Representative of Fiji Red Cross	National	Civil Society
Representative of regional NGO	National	Civil Society

When working in the field it turned out that the chief of the selected province (yasana) was difficult to interview, as he was constantly traveling both abroad as well as within Fiji. It also turned out that the chief of the selected district (tikina) died recently and the new chief was not yet selected. This is however not considered to lower the validity of the research too much, as the remaining sources still cover a broad range of potential stakeholders in disaster risk reduction in Fiji. It also turned out that the director of the National Disaster Management Office had two of his senior officers present and the paramount chief of a tribal confederacy had one official present during the interviews.

The interviews start by asking the respondents to explain what they do and what role they have in society. The respondents involved in the governing of Fiji is then asked to explain what type of information regarding risks they give or are requested to give to other stakeholders and also what information they get or request from others in everyday life. This question is then rephrased to cover what information that is given and requested during disaster situations. The data from these themes are not directly used in this article. The next part of the interview, which includes all respondents, is divided into two themes in which the respondents are asked to give their opinions on what they consider to be valuable in everyday life as well as in disaster situations. The length of the interviews varies between thirty minutes and two hours, but the majority of them are about one hour long, leaving approximately eleven hours of material to analyze.

The data for analysis is extracted from the interviews by listening through each interview and taking notes of what is expressed as valuable by the respondents, in what order these aspects are mentioned and if they are expressed in an associative manner. The result of this process can be illustrated in tables and analyzed in order to find potential similarities and differences among the respondents, see table 2 and 3 below. More qualitative data related to why the respondents express what they express is also extracted from the interviews and noted to be included in the analysis.

4. Results

The result of the study is rather interesting as there is a wide variety in what the different respondents express as valuable, especially in relation to everyday circumstances. The variation is somewhat less in relation to disaster situations. What the respondents express as valuable and important to protect is summarized in Table 2 and 3 below, as well as the order

in which each aspect is mentioned during the interviews. Aspects mentioned in an associative manner are represented by the same number but with a letter specifying the internal order. E.g. the provincial administrator rank marine resources (1) as the most valuable and important to protect and land resources (2) as second most, in everyday circumstances, but he specifies that the reason for this is that these resources are vital for the livelihoods (1a/2a) of the people in his province.

Almost everything that the respondents express as valuable can be categorized under aspects concerning life, property or the environment. Categories that are commonly used in disaster management legislation and policy, both in Fiji and elsewhere. The only two expressed aspects that do not fit into such categories are “transparency in public sphere” and “political stability”. What the respondents express is rather widely spread between the categories when it comes to what they consider valuable in everyday circumstances, with five respondents first mentioning aspects related to life and four respondents mentioning aspects related to the environment first. When it comes to what they express when putting themselves in a disaster situation, things are different with 9 out of 11 respondents mentioning aspects related to life first, and another respondent qualifying the importance of protecting the environment by stating that it is vital to sustain life. Aspects related to property are mentioned by six respondents in this context, out of which two mentions them before already mentioning aspects concerning life. Only one mentions aspects related to the environment.

Table 2. Summary of what the respondents expressed as valuable and important to protect in everyday circumstances

	Director of the NDMO	Commissioner of division	Provincial administrator	Chairman of provincial council	Headsman of village (Turaga ni koro)	Paramount chief of tribal confederacy	Chief of village	Representative of sugar industry	Representative of tourism industry	Representative of the Fiji Red Cross	Representative of regional NGO
Everyday circumstances											
Life	1	1				2		1	1		
- Life of people		1a								1a	2a
- Culture/Traditional knowledge		2	4			2a				1	4
-Livelihoods			1a/ 2a			1c					3a
Property	2										
- Infrastructure, roads/bridges						3					
- Infrastructure, jetties				2							
- Evacuation centre					1						
- Sea walls					2						
- Land use								2			
- Sugar mills and infrastructure								3			
Environment						1					
- Marine resources		1b	1			1a	2				1
- Land resources		1c	2				1				2
- Endangered species			3								
- Mangroves						1b					1a
Other											
- Transparency in public sphere				1							
- Political stability											3

The respondents from the National Disaster Management Office express ideas very similar to those specified in legislation and policy regarding disaster management in Fiji. This goes to a large extent also for the commissioner of one of the divisions in Fiji, but with additional specification that marine and land resources are vital to uphold life in Fiji, which is mentioned by four and three other respondents respectively. The commissioner also mentions traditional knowledge as valuable since it is vital for how people cope with disasters. Traditional

knowledge is mentioned in different ways by the provincial administrator, the paramount chief and both respondents from civil society. What the provincial administrator express as valuable is also much in line with relevant legislation and policy when in disaster situations, but not in everyday circumstances. Here the provincial administrator is first and foremost focused on environmental aspects, even if marine and land resources are specified as vital for the livelihoods of the people. Similar focus in everyday circumstances is found with the paramount chief, the village chief and one of the respondents from civil society.

Table 3. Summary of what the respondents expressed as valuable and important to protect in disaster situations.

	Director of the NDMO	Commissioner of division	Provincial administrator	Chairman of provincial council	Headsman of village (Turaga ni	Paramount chief of tribal	Chief of village	Representative of sugar	Representative of tourism	Representative of the Fiji Red	Representative of regional
In disaster situations											
Life	1	1	1			1b		1	1		
- Life of people	1a	1a		1			1			1a	
- Livelihoods											1a/ 2a
- Human dignity										1	
- Food	1b	1b					3				
- Water	1b	1b									
- Shelter	1b	1b	3								
- Sanitation	1b										
Property	2										
- Peoples' property											3
- Infrastructure			2								
- Evacuation centre					1						
- Sea walls					2						
- Boats							2				
- Sugar mill and infrastructure								2			
- Sugar cane/agricultural produce								3			1
- Tourism infrastructure											2
Environment						1					
- Marine resources						1a					
- Land resources						1a					

The chairman of the provincial council is focusing on life in relation to disaster situations, but not at all expressing aspects related to life or the environment in everyday circumstances.

The chairman is instead focusing on the importance of transparency in the public sphere and of building and protecting jetties along the coast. This focus on aspects related to property is shared with the local state representative on village level, the Turaga ni koro, who specifies evacuation centre and sea walls as valuable in both everyday circumstances and in disaster situations. The respondent from the sugar industry is also highlighting the importance of property aspects related to the cultivation of sugar cane and production of sugar, but only after expressing the overriding importance of human life. The paramount chief also includes the importance to focus on protecting road transport infrastructure in everyday circumstances, but first after mentioning aspects related to the environment and life. The village chief also mentions the importance of protecting boats in case of a disaster. The respondent from the tourism industry expresses a sole focus on protecting human life, but qualifies this by stating that the overriding importance is the safety of the guests at tourism facilities, followed by the importance of protecting staff and finally followed by assisting nearby communities. The respondent from the Fiji Red Cross expresses the importance of traditional knowledge in everyday circumstances and to preserve human dignity in disaster situations, both of which is explained by their vital importance for human life. The other respondent from civil society is instead focusing, in everyday circumstances, on environmental resources, on political stability and on preserving traditional knowledge, qualifying these aspects as important to the life and livelihoods of people. In disaster situations the focus is instead on protecting the two main industries in Fiji, as they are vital for the livelihoods of so many, as well as the country's general infrastructure.

5. Discussion

The results of the study indicates that any assumption that all stakeholders in disaster risk reduction activities implicitly agree on what is to be considered valuable and important to protect may not be valid with wider participation. The respondents are all potential stakeholders in disaster risk reduction and the variation between what they express is substantial. However, this variation is perhaps not surprising, as each respondent has his or her own roles, responsibilities, goals, experiences, values, sets of cognitive abilities, etc.

The roles and responsibilities of the respondents may play a role in what the respondents express as valuable. For example, the director of the National Disaster Management Office and the commissioner of a division, who is responsible for disaster management on the divisional level, express ideas that are in line with relevant legislation and policy. This may be an indicator that what they express is influenced by their central roles in making sure that the stakeholders in Fiji follow these legal and policy provisions. Similarly, the respondent from the Fiji Red Cross is the only respondent mentioning protecting human dignity, which was chosen in 2003 as the theme, overall goal and slogan for all Red Cross/Red Crescent activities worldwide [53]. Other examples is the respondent from the sugar industry who mentions sugar cane and sugar production infrastructure as valuable, or the village headman who mentions evacuation centers and sea walls, which both are within his responsibility to maintain. It thus seems like the roles and responsibilities of stakeholders in disaster risk reduction influence what they express as valuable.

Personal interests and experiences may also influence what the respondents express as valuable. For example, the provincial administrator is the only respondent mentioning endangered species, which turns out in the interview to be a personal interest as he is committed to and involved in wildlife conservation projects. The respondent from a regional Non-Governmental Organization (NGO) express marine and land resources and refers in the interview to projects that the NGO has been implementing recently. The respondent is also the only one mentioning political stability as valuable and important to protect, which later in the interview is explained by indicating that the respondent is Indo-Fijian and has only one cousin left in Fiji out of 16. The rest have emigrated after the riots and repression against Indo-Fijians since the 2000 military coup. The village chief mentions boats and describes in the next second how he lost his boat engine and how his boat now is destroyed. In general, all

respondents give reference to personal experiences when expressing what they perceive as valuable.

As values guide all human thinking [54], the values of the respondents are likely to have a direct impact on what they express as valuable. However, values are, as stated in the theoretical framework, notoriously difficult to measure and not dealt with directly in this study. How the values of the respondents influence what they express as valuable is thus not possible to determine based on the empirical data of this study. It is nonetheless an interesting field for future research.

The variation between what the respondents express is larger when asked what they think is the most valuable in general, than when the question is rephrased into what they think is the most valuable in a disaster situation, when winds are howling and flood water flowing. An explanation of this may be that most of the respondents are likely to have directly or indirectly experienced the impact of disasters. The specification of the situation thus gives the respondents a more common relevance structure in which similar sets of schemata and scripts are activated aligning what is expressed by moving similar blocks of knowledge from their subsidiary awareness into their focal awareness. The same cognitive processes are also likely to influence what the respondents express in the specific situation of the interviews. What we talk about, what I ask, what is visible from where we are sitting etc, are also likely to influence what they express. The empirical material is however not sufficient to draw any mayor conclusions on this.

The substantial variation in what the respondents express as valuable when asked individually should however not be understood as an indication that it would be difficult to reach consensus if the respondents got the opportunity to explicitly discuss the issue. Research has pointed in the opposite direction when studying how various groups of Swedish civil servants elicit mutually agreed lists of what to be considered valuable as a basis for risk and vulnerability analysis [9]. Reaching a general agreement in this issue may be particularly achievable if what is expressed as valuable is possible to relate to each other, e.g. the reason behind why boats are valuable along the coast of a remote island is that the people living there are dependent on them for their livelihoods (fishing, transporting goods to and from the market, going to school, etc). It is thus advised when facilitating such a explicit discussion not to make lists and attempt to directly prioritize and select what is to be considered valuable, but instead try to use what is expressed to build a network or system of what is valuable by asking why each expressed item is valuable as well as what else is necessary to secure that. For example, the reasons for expressing people's livelihood as valuable may be that people need their ways to sustain their living, or else they will not be able to afford food, which is vital not to starve or even die. What is needed for the people to secure their livelihood may be fishing and access to a marketplace, which both require boats. To be able to catch fish, the people need fishing nets and there must be sufficient fish in the ocean, which in turn requires a clean marine environment and enforced fishing restrictions. The system that results from this discussion is presented as a tree structure in figure 1 below (the numbers are only indicating the order in which each part is mentioned).

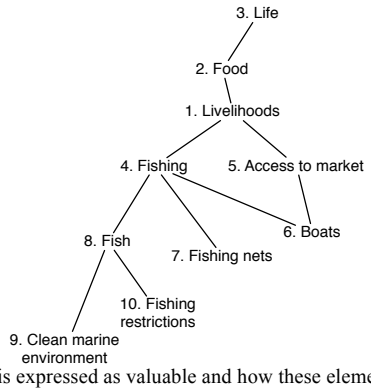

Fig. 1. An example of what is expressed as valuable and how these elements are related to each other.

This way of eliciting what stakeholders together view as valuable is not only likely to generate a rich picture, but also to facilitate consensus among stakeholders as most of what each express individually can be taken into account. The final system is then a tool for guiding the rest of any disaster risk reduction initiative as it visualizes and specifies in practice what is valuable and important to protect in that particular context. This approach may be particularly suitable for contexts with stakeholders from multiple levels of administration, as there may be a tendency for higher levels to focus on general things, like life or property, without specifying how these translate locally, and for lower levels to focus on specific practical things without explaining how these relates to higher societal values.

Common and mutually understood goals among stakeholders are important for the implementation of any project to be effective [55, 56]. Hence, to ensure effective disaster risk reduction it is vital that all stakeholders share objectives, and the first step of securing that is to have an explicit discussion of what is to be considered valuable.

6. Conclusion

So, what do stakeholders in disaster risk reduction in Fiji express as valuable and important to protect? The study indicates that all but a few mentioned aspects can be categorized under aspects concerning life, property and the environment. The variety between stakeholders is however substantial. This may not be surprising, as each respondent has his or her own roles, responsibilities, goals, experiences, values and sets of cognitive abilities. Factors that all seems to influence what stakeholders express and valuable. However, the variation in itself is enough to raise a serious question about the validity of any participatory approach to disaster risk reduction that is built on the assumption that all stakeholders implicitly agree on what is valuable. In order to facilitate effective disaster risk reduction projects, it is instead important to start by involving the stakeholders in an explicit discussion of what is valuable in their specific context. Without such discussion there is a risk that stakeholders unintentionally impede each other's efforts by pursuing different objectives. An explicit discussion of what is valuable is not only vital to facilitate the formulation of common goals, but is likely to generate a rich picture of what is valuable in that particular context. The discussion should not have the initial objective of listing and selecting individual aspects, but instead of trying to use what is expressed to build a system of what is valuable by asking why each aspect is valuable as well as what else is necessary to secure that aspect. This way of eliciting what stakeholders together view as valuable is likely to facilitate consensus among stakeholders as most of what each express individually may be included in the system. The final result of the discussion can then be used as a tool for guiding the rest of any disaster risk reduction initiative as it visualizes and specifies in practice what is important in that particular context and thus what the initiative should focus on protecting.

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III

What's important? Making what is valuable and worth protecting explicit when performing risk and vulnerability analyses

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Abstract: Values and opinions about what is valuable, are of central importance in risk and vulnerability analyses. Yet what is considered valuable is seldom explicitly established. The aim of this study is to explore what groups of civil servants express as valuable and worth protecting when performing risk and vulnerability analyses in their organisations and to discuss the underlying reasons for their stipulations. A theoretical framework is elaborated and applied on the outcome of four seminars, in which participants from Swedish public organisations express what they consider valuable and worth protecting. The results show considerable variation in what is expressed as valuable and worth protecting. Possible explanations for the variation and the usefulness of the outcomes of the different seminars are discussed.

Keywords: explicit; opinions; value; valuable; worth protecting; intrinsic; extrinsic; risk analysis; vulnerability analysis; make explicit; establish; variation; crisis management; emergency management; instrumental.

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1 Introduction

Swedish legislation states that each municipality and county council shall analyse what extraordinary events may occur within their geographical area of responsibility, as well as how these events may influence their own activities (SFS, 2006). The legislators specify that risk and vulnerability analyses should be conducted to meet this requirement.

Performing risk and vulnerability analyses is basically about estimating threats against what is considered valuable. In practice, however, what is considered valuable is far from always explicitly discussed by those participating in risk and vulnerability analyses, but taken for granted or reduced to a few all-embracing categories, such as safety, health and the environment, relying inherently on an agreement of what should be considered valuable and at risk or susceptible to the impact of hazards. Consequently there is a risk that other things that the participants as well as other stakeholders may view as valuable are not considered and are not included in the analysis. Making what is valuable explicit, however, provides a better chance to include whatever is relevant to the participants and other stakeholders in the analysis. In a municipal or county council context, it may be useful to specify what is valuable in order to identify threats to the basic goals of the particular organisation and what activities and societal functions are critical for society and necessary for avoiding or handling crises.

Despite some inability to appreciate the importance of explicating what is valuable when performing risk and vulnerability analysis in practice, the centrality of values[1] has been recognised by scholars and addressed in different studies concerned with risk and vulnerability. Renn (1998, p.53), for example, has remarked, "Values are reflected in how risks are characterized, measured and interpreted". Studies in this vein have considered individuals' ratings of different hazards with regard to qualitative characteristics (Slovic et al., 1980) and the central role of values (e.g., Otway and von Winterfeldt, 1982; Slovic, 1987) and culture (Douglas, 1982) in determining how individuals perceive risk and whether or not organisational values differ between public and private sectors (Van der Wal et al., 2008). Other studies have had a more prescriptive approach and for example emphasised the importance of studying values in risk management and of making them explicit. Keeney (1996) exemplified ways of bringing technical information and public values together in risk-based decision making (Bohnenblust and Slovic, 1998). Hallin et al. (2004), on the other hand, have stressed the importance of establishing what is considered worth protecting from deterioration in a specific context when performing municipal vulnerability analyses. That something is considered worth protecting signifies that it is seen as valuable in the sense of being good. Heretofore, however, there appears to be no study focusing on exploring what really is explicated, and how, when different groups of civil servants are gathered and given the opportunity to express what they consider valuable and worth protecting from being damaged in a crisis. The aim of this study is to explore what groups of civil servants express as valuable and worth protecting when performing risk and vulnerability analyses in their organisations and to discuss the underlying reasons for their expressions.

The study starts by discussing the meaning of the term valuable, how different entities considered valuable may be related to one another, as well as factors that may influence what groups of civil servants express as valuable when performing risk and vulnerability analyses. An account of the goals of the society that the civil servants' opinions on what is valuable may be related to is also given. Thereafter follow sections on methodology and empirical results from four participatory seminars, performed in three Swedish

municipalities and one county council. The study ends with a discussion of the results of the four seminars and with conclusions on the usefulness of explicitly establishing opinions on what is valuable and important to protect from damage as an initial step in risk and vulnerability analyses.

2 Participants' statements on what is valuable when performing risk and vulnerability analyses – a theoretical framework

Performing a risk analysis is about assessing the probability of undesired events and their consequences. Assessing the consequences is basically a question of evaluating the deterioration of something that is considered valuable. Similarly, vulnerability analysis is about assessing the incapability to withstand and manage crises and emergencies that arise from internal or external factors and that may threaten what is considered valuable and worth protecting (cf. Hallin et al., 2004). Although both the risk analysis and vulnerability analysis deal with opinions as to what is considered valuable, such opinions are not always explicitly identified and established. This study is an attempt not only to argue the importance of explicitly establishing views of what is valuable on the parts of those involved in risk and vulnerability analyses, but also to examine and discuss what different groups of civil servants express as valuable and worth protecting when they are given the opportunity. To do so it is needful first to:

1 elaborate on what valuable means and why something may be considered valuable

2 discuss factors influencing what is considered and expressed as valuable in a specific situation

3 consider how different entities found valuable may be related to one another

4 discuss goals of the society and public organisations that the civil servants' opinions on what is valuable and worth protecting may be related to.

2.1 The meaning of valuable and valuable as meaning

Arguing the importance of identifying opinions on what is valuable in risk and vulnerability analyses requires a clear definition of the term valuable. According to American Heritage Dictionary (2000) the meaning of valuable as an adjective is:

1 having considerable monetary or material value for use or exchange: a valuable diamond

2 of great importance, use, or service: valuable information; valuable advice

3 having admirable or esteemed qualities or characteristics: a valuable friend.

Many things may thus be valuable, such as concrete objects, processes, structures, people and even moral and ethical positions. However, nothing has value in itself, only the value ascribed through the projections of human sentiments onto whatever is declared to have value (Hume, 1739, Book 3, Part 2, Section 7; Hägerström, 1953). This value is not stable because the world is complex and fluid in such a way that the solution to one

problem in one particular context, place and point in time, may become the source of problems in another (Dewey, 1922). In accordance with this viewpoint, the way we experience a phenomenon, physical or imaginary and consider it valuable or not depends on the meaning it has for us in a certain situation (Blumer, 1969; Husserl, 1970) and context (Giddens, 1984). In a situational setting, meaning for a person is created through social interaction the individual has with his or her fellows and modified in an interpretative process by the person trying to define the situation (Blumer, 1969). In such an interpretative process, identities and power relations will play an important role (Cast, 2003) in the way that individuals may influence their conceptions of meanings in situations by acting, more or less guardedly, in ways that confirm or reject identities – their own or those of other people. What people find valuable can in this respect be seen as social constructs by human beings acting in different social contexts. When the system of reciprocal roles, or structure as Giddens (1984) calls it, becomes embedded in everybody in a particular context, it restricts people's conception of 'reality' and also what is ascribed as valuable. In other words, their actions produce and reproduce social structures that in turn guide and restrict them in what they think of and regard as valuable. Consequently, the social context will strongly influence how people perceive and understand something and therefore also what they will see as valuable and how they will act in that social context. Still, the mechanisms are largely subliminal to us and we perceive and take the world for granted (Husserl, 1970).

2.2 Mechanisms and factors influencing statements on what is valuable

Analysing what groups of people consider valuable is not an easy task. In this study the approach is to ask groups of people (i.e. civil servants), gathered in seminars, to express what they find valuable and worth protecting. In such situations some specific mechanisms have the potential to influence what will be expressed. Our cognitive abilities play an important role in accessing and articulating what we perceive as valuable. It has, for example, been suggested that our knowledge (or knowing) is not always possible to express due to some of it being tacit. Polanyi (1966, 1969) offers an influential account that is particularly helpful here. According to him, there is an intimate relation between our tacit knowledge and our awareness. Polanyi (1969, p.144) claims "all knowledge is either tacit or rooted in tacit knowledge". Tacit knowledge consists of two kinds of awareness, subsidiary and focal, in constant interplay. The subsidiary awareness is used as a function or tool for focusing our attention (focal awareness) toward something and experiencing it as an object or phenomenon, thus making it explicit for us. What is tacit and what is explicit are constantly changing, though. A person beginning to play the piano is initially aware of finger movements and other details. As the person becomes more skilled at playing the piano, he or she will only be subordinately aware of the finger muscles moving or his or her musical senses [Senge, (2006), pp.152–153]. Still, the person is dependent on these skills. She may also change focus to the finger movements and only be secondarily aware of the music they produce. Another example is the semiotic interpreter who cannot keep up with the interpretation if he starts listening to the meaning of what is communicated. This implies that an individual's perspective, prior knowledge, frames of reference, level of skill, perception of relevant structure and the specific situation determine what he or she may focus on at that moment. Similar results have been found in research in cognitive

sciences studying the use of schemata and scripts as instruments for simplifying our thoughts and behaviour.

The term schema was initially used when studying how people remember things (e.g., Bartlett, 1932). Schemata can be defined as 'mental structures that incorporate general knowledge' [Anderson et al., (1978), p.434]. They work as filters constantly evolving through incoming information and affecting how we understand, interpret and remember incoming information. It has been shown that activating an appropriate schema in a certain situation may enhance interpretation and remembering (Mason, 1992). However, there are also results showing that experiences that do not fit into existing schemata are less prioritised and eventually sorted out, at the same time as others are taken in that fill the gap and make the story more coherent (Mason, 1992). Another type of cognitive structure is a script. A script can be seen as 'a set of expectations about what will happen next in a well-understood situation' [Schank and Abelson, (1995), p.5]. Scripts make an individual act in a specific situation without thinking too deeply about what steps to take next. A certain stimulus will simply trigger a sequence of causal behaviours. Our scripts and schemata may thus be regarded as both triggers and filters for what we are thinking of, and do not come to think of, in specific situations. It is highly likely that the interplay between subsidiary and focal awareness, together with the existence of scripts and schemata, affects our ability to express what we consider valuable in a certain situation.

As already indicated, power relations are also likely to play an important role in what is expressed as valuable in specific social contexts. Power is a highly debated concept and has been defined in many different ways. However, Lukes' (1974, 2005) three dimensions of power may be helpful in this context. The first dimension is related to the use of power through concrete and observable behaviour in apparent conflicts between stakeholders' interests regarding concrete issues. The second dimension relates to non–decision-making power, in which potentially controversial issues are prevented from generating apparent conflicts by controlling the agenda and making certain issues unacceptable for discussion. The third dimension of power is the ideological power to influence the wishes and thoughts of people and to make them want things divergent from what would potentially benefit them. It is clear that different human agents in a specific social context influence the construction and maintenance of social structures to different degrees. Power thus automatically influences what is expressed as valuable in risk and vulnerability analyses.

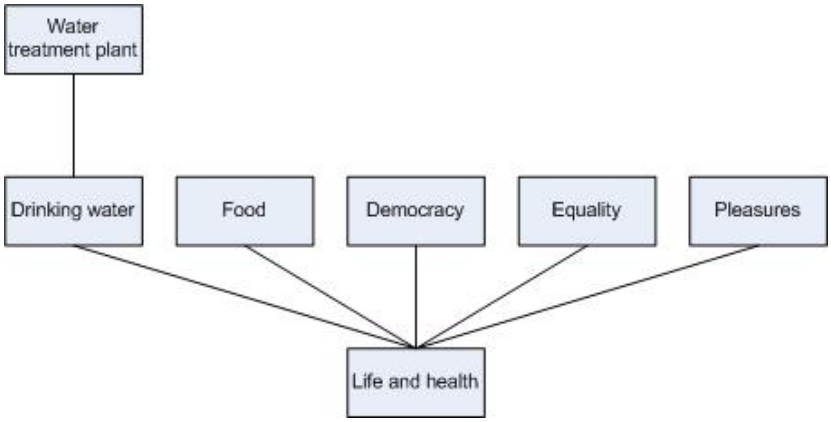
It can be noted that Lukes' account of power does not fully include power in the sense of using it for the good of other people. However, it is sufficient for illuminating the potential influence of power in the empirical part of this study.

2.3 Relations between different things considered valuable

Objects and phenomena in the world around us have relations and may be related to one another. Their value may be seen in light of such relations, something with which scholars in philosophic value theory[2] have been concerned for many years. From a philosophic value theory perspective, something that is considered valuable may be seen as either having a value in itself, i.e. being intrinsically valuable, or as having a value for something else, i.e. being extrinsically valuable. The notions of intrinsic and extrinsic values have their roots in Plato's reasoning about pleasure in relation to bad consequences (Stanford Encyclopaedia of Philosophy, 2009b). In Plato's view one may

for example condemn pleasure, not primarily for its own sake but for the consequences it might have. The distinction between intrinsic and extrinsic values is useful because it provides a way of understanding the relation between different things being considered valuable and why something is seen as valuable. Figure 1 illustrates a hypothetical example where different entities considered valuable by someone have been related graphically in an intrinsic-extrinsic structure by the person in such a way that 'life and health' is considered intrinsically valuable and all other things extrinsically valuable in relation to it. This particular example shows that the water treatment plant is considered valuable in its role of producing drinking water to support life and health. Entities which are means to something else in this manner are often more specifically referred to as having an instrumental value, which is a type of extrinsic value (Zimmerman, 2001; Vilkka, 1997).

Figure 1 Example of relations between what may be considered intrinsically valuable and what may be considered extrinsically valuable (see online version for colours)



Notes: In this example 'life and health' is considered intrinsically valuable and drinking water, food, etc. as extrinsically valuable. The water treatment plant is extrinsically (i.e., instrumentally) valuable in relation to drinking water because it is required to produce it.

2.4 Goals of the society to which the civil servants' opinions on what is valuable and worth protecting may be related

The idea of this study is to compare the outcome of different seminars where civil servants express their views on what is valuable and worth protecting, based on their organisational contexts. In the Introduction it was stated that each municipality and county council is required by law (SFS, 2006) to analyse what extraordinary events may occur within their geographical area of responsibility, as well as how these events may influence their individual activities. There is no point in maintaining such activities for their own sake, however. They need to be related to the purposes and goals of public organisations and society. The Swedish Parliament, taking an obvious anthropocentric perspective, has established that the goals for national security should be to protect peoples' life and health, the functionality of society, and the capacity to maintain our basic values, such as democracy, legal security and human freedoms and claims (Swedish

National Audit Office, 2008). This places a great deal of responsibility on the whole of society, but perhaps especially on public organisations such as municipalities and county councils, which are specifically required to see to the needs of individuals and society and for maintaining societal functions. It is reasonable to believe that the civil servants in some way relate to these goals when considering what is valuable in their organisations. These goals may therefore serve as a model for structuring and categorising the civil servants' opinions on what is valuable and worth protecting. Such a categorisation is described in the following section.

3 Methods

The question this study aims to answer is what groups of civil servants identify as valuable and worth protecting as a preliminary step in municipal or county council risk and vulnerability analysis and what motivates their statements. To empirically answer this research question, a study was conducted where the results from four seminars (A–D) were compared and contrasted in order to find variations in the outcome. This way of identifying variation in expressions about what is considered valuable has similarities with the phenomenographic research approach (cf. Marton, 1981). In a phenomenographic study the idea is to highlight differences in how a phenomenon is perceived and experienced by different people (Marton and Booth, 1997). The result of phenomenographic studies is a number of descriptive categories showing the perception of something in qualitatively different ways – in this case, the civil servants' perceptions and opinions on what is valuable and worth protecting are at the centre of the analysis. The data in the four cases were obtained in seminars with representatives from four Swedish public organisations where the participants were instructed to identify, on the basis of their organisational context, what they regarded to be valuable and in their opinions should be protected from damage and deterioration. Seminar A considers the view of nine managers in a municipal healthcare department. Seminar B covers the opinions of seven civil servants in a municipal housing and environment department together with one coordinating preparedness planner. Seminar C describes the views of nine individuals representing mainly preparedness planning and media functions in a municipality. Seminar D includes 21 individuals representing preparedness planning functions in different parts of a county council with responsibility for medical service, public transport, industry development and culture. In all cases the individuals taking part in the analyses were unanimously prepared to participate in vulnerability analyses aiming at assessing the capability of their organisation to handle different kinds of scenarios. In Seminar D all participants already knew at the first seminar that the subsequent seminars were to be about a pandemic flu scenario, something which may have affected the outcome of the seminar.

The seminars went on for 30–60 minutes and were led by a moderator who wrote down all views on what is valuable and worth protecting on a whiteboard until no one could add anything more. The writing consisted of single terms like 'drinking water' and 'freedom of speech'. The whiteboard was photographed and the discussions in Seminars A–C were also recorded on a Dictaphone. During the seminars no, or only a very moderate ad-hoc, categorisation of the input was made.

The participants' opinions on what is valuable and worth protecting were thereafter analysed by the authors using a mix of open and axial coding (Strauss and Corbin, 1990),

where the expressed opinions were related to the goals for national security as established by the Swedish Parliament. Attempts were first made to distinguish different categories of what is valuable and worth protecting among these goals. In this context, taking an anthropocentric viewpoint and acknowledging the role of the public organisation as well as applying the idea of structuring what is valuable in an intrinsic-extrinsic/instrumental manner, three categories could be identified and related to each other:

1 life and health (intrinsically valuable)

2 individuals' needs to maintain life and health (extrinsically valuable to life and health)

3 the functionality of the organisations and society for maintaining the life, health and needs of the individuals by supplying products and services (extrinsically valuable to individuals' needs).

These three categories will henceforth be termed more briefly 'life and health', 'individuals' needs' and 'organisational and societal supplies'. Life and health and individuals' needs in this respect include both those of the consumers of services and products of the organisations studied as well as those of the people working in the organisations. Organisational and societal supplies primarily involve products and services supplied by the public organisations, but also include societal functions, private companies and resources in a broader sense, since the public organisations studied here do not themselves possess all resources for maintaining people's life, health and needs.

Attempts were thereafter made to classify the expressed opinions in the seminars in accordance with these three categories. The authors also endeavoured to discern different subcategories of these three categories. Ten such subcategories were found. These subcategories are presented below and can be seen in Figures 2–5. In Figures 2–4 the different aspects of what was expressed as being valuable and worth protecting have also been numbered in the order in which they were brought up during the different seminars. Table 1 gives an overview of how the participants' statements of what is valuable and worth protecting were distributed among the specific categories in the four seminars. It should be added, for the clarification of issues related to the credibility of the data, that characteristics of the participants' speech, and emphasis on certain words and so forth, have not been considered in this study.

4 Results

Studying the outcome of the four seminars, in which the participants identified what they found valuable and worth protecting in their organisational contexts, revealed that they involved very different issues, such as elderly people's belongings and memories, whole infrastructure systems and freedom of assembly. Despite this variety of opinions on what is valuable, it was found that they could be grouped in the categories that related to the model of the civil servants' work contexts, i.e., life and health, individuals' needs and organisational and societal supplies.

Life and health can be seen as a category in its own right and although one could conceive of different subcategories of it, the empirical material obtained did not provide enough information for making such further categorisation useful. The category 'individuals' needs', however, was structured in four subcategories:

1 biological needs
2 affective and emotional needs
3 social needs
4 environmental needs.

Likewise, opinions of what was regarded valuable that could be related to the category 'organisational and societal supplies' were grouped in five subcategories:

1 processes and functions
2 structures (of the organisation)
3 culture and attitudes
4 equipment and resources (including natural and human resources)
5 infrastructure and real estate.

No attempts were made, however, to relate in detail the different subcategories to each other in an intrinsic/extrinsic structure.

Comparing the outcomes of the four seminars in Figures 2 to 5 and studying what categories and subcategories the different things identified by the participants as valuable and worth protecting from damage could be related to, one can on the whole see considerable variation. Studying first the outcome of Seminar A (Figure 2), one can see that the participants identified aspects of the category 'life and health' as valuable and worth protecting that were both quite general (i.e., life and health) as well as rather specific (i.e., subjects of life, such as clients and staff). The types of needs the participants brought up could be classified as 'biological needs' and 'affective and emotional needs'. Studying the organisational and societal supplies category, most issues brought up concern the subcategory 'culture and attitudes', followed by the subcategories 'processes and functions' and 'structures'. Only a few factors having to do with the subcategories 'equipment and resources' or 'infrastructure and real estate' were mentioned.

The outcome of Seminar B (Figure 3) differs very much from the outcome of Seminar A regarding what categories and subcategories the opinions on what is valuable and worth protecting brought up could be related to. In this case, no aspects of what was stated as being valuable could be directly associated with 'life and health', 'structures', 'culture and attitudes' or 'biological needs'. Only one subject of what was expressed could be classified as 'affective and emotional needs'. Frequently mentioned instead were needs that could be classified as 'social needs' and 'environmental needs'. The most considered subcategory, however, was 'infrastructure and real estate', to which several matters could be related. Many issues could also be classified as 'processes and functions' and a few as 'equipment and resources'.

The outcome of Seminar C (Figure 4) very much resembles that of Seminar B. Infrastructure and real estate, processes and functions, social needs and environmental needs are all subcategories to which a great deal of what was explicated as valuable and worth protecting could be related in both seminars. Another similarity is that nothing of what was identified as valuable in these two seminars could be classified as 'biological needs' or 'structures'. However, there were also some minor differences between the two cases. Culture and attitudes, for example, were considered in Seminar C but not in Seminar B, whereas matters that could be related to 'equipment and resources' were

identified in Seminar B but not in Seminar C. Other differences are that a few more subjects that could be related to 'affective and emotional needs' were brought up in Seminar C than in Seminar B and that life (albeit in a general form) was mentioned in Seminar C but not in Seminar B.

The outcome of Seminar D (Figure 5) is distinctive in that relatively few needs are identified. However, there are some similarities with the outcome of Seminar A. The subjects of life mentioned, for example, are similar to the ones in Seminar A, and, as in Seminar A, what is brought up by the participants can largely be linked to the subcategories 'processes and functions', 'structures' and 'culture and attitudes'.

In Table 1 an overview is provided of how often what was identified as valuable and worth protecting in the four seminars could be related to the different categories and subcategories. Most of what was found valuable could be classified as 'organisational and societal supplies' (97 entities) followed by 'individuals' needs' (46 entities) and 'life and health' (8 entities). The pattern that can be seen in Table 1 is, as has already been indicated, on the whole quite varied and most subcategories vary in occurrence between the seminars. However, some subcategories show certain stability between the seminars. Processes and functions, for example, is a subcategory where generally many features are identified in all seminars. This subcategory, together with 'infrastructure and real estate', also stands out among the subcategories to which most matters could be related when taking into account all four seminars. Studying the different types of needs identified as valuable and worth protecting in all seminars, it can be found that they most often can be associated with 'social needs' and least often with 'biological needs'.

Table 1 The distribution of entities mentioned as valuable and worth protecting among specific categories and subcategories in the four seminars

Categories and subcategories of what was regarded valuable and worth protecting	*Seminar A*	*Seminar B*	*Seminar C*	*Seminar D*	*Sum*
Life and health					8
Life and health	5	0	1	2	8
Individuals' needs					46
Biological needs	5	0	0	3	8
Affective and emotional needs	6	1	4	0	11
Social needs	0	5	7	3	15
Environmental needs	0	8	4	0	12
Organisational and societal supplies					97
Infrastructure and real estate	1	17	7	7	32
Equipment and resources	2	3	0	3	8
Structures	5	0	0	7	12
Culture and attitudes	8	0	1	5	14
Processes and functions	6	8	6	11	31

Three of the seminars (A–C) in Figures 2–4 were studied in particular with regard to the order of appearance of what the participants mentioned as valuable and worth protecting. Comparing the numbered words with the categories they were later placed in, it can recurrently be seen that the words are followed as an ordered sequence within these categories, indicating that the participants identified what they find valuable through an associative manner. This associative approach was sometimes also identified as the associations bridged the categories. The associations often stopped and started afresh by going back to something mentioned earlier. The procedure of going back to what was said before was especially evident in Seminar B, where what had been taken up earlier was discussed, questioned and somewhat reshaped throughout the seminar.

During the seminars it can be said that there were no, or only minor, indications of dominant persons influencing the process in one way or the other. In one case (Seminar C) though, the person responsible for the crisis management preparedness activities, a retired head of a municipal department (a physically big man with conviction), was the one who 'opened' several of the categories for wider discussion by mentioning something he found valuable. However, there was no apparent sign of any exercise of control or power in either of the dimensions described by Lukes (1974, 2005). This does not mean that the power distribution within this or the other groups has not influenced what is being expressed, but that it can be very difficult for someone from the outside, e.g. a moderator, to recognise it.

5 Discussion

The aim of this study is to explore what groups of civil servants express as valuable and worth protecting when performing risk and vulnerability analyses in their organisations and to discuss the underlying reasons for their expressions.

There are both similarities and variations in the results that are interesting to highlight. When trying to structure the opinions on what is valuable and worth protecting, it was found that all expressions could be sorted into ten subcategories, relating to the three overarching categories 'life and health', 'individuals' needs' and 'organisational and societal supplies'. Although the study only involves four public organisations, and other categories might be identified if a greater number of organisations, or other types of organisations, were studied, it appears that the categories found here are quite central and embrace a complexity that is found in the variety of expressions. However, the variation in what is identified in the different seminars and the categories they may be related to is considerable. Although there is an emphasis in quantitative terms on 'organisational and societal supplies', and especially 'infrastructure and real estate' and 'processes and functions' (cf. Table 1), the only specific identification of what is valuable and shared in all four seminars is the provision of elderly care. Moreover, some issues that one may assume everyone agrees on as being valuable and worth protecting, such as biological needs and life and health, are not recognised in some of the seminars.

It is not likely that the outcome of the seminars mirrors every feature the civil servants may consider valuable and worth protecting and the results should probably be complemented to be really useful as data for identifying all relevant hazards and threats. However, it is likely that what comes up is relevant for the participants and this result illuminates a variation among the seminars that partially mirrors the civil servants' different organisational contexts. In this paper it is argued that what is considered

valuable is constructed in social contexts and situations by individuals on the basis of the meaning they see. Although it may seem somewhat self-evident that different organisations hold different views on what is valuable and worth protecting, it is also evident that context matters. It could for instance be argued that the reason the participants in Seminar A, which belong to a municipal healthcare department, express many basic biological needs is that they are working in close contact with clients unable to take care of themselves and where they must satisfy such needs. The close relationship between clients and staff may also explain why relatively many issues that may be related to 'culture and attitudes' are regarded valuable. This perspective has probably been moulded and maintained through social interaction at work for years or decades. As a contrast, in Seminars B and C the individuals in the organisations do not work directly with such clients, which may be the reason biological needs are not expressed as being valuable and worth protecting. Studying in particular the outcome of Seminar B, which involved civil servants working in a municipal housing and environment department, shows instead that the participants have focused on issues which can be related to the subcategories 'infrastructure and real estate' and 'environmental needs'. Although a large part of the listed infrastructures are not controlled by the organisation itself, they may be issues that are closer to the individuals, in their roles as civil servants in a municipal housing and environment department, than to the individuals working in a municipal healthcare department. However, at the same time the outcomes of the seminars are full of examples showing a variety that is poorly explained by the different contexts and where it can be questioned what the reasons for the explicated opinions really are. Studying the different seminars, we can find some indications of different mechanisms related to the participants' cognition and analysis situation having an effect on the outcome.

The material shows, for example, that there is a strong associative element present when the participants clarify what they find valuable and worth protecting. This is visible in all cases, but can perhaps be seen most clearly in Seminar B, where many infrastructure issues were identified in a cohesive order. What springs to the participants' minds and becomes explicit in the dialogue at the seminars is influenced by their schemata, their mental models through which they interpret the world, as well as their scripts, their encoded sequences of causal expectancies and behaviours that are activated by a given impetus. These mechanisms are likely explanations why specific subjects, like 'practicing good leadership', which ought to be relevant for all the four organisations, are identified in one seminar but not the others.

A related explanation for the outcome may be found in the technique used during the seminars. The approach chosen, i.e., not structuring the expressions of what is regarded valuable and worth protecting systematically in a supply and need structure at the time of the seminars, is a likely reason that, for example, issues relating to biological needs, are not always mentioned. Participants mentioning an issue as either a supply or a need may at the same time implicitly include the other aspect, i.e. an individual's perception and opinion regarding a phenomenon may be broader than how it is described in words. It is highly likely that if a group of civil servants, for instance, describe a food supply system, which is about infrastructure, then they implicitly include food as a type of need. This can, for example, be seen in Seminar B, where many issues related to 'infrastructure and real estate' are identified, but very few directly related to the biological needs the infrastructure should supply. This strongly suggests that it is necessary at some point during a seminar to structure what has been taken up, for example in an intrinsic-extrinsic

manner or supply-need relation, in order to make sure the participants have not unintentionally omitted something. It may also be useful to simply ask more probing questions at the seminars, as why something is considered worth protecting.

The theoretical assumption that uneven distributions of power in social contexts decide who has the biggest influence on social structures and thus on what values and valuable objects are explicated, discussed and chosen as focal points, may also play a role in explaining the variations among the seminars. The empirical material and study approach allow us to make only minor assumptions about the influence of power in these situations, but it is highly likely that different power dynamics play a crucial role here, as power is ingrained in all social activity. Additional studies, scrutinising the power dimensions in contexts such as these more carefully, are needed.

For reasons of clarity, the outcome of the seminars was classified in three major categories structured in an intrinsic-extrinsic manner, where human life and health was considered intrinsically valuable and individuals' needs and organisational and societal supplies extrinsically valuable. This arrangement applied by the researchers may not necessarily reflect the participants' mindsets concerning relations between things they consider valuable and worth protecting. Nevertheless, the structure applied here seems not unduly inappropriate and provides a perspective in which the participants' expressions may be understood. Still, letting the participants, in seminars like the ones dealt with here, themselves relate what they find valuable in an intrinsic-extrinsic manner may lead to another structure and classification. Further studies are needed that may cast additional light on this matter.

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Notes

1 For a detailed account of the distinction between the terms 'value' used as a noun, 'to value' used as a verb and 'valuable' used as an adjective see Zimmerman (2001).

2 Philosophic value theory may be looked upon in other senses, but is here used to describe the area of moral philosophy that is concerned with questions about value and goodness of all varieties (Stanford Encyclopaedia of Philosophy, 2009a).

Appendix

Figure 2 Results for Seminar A: a municipal healthcare department (see online version for colours)

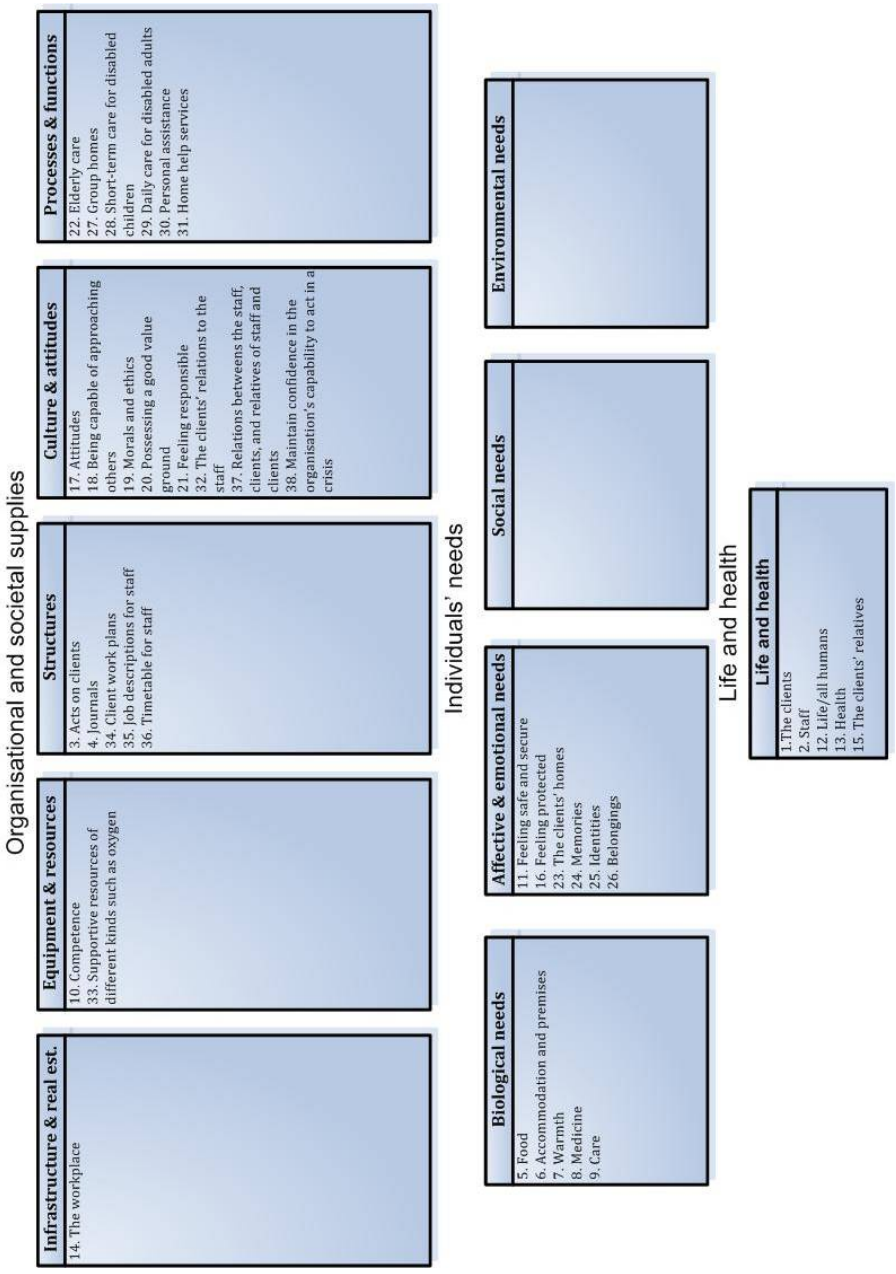


Figure 3 Results for Seminar B: a municipal housing and environment department (see online version for colours)

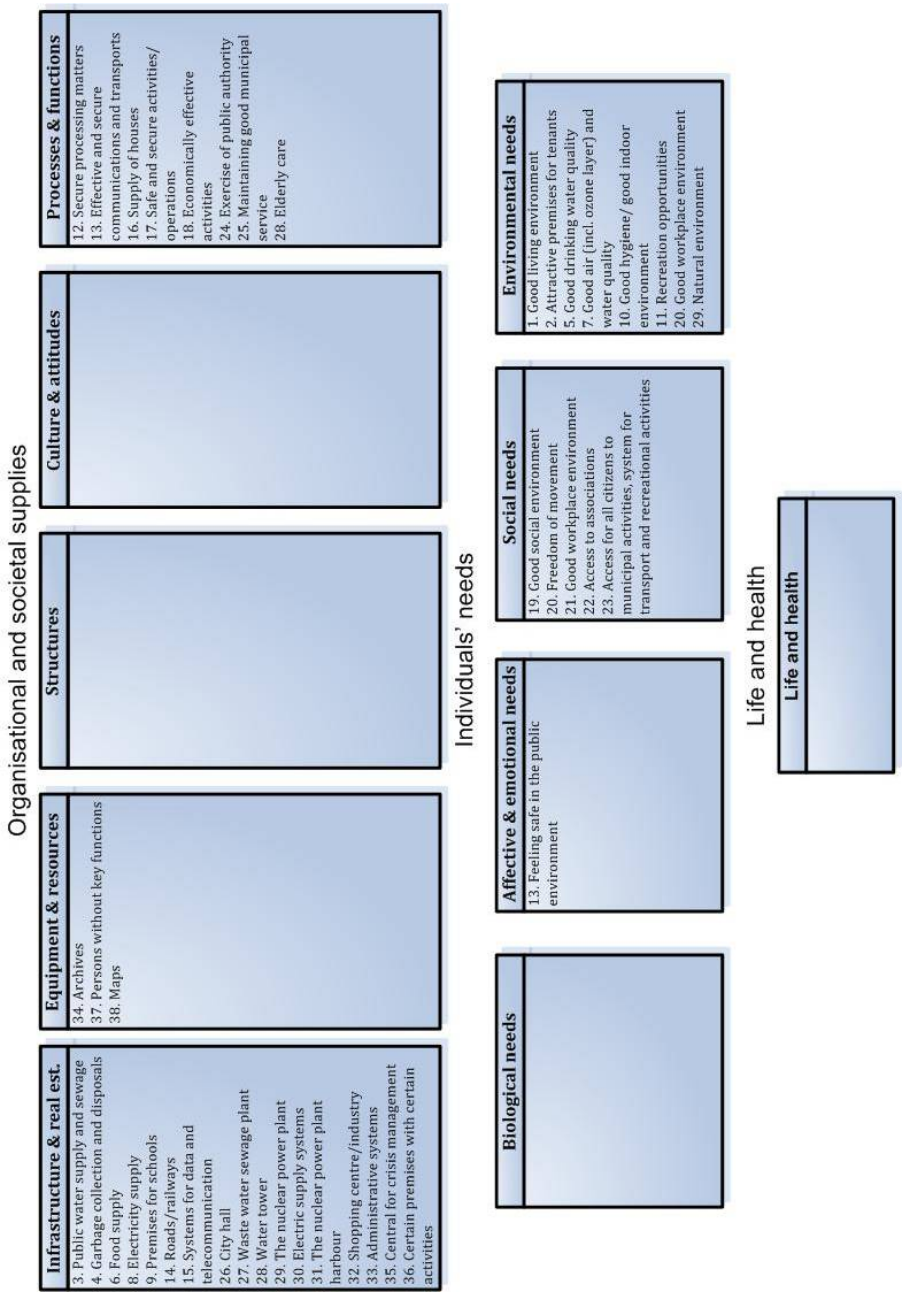


Figure 4 Results for Seminar C: preparedness planner and media functions in a municipality (see online version for colours)

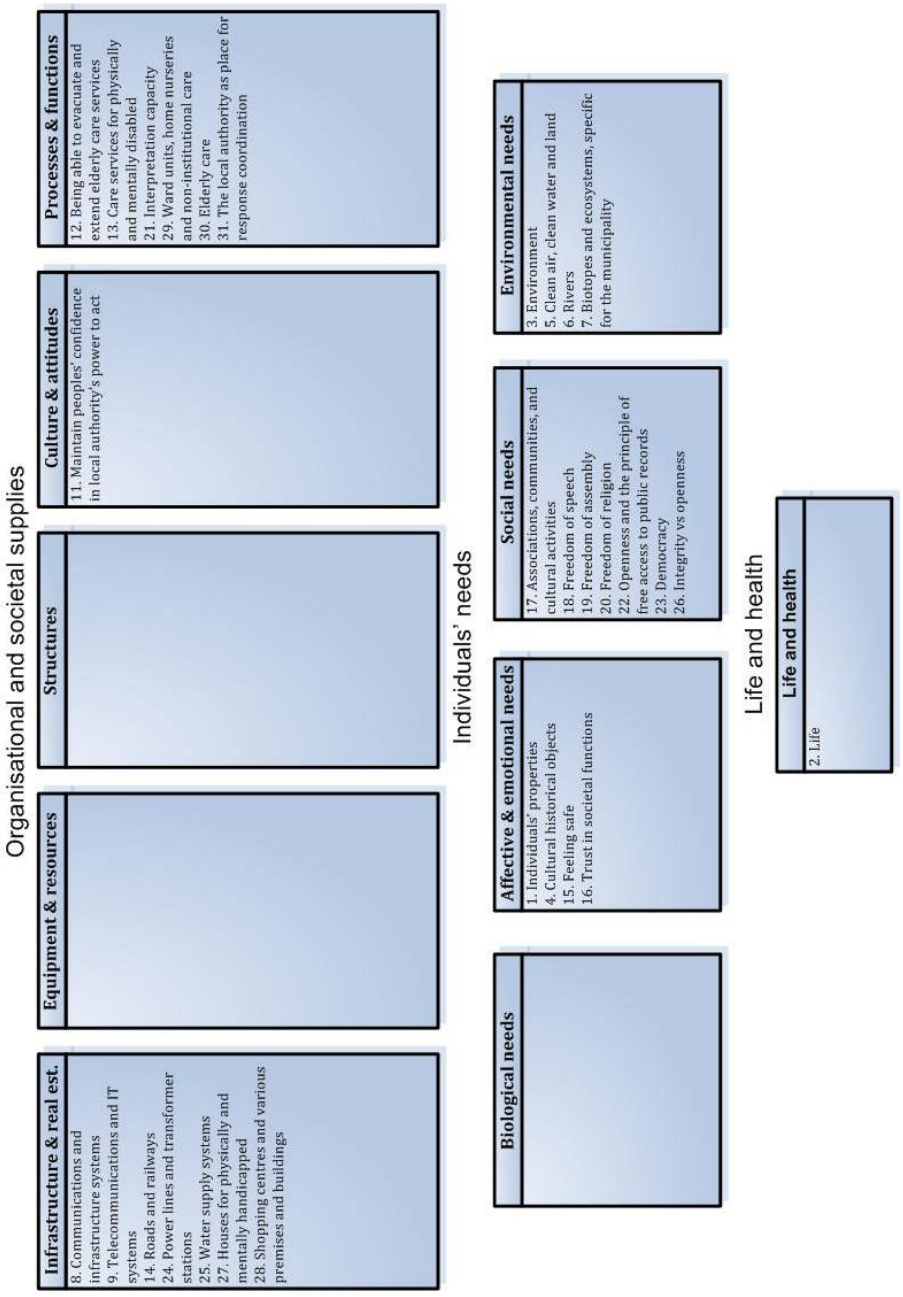
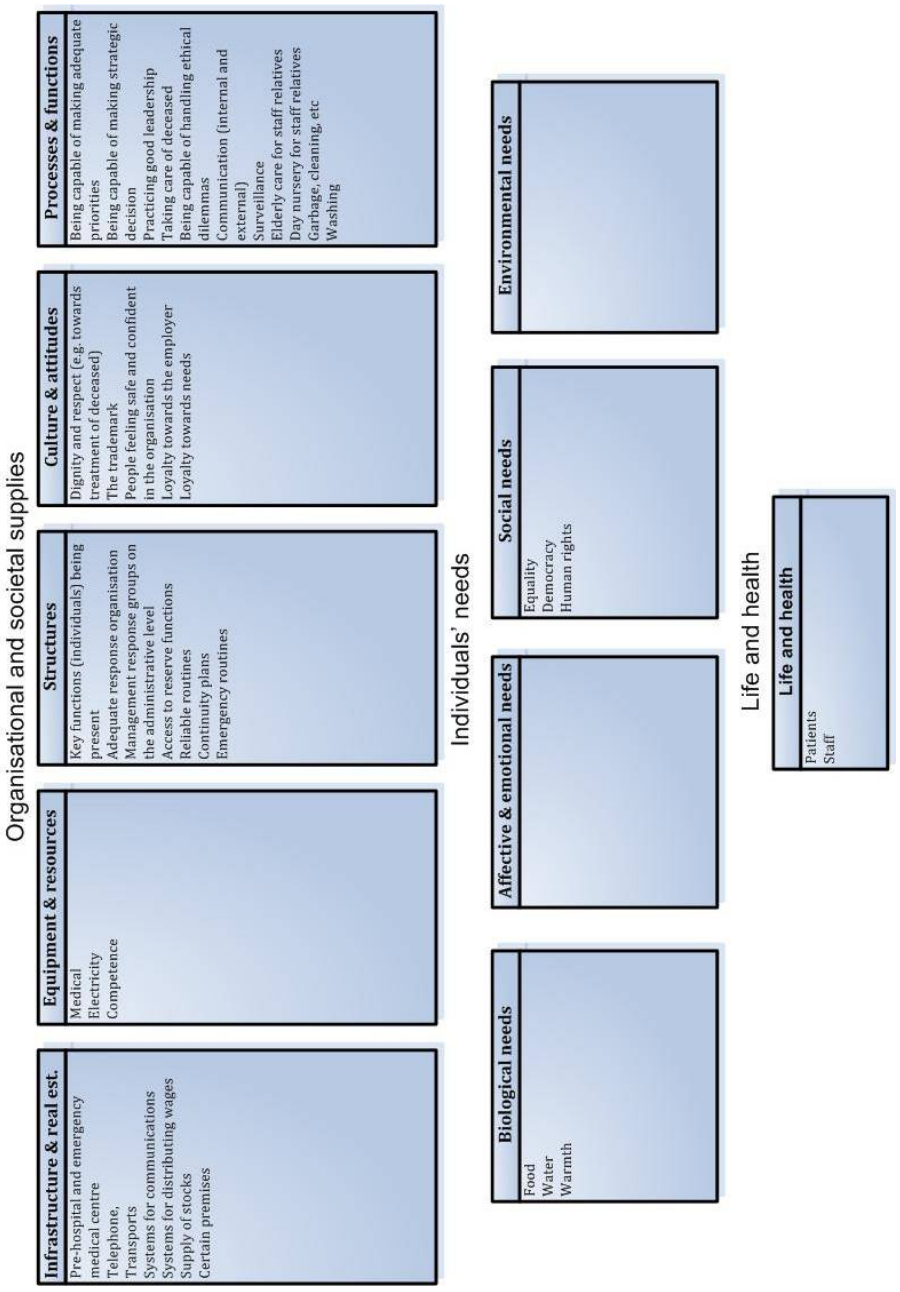


Figure 5 Results for Seminar D: preparedness planning functions from different parts of a county council (see online version for colours)



IV

Whose risks? – Gender and ranking of hazards

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1. Introduction

There is an increasing awareness of the relationship between poverty and disasters around the world. This, together with the mounting threats of climate change, has led to a growing global interest in reducing disaster risk. The more affluent states have a responsibility to assist in the fight against poverty and there are a growing number of initiatives and projects around the world seeking to reduce disaster risk through international development cooperation. But who decides what risks to focus on?

The perception of risk is central to the processes of risk reduction and preparedness (Paton and Johnston, 2001). There are many factors that have been identified as influencing risk perception, out of which gender is the main focus of this essay. If gender is influencing the perception of risk, do these differences in risk perception automatically mean that women and men rank the hazards of their community differently? This would mean that any risk reduction measures would focus on the priority risks of only 50 percent of the population. This essay is an attempt to shed light on this problem by trying to answer the following research question:

How do women and men of three municipalities in El Salvador rank hazards in their communities?

2. Gender and risk perception

There has been a growing recognition that cultural differences play significant roles in affecting perceptions of risk (Slovic, 1987:281; Bontempo et al., 1997; Lam, 2005). Differences that are significant enough to suggest that cross-cultural miscommunication about risk in many cases are virtually guaranteed (Yates et al., 1989:169). Recognising the risk perceptions of the host community of any risk reduction project is thus vital for any project to be successful and sustainable.

Differences in risk perception are not only significant between different cultural groups, but also between sub-groups within them. A major dividing line is gender, where women generally are viewed to be more averse to risks and men to be more tolerant to risks (Flynn et al., 1994; Fordham, 2000; Armas, 2006). Many researchers seek to increase our explanation and understanding of how, to what extent, and why risk perceptions differ between women and men. Other important factors influencing risk perception are age (Sjöberg, 1998:86-87; Hermand et al., 1999), income level (Johnson, 2004:111), education (Sjöberg, 2000:7-8), and personality traits (Chauvin et al., 2007).

The question, however, is whether gender-related differences in risk perception automatically generate differences in how women and men rank the hazards in their

communities, potentially biasing any risk reduction efforts towards the priority hazards of one group.

3. The case of three municipalities in El Salvador

Two major earthquakes hit El Salvador on 13 January and 13 February 2001, causing widespread devastation and attracting immense international attention. A year after the earthquakes, a study was carried out to learn more about how to reduce peoples' vulnerability to the impact of hazards. A field PPS method (Probability Proportionate to Size) is used to randomly select three municipalities for the study (Bernard, 2006:160-162), using a grid system and randomisation using dice. The data were collected in the municipalities of Nueva Concepción, Santa Clara and Tecoluca (Figure 1), and included a hazard-ranking exercise that is now used to answer the research question.

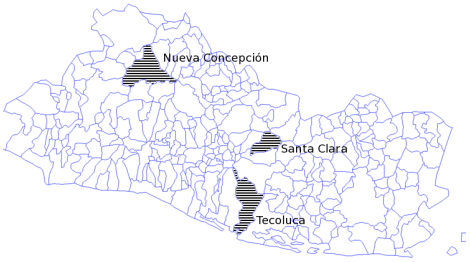

Figure 1. The selected municipalities for the study in El Salvador.

4. Methodology

A limited survey is carried out in the three selected municipalities. There is a multitude of different ways of doing survey research, but taking into account the considerable chance of illiterate informants and informants without a phone, structured personal interviews are deemed most appropriate for gathering the input data. The advantages of being able to explain the survey questions and making sure the "right" respondents are answering them are in this case deemed greater than the risk of response and deference effects in the respondent-interviewer interaction (Bernard, 1995:258-260).

The data for this study are drawn from interviews with 69 randomly selected respondents. One third live in the central villages of the municipalities, one third along major infrastructure routes and the last third in secluded places far from such infrastructure. Thirty-five of the respondents are women and thirty-four are men. A field PPS method is again used to select the respondents, using maps and sketches of the towns, as well as of the *cantones*, *caserios* and *comunidades* of the municipalities, and randomisation using dice. Even if deemed to be the only way to get a proportionate random sample with the existing resources, this method has limitations to its proportionality, thus limiting its statistical generality.

The questionnaire used for this study consists of a set of basic questions regarding age, family size, education, etc., and a ranking exercise for various hazards. It is thus highly structured and standardised. The data are statistically analysed using SPSS [i].

A professional interpreter translated the questionnaire into Spanish. To make sure that nothing is altered in the translation, a back-translation was made by another person (Bernard, 1995:275). During the pre-testing, a number of informants are interviewed and the questions are altered until they are easily understood and answered. The results of the pre-testing are not used in the study in any other way.

The hazards used for the hazard-ranking exercise were selected after studying the hazard profile in El Salvador [ii]. The hazard-ranking exercise is in itself a rather straightforward procedure in which the interviewer asks the respondents to rank nine selected hazards according to how afraid they are of them, where '9' is 'most afraid' and '1' is 'least afraid' (Becker, 2002:xxxv-xxxviii). The exact Spanish phrasing of the question is "Clasifique los siguientes peligros según el grado de temor que le causan de 1-9, donde 1 es menos temor y 9 más temor", which in English means "Rank the following hazards according to how afraid you are of them from 1-9, where 1 is least afraid and 9 is most afraid". Each number between one and nine can only be used once, forming an ordinal ranking of the hazards. The number assigned to one hazard is, in other words, dependent on the numbers assigned to other hazards. There are limitations to what statistical analyses can be applied to subjectively assigned rankings of hazards and risk (Lloyd and Wilson, 2002), but it is still possible to describe the distributions of the results themselves.

The empirical data are presented in *boxplots* or *bar graphs* depending on type of variable and analysed for significant statistical associations using *Pearson's* χ^2 (chi-square) test of association for nominal variables and γ (gamma) test of association between ordinal variables. 'Gender', 'Livelihood based on agriculture or not' and 'Area' are nominal variables, while 'Level of education', 'Age group', 'Location', 'Number of children', 'Size of household', 'Number of persons working in household', and the ranking of each hazard are ordinal variables. The rankings of hazards by women and men are also studied using the means of the values assigned to each hazard by the male and female respondents. Two statistical methods are then used to analyse the statistical significance of any differences in ranking between the groups: *Paired sample t-test* for analysing differences in mean between hazards within each group, and *independent sample t-test* for analysing equality of mean values for each hazard between groups.

5. Results

The results from the hazard-ranking exercise in the survey indicate, as expected, considerable variability in opinions among the respondents. However, when returning to the research question of how women and men rank hazards, it appears that the two groups of respondents have much in common (Figure 2).

It is clear, when studying the distributions of answers in the hazard-ranking exercise, that there are minor differences in hazard-ranking between the female and male groups in the survey. However, none of these differences turn out to be statistically significant [iii].

Even when ranking the hazards in a more deterministic manner on the basis of the average score given for each, the average hazard-ranking is strikingly similar between women and men. It is only between 'War and civil war' and 'Hurricane', as well as between 'Landslide' and 'Flood', that differences become visible. However, the differences between these pairs of hazards within the two groups of respondents are not statistically significant [iv], nor are the differences in mean values between women and men for these hazards [v].

None of the other variables included in the survey, i.e. 'Livelihood based on agriculture or not', 'Area', 'Level of education', 'Age group', 'Location', 'Number of children', 'Size of household', and 'Number of persons working in household' have any statistically significant associations with 'Gender' [iii, vi].

Statistically significant differences in ranking hazards do however appear when analysing 'Level of education'. The categories used here are: respondents with no schooling, those with primary or secondary schooling, and those with high school or university education. The analysis also shows that the differences in ranking of hazards are statistically significant for 'Earthquake', 'Volcano eruption', 'Landslide', 'Drought', and 'War or civil war' [vi] (Figure 3) as shown in the *boxplots*. It is interesting to note that 'War or civil war' and 'Drought' are ranked lower the more education the respondents have, while 'Earthquake' and 'Volcano eruption' are ranked higher. 'Landslide' generates less significant differences in a less clear direction. 'Level of education' has, in turn, a statistically significant association with 'Location' [vi], in other words, the respondents tend to have more education the closer they live to the central town of the municipality (Figure 4).

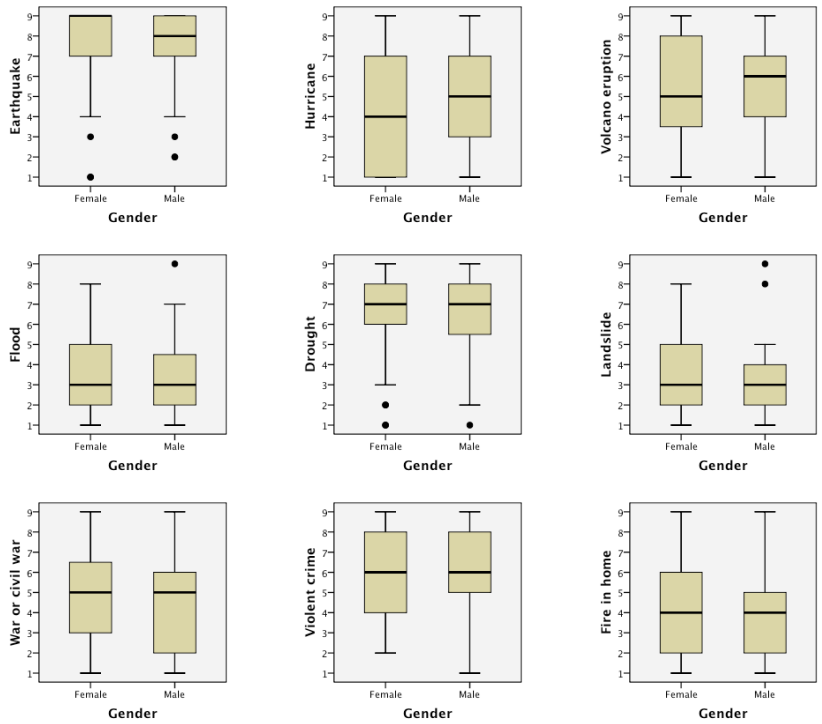

Figure 2. Boxplots presenting the statistical analysis of the hazard-ranking exercise for women and men.

The analysis of household livelihoods focuses on whether the livelihoods are based on agriculture or not. There are statistically significant associations with level of education and location, in other words, the less educated the respondents are [iii], and the further they live from the central town of the municipality, the more likely they are to be part of agrarian

households [vi] (Figure 4). The analysis indicates that respondents whose households are dependent on agriculture for sustaining themselves rank 'Drought' higher than respondents whose households are not (Figure 3). This association may seem to be rather common-sense, but it is nonetheless statistically significant [iii]. A similar, but less expected, statistically significant association is found with 'War or civil war' [iii] (Figure 3).

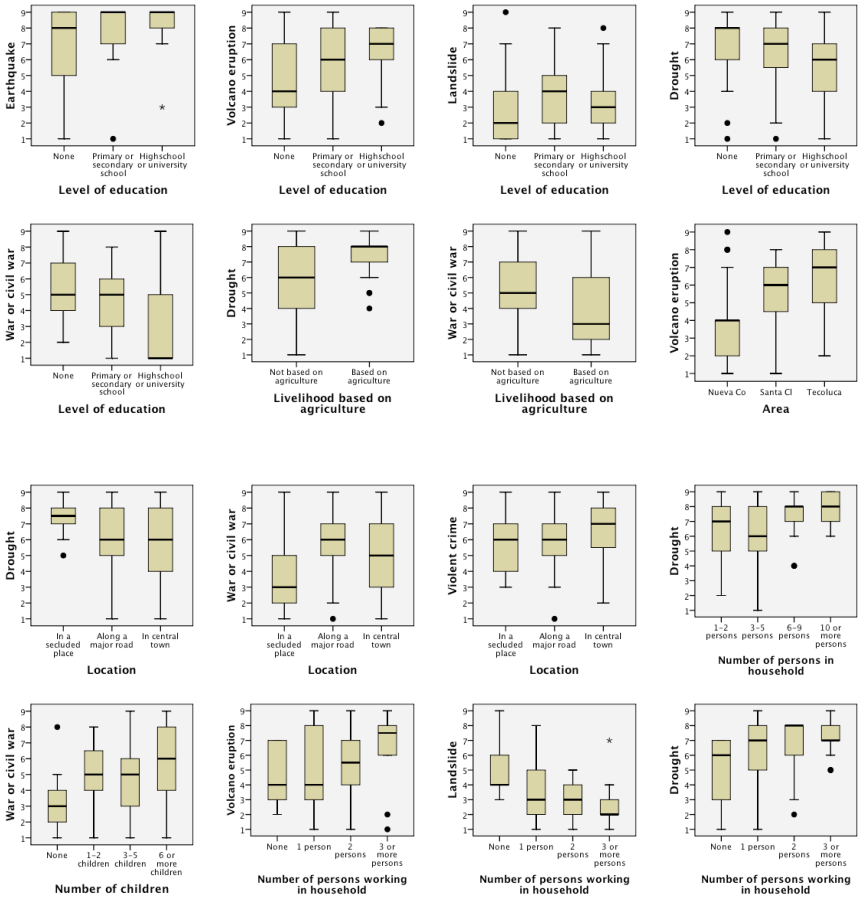

Figure 3. Boxplots representing the statistical analysis of the hazard-ranking exercise, with statistically significant associations.

The three selected municipalities are situated in different parts of El Salvador (Figure 1), so the respondents in these areas may be exposed to, and have different experiences concerning, different sets of hazards. When analysing the empirical data, only 'Volcano eruption' supplies a statistical significant difference in the ranking of hazards between the three areas. The respondents of Tecoluca rank 'Volcano eruption' significantly higher than the respondents of Santa Clara, who in turn rank it significantly higher than the respondents of Nueva Concepción [iii] (Figure 3). This may have a common-sense explanation again, as the respondents in Tecoluca live directly underneath the active San Vicente volcano, Santa Clara is close to the volcano and Nueva Concepción is situated

further away from active volcanoes. The variable 'Area' also shows a statistical significant association with 'Number of children' [iii] (Figure 4), but this is likely a result of an anomaly in which the distribution in Santa Clara is skewed by a small number of respondents with a large number of children.

'Number of children' has a statistically significant association in that respondents with more children tend to rank 'War or civil war' higher [vi] (Figure 3). 'Number of children' has statistical significant associations with 'Level of education' [vi], which already has been identified as being connected to the ranking of 'War or civil war', and with 'Age group' [6] (Figure 4). 'Age group' has, in addition, statistically significant associations with 'Level of education' and 'Size of household' [vi].

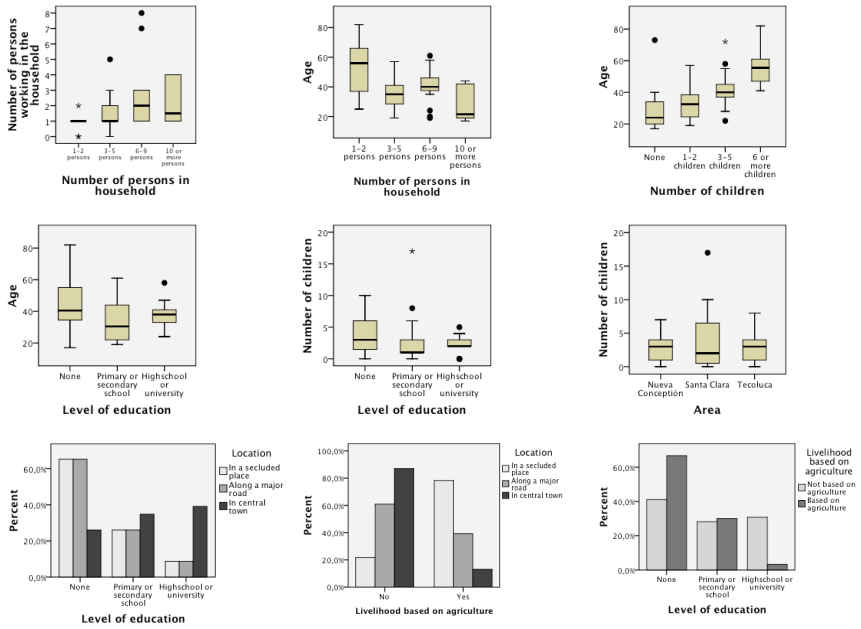

Figure 4. Boxplots and bar graphs representing the statistical analysis of non-hazard variables, with statistically significant associations.

Another variable that shows interesting connections with ranking of specific hazards is 'Number of persons working in household'. This variable has statistically significant associations with the ranking of 'Volcano eruption', 'Drought' and 'Landslide' [vi], where the two former are ranked higher, while the latter is ranked lower, the more persons working in the household (Figure 3). 'Number of persons working in household' also has a statistically significant association with the variable 'Size of household' [vi], where more people generally work the bigger the household (Figure 4). 'Size of household' has also its own statistically significant association with the ranking of 'Drought' [vi] (Figure 3). 'Size of household' does not have any statistically significant association with the 'Location' where the respondents live; in the central town of the municipality, along a major road, or in a secluded place away from infrastructure.

However, the variable 'Location' has statistically significant associations with other variables. Respondents living in the central town of the municipality have a generally higher level of education and are less dependent on agriculture than respondents along major roads, who in turn have a generally higher education and are less dependent on agriculture than respondents living in more secluded places [iii] (Figure 4). 'Drought' is ranked lower while 'Violent crime' is ranked higher the closer to the central town of the municipality the respondents live [vi]. 'War or civil war' is slightly different, with higher ranking along major roads and in the central town of the municipality, compared to significantly lower ranking in the secluded locations [vi] (Figure 3).

In addition to the connections between variables described above, statistically significant associations are also found between the rankings of hazards [vi]. This may be due in part to the methodology used, as each ranking is dependent upon the rankings of the other hazards. It seems, however, that any relationships are somewhat more complex since the ranking of one hazard only has statistically significant associations with the ranking of a limited number of other hazards. All hazards except 'Violent crime' and 'Landslide' have links to at least one of their closest in rank and 'War or civil war' and 'Hurricane' have links to both adjacent hazards in rank. The next category of links in order of proximity is connections that skip the two closest hazards in rank, i.e. between 'Earthquake' and 'Violent crime', and between 'Drought' and 'Volcano eruption'. The rest of the statistically significant associations are between hazards with 3-5 intermediary ranked hazards between, i.e. between 'Volcano eruption' and 'Flood', 'Volcano eruption' and 'Landslide', and 'Earthquake' and 'Fire in home'.

6. Discussion

The statistical analysis of the survey data indicates that there are no significant differences between the ranking of hazards by women and men in the studied communities. This is a somewhat surprising result considering the large volume of peer-reviewed literature on the gendered differences in risk perception. However, the findings do not constitute a criticism of the view that women and men perceive risks differently, but only indicate that, regardless of how different women and men may view and feel about hazards, there is a possibility that they still rank them in a similar internal order. In fact, 'Gender' does not generate a statistically significant association with any of the other variables of the analysis.

The apparent lack of statistically significant gendered differences may obviously be related to uncertainties in the statistical data (e.g. Quarantelli, 2001), such as anomalies and sampling errors that may occur regardless of the rigour of the sampling strategy and the management and analysis of the collected data. Another explanation may be that it is a result of the rather limited sample size. However, other variables in the survey generate statistically significant differences in the ranking of specific hazards, which indicate that statistically significant differences are possible within the selected sample size. These statistically significant associations in the study are indicated in Figure 5. A third explanation for the lack of significant differences between women and men may be that there are other variables that, through spurious relationships, cancel out any gendered differences. This may be correct, but is not the case for any of the other variables included in this study, as there are no significant associations between any of them and 'Gender'. Even if all three of the above are possible explanations for the results of the survey, the findings are too interesting to be dismissed in such a way.

The bivariate analysis behind the network in Figure 5 does not provide any direction in determining which associations are causal and which are spurious. Any such analysis is therefore liable to my own potential biases and possibly flawed logical reasoning. However, it seems plausible that 'Livelihood based on agriculture' is casual for ranking 'Drought' high. If that assumption holds, it would mean that the association between the 'Location' of their home and the ranking of 'Drought' may be spurious as farming families are likely to live in a secluded place. It would also mean that the association between their 'Level of education' and the ranking of 'Drought' may be spurious as farming families also are likely to have less education. It is however difficult to say if this tendency towards less education is because they are farmers and could not attend school due to time or economic constraints, or because there are fewer schools in secluded places.

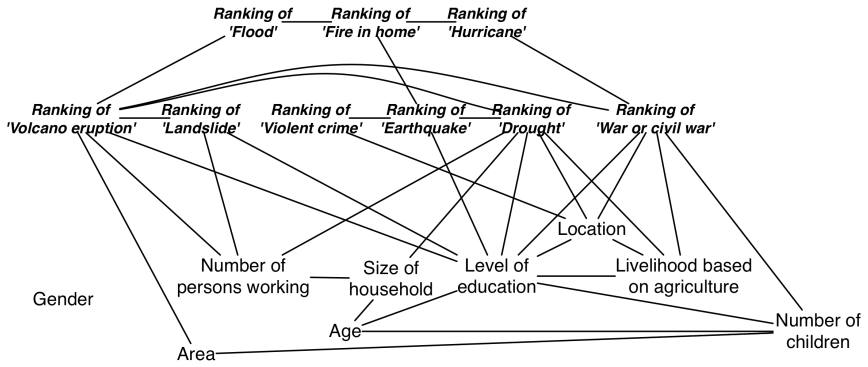

Figure 5. Network of statistically significant associations between variables in the study.

The ranking of 'War or civil war' also has significant associations with agrarian livelihood, 'Location' and 'Level of education', but with the addition of 'Number of children'. In this case, respondents rank 'War or civil war' lower the more education they have, which may also explain the association between the ranking of 'War or civil war' and 'Number of children', as informants with less education are more likely to have more children. However, informants rank 'War or civil war' lower when their livelihood is dependent on agriculture, contrary to the already discussed association between 'Level of education' and agrarian livelihood. The answer to this may lie in the 'Location' of the informants' home. Even if the 'Level of education' is generally lower in secluded places, this is where the informants rank 'War or civil war' the lowest. A reason for this may be that the civil war that ravaged El Salvador from 1980–1992 severely affected the civilian population, especially along major roads and in the central towns of the municipalities as people living in these areas were more exposed to the armed conflict.

The differences in exposure of respondents to other hazards may also help us explain and understand some of the other statistically significant associations. The 'Location' of where the informants live also has a significant association with the ranking of 'Violent crime'. The higher ranking of 'Violent crime' in the central towns of the municipalities is thus rather common-sense, as crime rates generally are higher there than elsewhere. Equally common-sense is the high ranking of 'Volcano eruption' in Tecoluca, which is located directly beneath an active volcano, the somewhat lower ranking in Santa Clara, which is

close to the volcano, and low ranking in Nueva Concepción, which is far away from active volcanoes.

'Level of education' also has significant associations with the ranking of 'Earthquake' and 'Volcano eruption', where both are ranked higher the more education the informants have. This may be the result of the significant association between them and the ranking of 'Drought', where less educated informants place their highest rank on 'Drought' instead on 'Earthquake' or 'War or civil war'. There is also an association between 'Level of education' and the ranking of 'Landslide', but this is less clear and does not point in any direction, and thus would make it appear as spurious to other parameters. The associations between the ranking of hazards and the 'Size of household' and 'Number of people working in the household' are also difficult to explain logically and are thus left out of the discussion.

Regardless of which statistically significant associations are causal and which are spurious, there are many parameters influencing how individuals rank the hazards of their communities. Interestingly enough, in the case of the three municipalities in El Salvador, gender does not seem to be one of them.

7. Conclusion

So, how do women and men of Nueva Conception, Santa Clara and Tecoluca rank hazards in their communities? The short answer is that the participating women and men rank hazards in similar order. There is, however, a number of other parameters that seem to influence such a ranking exercise. This indicates that regardless of whether there are gender differences in risk perception or not, hazards may be ranked in similar order. It also indicates that there are dividing lines other than gender that may influence perceptions and priorities of risk reduction initiatives. This makes it vital to communicate with and to include as wide group of people as possible to participate in the risk reduction process. This applies not only to women and men, but also to representatives with various livelihoods, income levels, level of education, ethnic background, locations of their dwellings, etc. If this is not done, there is a danger that vital needs and opinions could be left out, and community commitments to the risk reduction measures could be reduced. The process may take longer, but even if risk perceptions may differ between different people, there is still a chance that risk reduction measures can focus on the priority hazards of several different groups, without conceding precedence to any one group over another.

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Notes

[i] *Statistical Package for the Social Sciences* (SPSS) is a computer-based software for statistical analysis of data.

[ii] With hindsight it would have been interesting to include traffic accidents into the hazard-ranking exercise, but the focus at the time of the survey was placed on potential hazards in relation to where people live.

[iii] Using Pearson's χ^2 (chi-square) test of association between variables including at least one nominal variable.

[iv] Using paired sample t-test.

[v] Using independent sample t-test for equality of mean values.

vi Using γ (gamma) test of association between ordinal variables.

V

The importance of integrating multiple administrative levels in capacity assessment for disaster risk reduction and climate change adaptation

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1. Introduction

The terrible impacts of disasters are not evenly distributed in the world. Developing countries are bearing the brunt of the suffering and devastation (UNDP 2004), and the international community is urging more affluent countries and international organisations to assist these countries in developing their capacities for disaster risk reduction and climate change adaptation. Capacity assessment has been identified as a vital tool to pursue this capacity development agenda (Lopes, & Theisohn 2003; UNDP 2008a; UNDP 2008b; UNDP 2009), but seems to be applied to various degrees in the context of disaster management (Hagelsteen, 2009).

Influential guidelines clearly state that capacity assessment can be conducted at various administrative levels (e.g. UNDP 2008b, p. 5), but most assessments focus only on one administrative level. Potentially skewing the foundation for effective capacity development. If only including stakeholders on, for example, the national level, how valid is the generated picture of how the current system for disaster risk reduction and climate change adaptation works in total? Is it really so that there may be no biases between stakeholders on different administrative levels in how they perceive the system to work? The purpose of this article is to investigate the potential for such biases, and it attempts to meet that purpose by answering the following research question:

What are the similarities and differences in expressed flows of information and assistance regarding risk and disasters between different administrative levels involved in managing risks and disaster situations in Fiji?

2. Theoretical framework

Far from all efforts by international organisations to support capacity development for disaster risk reduction and climate change adaptation have generated real and sustainable results. One reason may be lack of analysis and understanding of the relevant risks and initial capacities, within the countries in question, to use as basis for project planning and implementation (Twigg 2004, p. 289; Schulz et al 2005, p. 7; Becker 2009). Several researchers and policy-makers stress the importance of capacity assessment, in response to a need for capacity development (UNDP 2008b, p. 5), as well as give general guidelines on how to do it (Lopes, & Theisohn 2003, p. 74; UNDP 2008a; UNDP 2009, p. 23-26). Capacity assessment is in this context viewed as a vital tool to improve consistency,

coherence and impact of capacity development projects, not only because it assists stakeholders to develop a comprehensive view of current capacities and future capacity needs, but also because it may create a common language and structure for discussion and sharing experiences among stakeholders, provide a basis for project planning, and facilitate an understanding of complex development situations (UNDP 2009, p. 24).

Recent research indicates that many professionals working for international organisations involved in capacity development for disaster risk reduction and climate change adaptation are unaware of existing general capacity assessment methodologies, and even fewer have actively adapted these to their specific context (Hagelsteen, 2009). Although guidelines from influential sources clearly state that capacity assessment can be conducted at various administrative levels, sectors or organisations to grasp the strengths and challenges of that particular entity under study (e.g. UNDP 2008b, p. 5), they express nowhere explicitly the importance of including potential interdependencies between such entities in the assessment. A limitation which may be devastating to the success of any capacity development project (Becker 2009). Most contemporary capacity assessments in this context, which seldom are explicitly referred to as capacity assessment but still include vital aspects of it (Hagelsteen, 2009), focus on only one administrative level, with only minor involvement from another level at best. Opening a potential for biases if different administrative levels have different views on the capacities of the system in total.

3. Methodology

Case study research stands out as a particularly suitable methodology to meet the purpose of this article considering its outline and contemporary context (Yin 1994, pp. 4-9), the limited resources available (Blaxter et al 2001, p. 71) and its focus on analytical generalisations (Flyvbjerg 2001, pp. 73-77). Fiji appears to be a suitable case, as it is a disaster-prone and developing island state of limited size in both land mass and population. Fiji also has a complex social and political set-up, with parallel power structures between the formal state structures and the continuously strong traditional structures, supplying administrative levels on national, divisional, provincial, and municipal or village level depending on if you are in urban or rural areas.

Semi-structured interviews are conducted with involved stakeholders from all administrative levels. Interviewing each respondent on their own is assumed to be a valid method to elicit their expressed view on what information and assistance regarding risks and disasters that are passed between levels in Fiji. The respondents are the director of the National Disaster Management Office (national, two deputies present), commissioner (divisional), provincial administrator (provincial), chief executive officer (municipal), and headman/turaga ni koro (village).

The interviews start by asking the respondents to explain what they do and what role they have in society. The respondents are then asked to explain what type of information regarding risks they give or are requested to give to stakeholders on other administrative levels, and what information they get or request. This questions are then rephrased to cover what information and assistance that is given and requested between administrative levels during disaster situations. The total length of the interviews varies between thirty and eighty minutes, but most of them are about one hour long.

The data for analysis is extracted from the interviews by listening through each interview and taking notes of what information and assistance that are expressed as requested as well

as passed up and down between administrative levels. The focus of the analysis is on identifying potential similarities and differences between the different accounts.

4. Results

The National Disaster Management Office (NDMO) states that Fiji focuses both on reducing risk and on managing disaster situations. Fiji is also working according to the global Hyogo Framework for Action 2005-2015 and its regional framework for the Pacific, which are clearly visible in the six official guiding principles of the system for disaster risk management in Fiji. These six guiding principles are used as a framework when presenting the results of the study and form the titles of the following sections.

Governance – Organisational, Institutional, Policy and Decision-making Framework

The accounts of the respondents on national, divisional and provincial levels all corresponds well regarding the overall legal and institutional framework. They all refer to the Natural Disaster Management Act and the National Disaster Management Plan, but it is only on the respondents on the national level who mention provisions in these documents to reduce risk. They are also the only ones mentioning issues focused on by global and regional frameworks for disaster risk reduction, which they claim to have implemented in Fiji. The municipal respondent states that they are not a central part of reducing risk and managing disaster situations at all, which is indirectly confirmed by the other respondents as none of them ever mention the municipal level during the interviews.

The respondents on national, divisional and provincial levels all mention the importance of declaring state-of-emergency for granting powers to them to request and use resources of all line-ministries and departments, as well as access to special funds, to manage a disaster situation. There are no specific powers or funds mentioned for reducing disaster risk. The process of such declaration is also similarly explained, but when going into what happens during the response after, the different accounts are more diverse.

The national and divisional levels give similar pictures when explaining that disasters are initially managed by the provincial level, but when beyond the provincial capacities the divisional level is activated, and when beyond the divisional capacities the national level is activated. The provincial level on the other hand states that regardless of disaster, the province will have to deal with it using only the resources available in the it.

Knowledge, Information, Public Awareness and Education

The respondents on national, divisional and provincial levels all give corresponding accounts on training and education of civil-servants. The commissioner and the provincial administrator can both mobilise teams of predetermined experts, normally the heads of all line-ministries and departments represented in their area, to support in case of disaster. The respondents declare that these people all have training in disaster management. The provincial administrator also maintains that all village headmen in the province, or others appointed, have undergone training in disaster management at a workshop at the government station. A workshop supported by the NDMO. The respondent from village level confirms that, but in the case of his village it was the village chief who attended the training.

When it comes to public education and awareness the accounts become divergent. The respondents on divisional and provincial levels both state that they are active in public

awareness and education, independently of each other, through sending radio messages. The commissioner states that his messages suggest people to plant cyclone resistant crops and guide each household in how to prepare cyclone kits with food, water, kerosene, etc. The provincial administrator claims his messages to focus on how people prepare for disasters in general. The commissioner also states that villages have two flagpoles, one for the national flag and one for a flag that reminds people that it is cyclone season. These public awareness raising activities are however neither known to the respondents on the administrative levels below nor are there any double flagpoles in any of the villages visited during the field research.

Analysis & Evaluation of Hazards, Vulnerabilities and Elements at Risk

The national respondents state that they regularly request and get risk and vulnerability analyses from the divisional level, identifying all risk areas and what vulnerable people and infrastructure that are located in those areas, and that the commissioners on the divisional level request and get the same from the provincial level. However, the commissioner of the divisional level gives a somewhat mixed picture. Although it is initially stated that the divisional level develops and submits a reviewed plan every year to national level covering risks that normally occur and vulnerable areas that can be affected by such risks, it is later admitted that reports are only written and submitted to national level when a disaster have struck. The provincial administrator never documents and submits anything about risk and vulnerability to the divisional level, but tries to get involved to inform governmental line-departments and the public on risks that may arise from the implementation of planned development projects in the province. The municipal level is according to the municipal respondent not required to analyse risk.

Planning for effective Preparedness, Response and Recovery

The respondents on national and divisional level state that if it is a small disaster the provincial administrator manages it, but if it is bigger the commissioner mobilises his team and, according to the commissioner, moves in to establish his head-quarter in the disaster area. The commissioner maintains that they stay in the disaster area as long as necessary, around one month, and that the affected provincial administrators send situation reports to the divisional level every hour. These are analysed and used for preparing situation reports to the national level and for a cabinet paper about the recovery needs. The provincial administrator on the other hand states that although he contacts the divisional level when disaster has struck, or when he thinks it will strike soon, for the cabinet to declare state-of-emergency, the province will not get any addition resources and the provincial administrator will be in command regardless of scale of disaster.

The inconsistencies do not stop there. The provincial administrator claims that all village headmen call in regular situation reports to his operation centre during the disaster, which are collected and sent to the divisional level. The respondents on the village level maintain however that they have no contact with the provincial level before or during a disaster situation, only after the disaster is over when the provincial disaster team assess damages. The sending of situation reports to divisional level is consistent with the account of the commissioner above, but not with the respondents on national level who claim they get situation reports every six hours directly from the provincial level and not through divisional level. The respondent on the municipal level states that municipalities are not

part of the management of the disaster situation as such, but may be requested to assist the assessment of damages after the disaster by supplying information.

Last but not least, the provincial administrator states that all villages in the province have designated evacuation centres to which people evacuate in case of disaster, and all village headmen, church leaders and retired civil-servants living in villages have training on how to evacuate people. The respondents on village level do however maintain that there are no evacuation centres in the village, but that there are many good houses in the village and people go to their relatives and neighbours for shelter. There are no plans, each family decides where to go on their own.

Effective, Integrated and People-Focused Early Warning Systems

The respondents on national and provincial level both states that they actively give warnings to the public about imminent threats. Both levels admit however that they are not involved in the official tsunami warnings that goes directly from the Pacific Tsunami Warning Center on Hawaii, only relayed through mineral resources department, to media. Many people in the capital and elsewhere responded however by going to the shore to have a look at the potential tsunami. For other hazards, for instance floods, the NDMO give warnings to people to move out of harms way before affected. These warnings are however also too often ignored, as people wait until the water reaches their doorstep and it is too late to evacuate on their own. The provincial administrator also claims to transmit warnings through the radio about cyclones and tsunamis and is sure that people move to safety when receiving the messages. He also claims to follow the disaster closely and directly contact the headmen of villages that are likely to be affected in the near future, for them to take action to protect their people. The respondents on the village level do however maintain that they have no contact with the provincial level before or during a disaster situation, but claim that the only time they have contact with the provincial level is after the disaster is over when the disaster team comes to assess damages.

Reduction of Underlying Risk Factors

The respondent on the municipal level states that the municipal level play a role in the reduction of underlying risk factors, e.g. municipalities work to maintain storm water drainage in urban areas, inspect buildings against building codes, etc. None of the other respondents address directly how they work to reduce underlying risk factors, as even if the focus is claimed to be shifting to reducing risk, the system for disaster risk management in Fiji still seems to be highly focused on response to and recovery from disaster situations.

5. Discussion

It may be obvious that different people will see the world differently and focus on different things when expressing their view on how the system for managing risks and disaster situations in Fiji functions. However, by eliciting perspectives of both sender and receiver of information and assistance passed between administrative levels it is possible to compare and contrast these perspectives on specific central parts of this system. The results of this study indicates substantial discrepancies between the perspectives of respondents on different administrative levels in most areas not directly regulated by the Natural Disaster Management Act and the National Disaster Management Plan. There may obviously be several potential reasons for this, out of which this article only will mention a few.

The differences between the respondents on the national level and the others regarding the expressed focus on disaster risk reduction is likely to be the result of the topdown approach of the implementation of the Hyogo Framework for Action 2005-2015. A process that is trickling down slowly to lower administrative levels in most countries around the world (GNCSODR 2009). A more general explanation of the differences between the accounts of the respondents may be that some respondents answer how it is in practice, while others answers how it ought to be, or extrapolates a few good examples to become general. Other explanations could be that the respondents' roles, responsibilities, goals, experiences, values and sets of cognitive abilities altogether interact with the context of the interview situation influencing what was elicited at that particular time, or the interviewer could just have misunderstood what was said entirely. Regardless of reason, the information gathered entails substantial discrepancies regarding how the system for managing risks and disaster situations in Fiji functions. Catering for a possibility of biases if a capacity assessment would have included only one administrative level in the process.

6. Conclusion

This limited empirical study illustrates that there may be substantial discrepancies between what stakeholders on different administrative levels express when explaining how their system for disaster risk reduction and climate change adaptation functions. The study is not claiming that this is always the case, but that there may be a possibility for it. Indicating that any capacity assessment would benefit from aspiring to include information from different levels in attempting to construct one comprehensive view of the current capacities and future capacity needs. This may even have been the implicit intention of several contemporary capacity assessment guidelines, but this crucial point must be made more explicit if future capacity development for disaster risk reduction and climate change adaptation is to have real and sustainable results in developing countries.

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VI

Risk informed capacity development for managing risk to facilitate sustainable development

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Introduction

Disastrous events pose a major threat to sustainable development (Humphreys & Varshney, 2004; Fordham, 2007:339-340). This calls for the development of the capacity to manage risk in countries prone to such events (ISDR, 2005; UNISDR, 2009:180-181). Although the number of projects with this focus is increasing around the world, far from all these efforts have generated real and sustainable results (Kennedy *et al.,* 2008:34; GNCSODR, 2009). This may at least be partly explained by a lack of analysis and understanding of the initial situation in the countries in question (Schulz *et al.,* 2005:7; Becker, 2009). In developing the capacity to manage risks, it is first necessary to know which risks must be taken into consideration, and to obtain information about them. Many frameworks for risk analysis have been developed during the past 40 years (e.g. Haimes, 1998; Aven, 2003). However, the management of risks to facilitate sustainable development entails additional and sometimes different requirements.

The world is becoming increasingly complex (Calvano and John, 2004:25-26; Renn, 2008:5). To facilitate sustainable development it is necessary to integrate phenomena over a wide range of spatial and temporal scales, from local to global, and from delayed to immediate (Kates *et al.*, 2001:641). It also requires the ability to grasp structural and functional complexity (*ibid.*), which means not focusing on individual elements in isolation, but on how they are connected, interact with, and depend on each other (Haimes, 1998:104; Turner *et al.*, 2003:8077). Understanding these relations is crucial to understanding how the consequences of an event propagate through the system (Rinaldi *et al.*, 2001; Hollenstein *et al.*, 2002:56-61). To facilitate sustainable development, society must have the capacity to manage a wide range of risks (Haimes, 1992:415; Haimes, 2004:101-106). It is thus vital to include many events in the analysis, and an even larger set of interdependent factors and processes, both social and biophysical (Kasperson & Kasperson 1996:96; Turner *et al.* 2003), that contribute to the susceptibility of these elements to the direct or indirect impact of the events. It is also vital to include a wide range of stakeholders (Haimes 1998:104; Renn 2001). Moreover, risk analyses are often performed by different stakeholders.

Therefore, the development of the capacity to manage risk, aimed at sustainable development requires a risk analysis framework that can:

1. integrate phenomena on various spatial and temporal scales, as well as structural and functional complexity (systemic),
2. accommodate different stakeholder values (multi-value);,
3. incorporate a wide range of events that may have an impact on the things stakeholders value (multi-hazard),

4. integrate many factors and processes contributing to the susceptibility of what stakeholders' value to the impact of the events (multi-susceptive),
5. involve various stakeholders over functional, administrative and geographical borders (multi-stakeholder), and
6. integrate several risk analyses performed by different stakeholders (multi-analysis).

The purpose of the work presented in this article is to outline, test and evaluate initial ideas for a framework for analysing risk that meets these requirements, to inform the development of capacity to manage risk to facilitate sustainable development.

On the design of frameworks

To scientifically design a framework for analysing risk that meets certain requirements, or design criteria as commonly referred to in design science, requires a different approach from the more traditional one (March and Smith, 1995). Instead of being mainly concerned with the pursuit of knowledge (Weber, 1949; Ravetz, 1996), we need to focus on designing an artefact that meets a predefined purpose (Simon, 1996:4-5, 114; Poser, 1998:85-87). As it is impracticable to identify all the artefacts that fulfil a particular purpose, it is also impossible to design an optimal artefact (Simon, 1996:119-120; Hevner *et al.*, 2004:88-89). We must therefore settle for an artefact that satisfies a number of predetermined criteria (March and Smith, 1995; Simon, 1996:119-121).

Recent applications of design science in the context of risk- and disaster management provide us with comprehensive processes for designing such a framework (Figure 1) (Abrahamsson, 2009:22-24; Hassel, 2010:42-47).

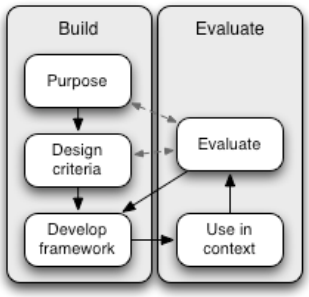

Figure 1. A scientific process for designing frameworks (developed from Abrahamsson, 2009:22-24; Hassel, 2010:42-47)

The requirements on the framework, presented above, not only guide the development of the initial version of the framework, but together with the purpose, are what the framework is evaluated against after being used in context. The result of the evaluation guides the further development of the framework and may also lead to changes in the purpose or design criteria.

To be able to evaluate the framework after it has been used in context, data must be collected systematically. The framework itself does not stipulate which data collection methods should be used. Examples of potential methods are: review of secondary sources, interviews, focus groups, observations, mapping, transect walks, seasonal calendar, etc.

Justification for and implication of the requirements

Most approaches to risk analysis share some kind of idea of uncertainty regarding which scenarios may occur, as well as their potential impact on the things human beings value (Renn, 1998:51).

Risk is then determined in relation to a preferred expected future (Kaplan and Garrick, 1981; Luhmann, 1995:307-310). This means that risk is a representation of potential negative deviations in any variable or set of variables of what human beings value *(y)* from the preferred expected development over time (Figure 2). Therefore, not only the variable or set of variables, their current and desired state, and their preferred expected change must be defined, but also the time period over which they must be analysed.

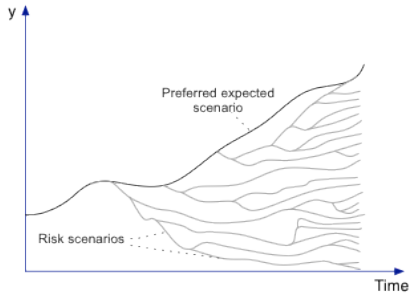

Figure 2. Risk scenarios illustrated as deviations from the preferred expected scenario

According to this approach, analysing risk is the practice of structuring risk scenarios and comparing them against the preferred expected scenario. Risk analysis can be formulated as three questions (Kaplan and Garrick, 1981:13):

1. What can happen?
2. How likely is it to happen?
3. If it happens, what will the consequences be?

Many risk analysis frameworks are available to facilitate the answering of these questions, but the six requirements stated above demand further development. The remainder of this section presents justifications for each of these requirements.

1. Integrating phenomena on various spatial and temporal scales, and structural and functional complexity

This framework rests on the assumption that our world can be represented as a complex human–environment system (e.g. Turner *et al.*, 2003; Haque and Etkin, 2007). Disastrous events that threaten sustainable development are neither the result of linear courses of events, like dominos falling on each other (Hollnagel, 2006:10-12), nor unfortunate external events detached from everyday societal processes (Hewitt, 1983:25; Ariyabandu and Wickramasinghe, 2003:35-37). They are nonlinear phenomena that emerge within this complex system itself (Perrow, 1999; Hollnagel, 2006:12).

To grasp this complexity we need to implicitly or explicitly create models of the world (Conant and Ashby, 1970). Structuring risk scenarios in this context is thus intrinsically linked with building a human–environment system. Although it is possible to use both quantitative and qualitative methods when constructing such a system, we use only the latter type here. In this initial design phase, the complexity is such that we deem it premature to undertake extensive quantified modelling (see Jackson, 2003:21).

The basic building blocks when constructing such a human–environment system are elements and the directional relations between these elements (Maani and Cavana, 2000:26-27; Boardman and Sauser, 2008:67). A positive relation means that a change in one element leads to a change in the same direction in the associated element, e.g. increasing rainfall causes increasing river flow. A negative relation means that a change in one element leads a change in the opposite direction in the other (Leveson *et al.*, 2006:107-108), e.g. an increase in the number of malaria cases causes a decrease life expectancy in a community (Figure 3).

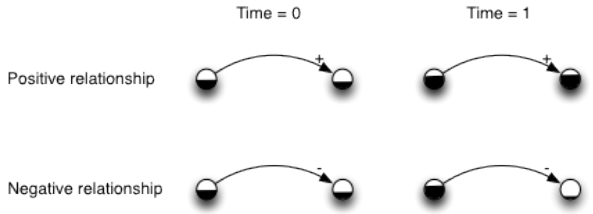

Figure 3. Two types of directional relations between elements

A change in one element may cause changes in others, creating a branching chain of causal relations through which any impact on the system may propagate to distant parts of it (e.g. Hollenstein *et al.*, 2002:56-61). The propagation of a change between each pair of elements may be immediate or delayed. These delays are also major contributors to the complexity of the system (Maani and Cavana, 2000:33; Senge, 2006:88-91). Thus, not only the number of elements determine the complexity, often referred to as detail complexity (Senge, 2006: 71), but also the relations between them (Yates, 1978:R201; Flood, 1987:180), leading to what Senge (2006) refers to as dynamic complexity by the separation of cause and effect in both space and time. The chains of causal relations sometimes create loops (causal loops) feeding the propagating changes back to elements earlier in the chain (Figure 4) (Ashby, 1957:53-54; Senge, 2006:73-79).

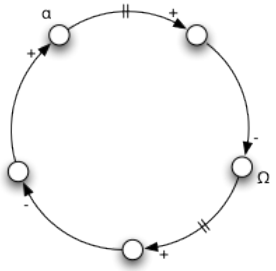

Figure 4. A causal loop of elements, directional relations and delays

These causal loops can be either reinforcing, i.e. resulting in either continuous growth or decline of the element of interest, or balancing, i.e. resulting in stability, through damping or negating changes in the element or in meeting a set target (Maani and Cavana, 2000:28-33; Senge, 2006:79-88). It is, however, important to note that growth, decline and stability may be positive or negative depending on values and perception.

Balancing loops are not always as easy to distinguish from reinforcing loops, as the distinction depends on the element considered. For example, when focusing on the element denoted in Figure 4, any change in will continuously reinforce itself as the change propagating from has the same polarity as the subsequent change feeding (Maani and Cavana, 2000:32). When

focusing on the element denoted Ω, on the other hand, any change in Ω will be attenuated as the change propagating from Ω has the opposite polarity to the change feeding it (*ibid*.).

The challenge when constructing an explicit human–environment system to structure risk scenarios is to find a balance between including sufficient information to capture the complexity of the world, while limiting it to include only what is relevant regarding the purpose of the analysis and the resources available. Finding this balance between Ashby's (1957) law of requisite variety and Ockham's classical razor (Checkland, 1999:35-36) relies on certain considerations (Churchman, 1970:B43-44; Midgley *et al.*, 1998:467). These considerations are often referred to as boundary judgements to underline their inherently subjective nature (Ulrich, 1996:156-158; Ulrich, 2002:41), as they are tripartitely interdependent with what we know about the problem we address and with our purpose, objectives, etc., for doing so (Ulrich, 2000:251-252). In short, the primary issues in making boundary judgements are relevance to what we want to address and to what we want to achieve (Simon, 1990:7-13).

It is important to note that human–environment systems are hierarchical in the sense that the system of interest is part of a system on a higher level, and is made up of systems on a lower level (Simon, 1962:468; Blanchard and Fabrycky, 2006:5). This becomes particularly important as constructing our human–environment system is likely to result in a complex web of elements and relations that is all but impossible to grasp. It is here that hierarchy plays its most vital role, as it allows us to simplify the system by aggregating sets of interdependent elements into subsystems (Simon, 1962:473-477; Simon, 1990:12; Simon, 1996:197-204). The hierarchical structure of human–environment systems thus enables us to describe and explain the behaviour of an element/subsystem at any particular level with no need for a detailed representation of, and with only moderate concern for, the structures and behaviour on the levels above and below (Simon, 1990:12).

To discern what is essential and what is not when constructing our human–environment system, we argue below that structuring risk scenarios in this context entails explicit and relevant information regarding: (1) the things human beings value, (2) which events can have a negative impact on them, and (3) how susceptible they are to the impact of each event, including the capabilities that are available to limit the impact of the event in a particular scenario. To be able to structure risk scenarios in this complex setting, the human–environment system is constructed step by step.

2. Accommodating different stakeholder values

The things human beings value are at the core of any notion of risk (Renn, 1998:51). If nobody cares about a specific thing, the impact of potential harmful events on it matters little. The first step in constructing our human–environment system is thus to define what is deemed valuable and important to protect in each particular context and for each particular time span. In other words, we are not trying to identify the values of the stakeholders, but what they express as being valuable and important to protect from their own point of view.

The things considered valuable and important to protect are rarely explicitly debated or stated when analysing risk, rather, it is assumed that all the stakeholders have the same view (Nilsson and Becker, 2009). However, stakeholders may have different opinions on what should be protected, which may result in them pursuing irreconcilable goals. This is the result of human beings constructing their own mental models of reality through active selection and interpretation of the information around them (Vennix, 2001:14), making any ideas about risk highly subjective as one person's risk may be another person's opportunity (Renn, 2008:2).

Most things expressed by stakeholders to be valuable are related to other valuable elements, e.g. clean drinking water is valuable as it is vital for physical health, and thus sustaining human life. Following such a chain of thought upwards through what stakeholders deem valuable eventually leads to an endpoint for which there is no higher reason to protect. Protecting what is deemed valuable simply for its own sake is a fundamental objective, whereas protecting what is expressed as valuable further down the chain is a means objective (Keeney, 1992:34-35). These causal chains can also be traced downwards by asking what other things are valuable to secure what just have been mentioned as valuable. The aim of explicit discussions among stakeholders concerning what is valuable and important to protect is not to make a list of priorities, but to identify what stakeholders deem to be valuable and important to protect from their own point of view. This constitutes the initial part of our human–environment system.

3. Incorporating a wide range of events that have an impact on the things stakeholders value

As sustainable development requires the capacity to manage a wide range of risks (Haimes, 1992:415; Haimes, 2004:101-106), it is vital to include an equally wide range of events in the analysis. The second step in constructing our human-environment system for structuring risk scenarios is therefore to analyse the events that can have a negative impact on the valuable elements. This step is sometimes referred to as hazard analysis (e.g. Coppola, 2007:34-39), but is in this case specific and only includes events that can have an impact on what is considered valuable in that specific context. A clear definition of the location and spatial extent of an event, its speed of onset and duration, its magnitude or intensity as well as its likelihood or frequency are necessary.

The more specifically each hazardous event is defined, the easier it is to construct risk scenarios. For practical reasons, it is important to group events into categories and allow one specific event to represent a number of events. This can be referred to as partitioning risk scenario space (Kaplan *et al.*, 2001:810-811). For example, it is impractical to differentiate between potential earthquakes with an epicentre at every possible location and with any magnitude. A more pragmatic approach is to define larger areas (e.g. deep sea, northern shallow waters, in the vicinity of a capital city, etc.) and intervals of earthquake magnitude (e.g. 4.0-5.9, 6.0-6.9, >7) and allow one event to cover a region of scenario space.

Although it is important to include people from a broad cross section of society in identifying potential hazardous events (as differences in livelihoods, level of education, location of dwellings, etc., may influence how potential hazardous events are prioritised), formal expertise is also vital (Renn, 2008:7). Having identified a relevant event, it is important to analyse the factors that contribute to it, as these may be connected to, and amplified by, processes related to the things human beings value (Hewitt, 1983:25; Kates *et al.*, 1990; Renn, 2008:5), e.g. mining and pollution; logging and flash floods; irrigation for agriculture and sinkholes, etc. It is also important to note that one hazardous event may trigger another, e.g. earthquakes and heavy rain may cause landslides. All the relevant elements, i.e. the events, their contributing factors, and their relations, are included in our human–environment system.

4. Integrating factors and processes contributing to the susceptibility of the things stakeholders' value to the impact of the events

The third step is to analyse how susceptible the things stakeholders deem valuable are to the direct and indirect impact of specific events. This susceptibility to harm is often referred to as vulnerability, and is never a general attribute, but must always be defined in relation to the

impact of a specific event (Hollenstein *et al.*, 2002; Wisner *et al.*, 2004:11-13). Vulnerability is determined by factors from all spheres of society, i.e. the physical and environmental, the social and cultural, the political and the economic (Wisner *et al.*, 2004:49-84; Coppola, 2007:146-161). Some of these contributing factors may have already been included in our human–environment system in previous steps, but it is nonetheless important to identify and include additional factors that contribute to the vulnerability of each valuable element in the human–environment system. It is also important to note that even when a specific hazardous event has been defined, there may still be considerable uncertainty in the impact it may have (Jönsson, 2007:61-63).

As part of the analysis of how each specific event impacts the valuable elements, it is often important to include the capabilities of individuals and organisations to act so as to limit the impact (Jönsson, 2007:81; Jönsson *et al.*, 2007). It is only important to include the capabilities of performing tasks that have a direct influence on the risk scenario in the human–environment system, i.e. different response and recovery activities. Other capacities with indirect influence on risk scenarios, e.g. risk assessment, preparedness, etc., are not included directly in the risk analysis. Although capacity and capability may be considered synonymous in a purely linguistic sense, they are here used deliberately to differentiate between the capability to act and influence specific risk scenarios and other capacities relevant in risk management.

5. Involving various stakeholders over functional, administrative and geographical borders

Managing risk for sustainable development requires the involvement of a wide range of stakeholders (Haimes, 1998:104; Renn and Schweizer, 2009) representing legal, institutional, social, political and economical contexts (Renn, 2008:8-9), as well as experts, policymakers and the public at large (Renn, 2001). Considering the wealth of information and the multitude of stakeholders necessary, the framework requires the human–environment system to be explicit. Integrating individual mental models of reality, each of which gives a limited perspective of the world, into one common model is central in creating a common understanding of the challenge at hand (Vennix, 2001). Not only formal expertise is vital here, as the common sense of other stakeholders can be rather effective in this process, providing the results with some degree of moral force and political influence (Ravetz, 1999:651). It is not necessary for all the mental models to converge, as long as they are made explicit among stakeholders. Effective collaboration depends on having a shared vision of what is to be achieved together (Jackson, 2003:22; Senge, 2006:187-197), and an understanding of where the mental models differ. Systems approaches to the world have been suggested to provide the scaffolding for constructing such a human–environment system (e.g. Jackson, 2003; Leveson *et al.*, 2006) and for creating shared vision among stakeholders (Senge, 2006:210-214).

Having a large number of stakeholders makes systematic scrutiny of what is included in and excluded from the risk analysis particularly important, as different stakeholders may disagree on the boundary judgements or on the descriptive and normative statements behind (Midgley *et al.*, 1998:467-470; Ulrich, 1996:171-176). Involving many stakeholders is, however, not only important for making boundary judgements and for accommodating various stakeholder values, but also for allowing stakeholders to develop their understanding of the complexity of the system as they go along (Gregory and Midgley, 2000:280).

Analysing risk in this broader societal context often entails some geographical or administrative delimitation, e.g. a community, a municipality, a country, etc., which in these cases provides the first boundary judgement to be discussed by stakeholders. What is within this

geographical area can be considered for being part of the human–environment system of interest. This said, a great deal of what is found within such geographical boundaries may be irrelevant for a particular risk analysis and should not be included, while there may be several relations that cut across such boundaries that should be included. Although it is important to focus risk analyses on the administrative level of interest, some integration of information from multiple administrative levels is important as there may be a potential for biases in views expressed by the different levels.

Parts of the world that are not directly part of the human–environment system, but may influence the system or be influenced by it to a degree deemed relevant, are referred to as belonging to the surroundings of the system (Ingelstam, 2002:19). What distinguishes the elements in the surroundings from the elements within the system itself is that we are only interested in their transboundary relations with the system and not the relations between them. For instance, it may be relevant to include the effects of changing global weather patters on floods in our own municipality, but it is probably not relevant to include the global causal factors of climate change in the municipal risk analysis.

6. Integrating several risk analyses performed by different stakeholders

As a result of the complexity of the world, the functional, administrative and geographical disjointedness of it, and the variety of stakeholder values, multiple risk analyses are often performed by different stakeholders with different purposes. This is the reality which the framework must function in and make use of.

In addition to the principles of wholeness (representing the integrity of human–environment systems) and hierarchy (representing the internal structure of these systems), large complex systems require a third principle to be taken into consideration when constructing our human–environment system; the principle of multiplicity of descriptions (Blauberg *et al.,* 1977:132). This principle states that to sufficiently represent any large, complex part of our world, requires the construction of a range of different descriptions, each of which only covers certain aspects of the wholeness and hierarchy of the system. In other words, our framework for analysing risk must be able to structure risk scenarios by constructing and merging multiple overlapping subsystems into one human–environment system.

Hierarchical Holographic Modelling (HHM) builds on the idea of this third principle, and provides a basic framework for understanding complex systems by merging several complementary descriptions into one multidimensional picture (Haimes, 1981; Haimes, 2004). However, HHM focuses on multi-objective settings in which many stakeholders may vary but a number of them are participating in creating all descriptions. This is unlikely to be the case in the wider context of analysing risk for sustainable development, which complicates matters even further. Our framework must, therefore, be able to combine risk analyses performed by different groups of stakeholders.

The implications of requiring the ability to integrate risk analyses performed by different stakeholders are that each risk analysis must include an explicit model of the system being analysed, the negative consequences must be clearly stated in the analyses (values), and the risk scenarios that have been identified must also be clearly described, together with estimates of their respective probability of occurrence and the consequences.

Summary of justifications

The framework presented here rests on the idea that analysing risk is concerned with structuring risk scenarios which, in this complex context, is intrinsically linked with the construction of an

explicit human–environment system. To guide the construction of such a human–environment system and the structuring of risk scenarios, the framework can be summarised in ten questions (Table 1).

Table 1. Ten questions for the construction of human–environment systems and structuring risk scenarios.

Establish what is valuable and important to protect	1. What is valuable and important to protect? 2. Why is it valuable? 3. Which other elements are valuable to secure that valuable element?
Establish which events can have a negative impact on these valuable elements	4. Which events may happen that can have an impact on what human beings value? 5. Which factors contribute to these events occurring? 6. How likely is each event to occur?
Establish how susceptible these valuable elements are to the impact of the events, including the capability to act to reduce the impact when relevant	7. What can happen to what human beings value, given a specific event, considering actors performing tasks that may influence the outcome where relevant? 8. Which factors contribute to their susceptibility? 9. How likely is that to occur? 10. If it happens, what are the consequences for what human beings value?

Using the framework in South Africa

To be able to evaluate the framework against the requirements, it was applied in a district in the North-West Province of South Africa. Data were collected through focus groups on district and local levels, and through a transect walk, including informal interviews, on ward level. The method was also applied on district level in the Western Cape, South Africa, to investigate the possibility of generalising the higher levels of the human–environment system. Focus groups were chosen as the primary method since these provide an opportunity for dialogue between stakeholders, which facilitates the formulation of an explicit, comprehensive and common mental model of the world.

The three focus groups included between 7 and 10 members, who represented different municipal departments and other organisations with roles in risk management in their respective areas. The discussions were recorded, generating 6 hours 49 minutes of recordings, from which elements and relations were elicited. A one-day transect walk in one ward was then used as a reference to verify the information obtained on the higher administrative levels.

Application of the framework in this limited South African example generated a great deal of data. About 100-120 elements and 200-250 relations were elicited from each focus group, making the raw data cumbersome in their original form. The elements and relations were therefore aggregated into subsystems on different hierarchical levels, with increasing level of abstraction the higher the level. It is important to remember that the resulting human–environment system is not in any way an objective picture of reality, as the raw data collected and the system and subsystems presented below are constructed in social processes.

The results of the first step of the method (questions 1-3) show that the fundamental objective of managing risk in this context is to protect human lives and ensure the well-being of people. To achieve this, critical infrastructures must be protected, as well as the livelihoods of people. All the elicited elements and relations were aggregated into nine elements, forming the overall system of the things deemed to be valuable and important to protect (Figure 5).

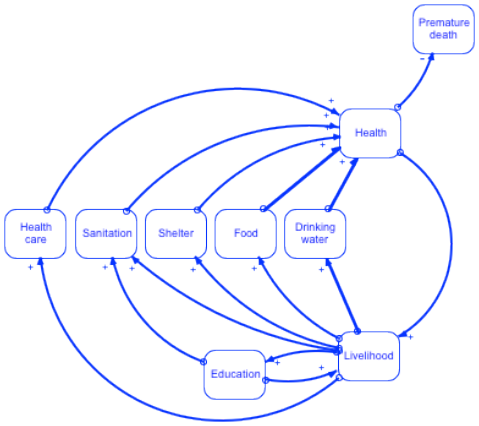

Figure 5. The overall system of the things deemed valuable and important to protect

This system shows that good health means less premature death and better potential for securing a livelihood. Good health is dependent on access to drinking water, food, shelter, sanitation and health care, which in turn are dependent on the livelihood of people. People's livelihood is interdependent on their education, which also influences sanitation. These rather common-sense dependencies create a number of feedback loops, which can be either virtuous or vicious cycles depending on the shocks, seasonal changes and trends that occur in the system.

Each of the nine elements is a subsystem made up of their own elements, which in turn consist of subsystems. The subsystem for health is assumed to be the aggregate of the output of the other subsystems, and premature death the result if health deteriorates below a critical level. The other subsystems are illustrated in Figures 6-12.

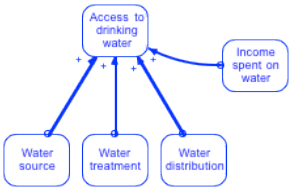

Figure 6. The subsystem for drinking water

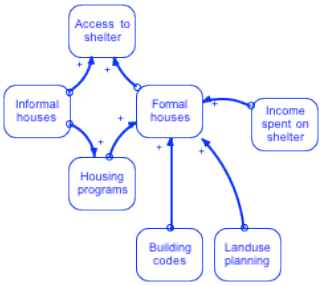

Figure 8. The subsystem for shelter

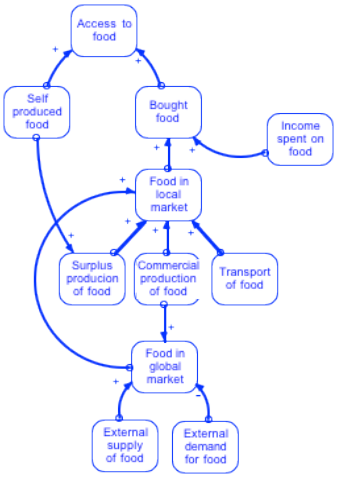

Figure 7. The subsystem for food

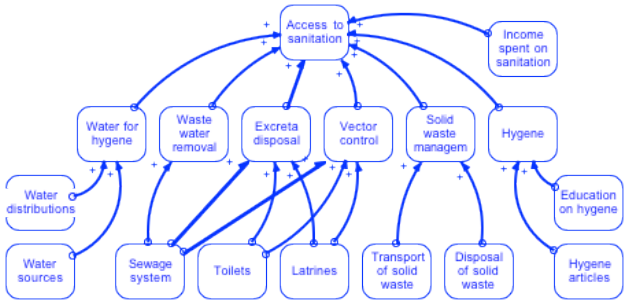

Figure 9. The subsystem for sanitation

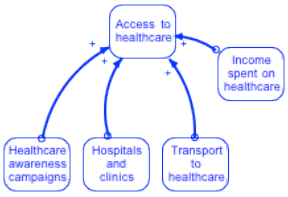

Figure 10. The subsystem for health care

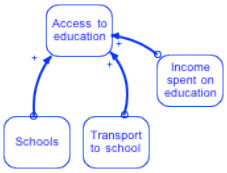

Figure 11. The subsystem for education

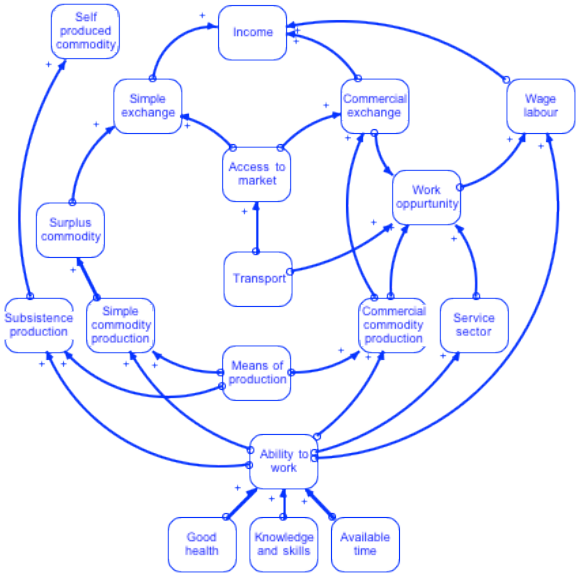

Figure 12. The subsystem for livelihood

Both of the hierarchical levels of the system are rather general. More specific contextual information appears at the hierarchical level below. The richness of detail makes it difficult to present this level in full for each subsystem. For instance, the sources of drinking water in the district in the North-West Province are generally provided by dams and reservoirs in urban areas and boreholes in rural areas. The urban water is purified in water treatment plants before being distributed through water pipes, while the borehole water is often potable without purification, and is either pumped and distributed locally through pipes, or distributed manually (carrying containers to and from the pump). More affluent households have access to drinking water through taps in their house, although most of these households buy bottled water for direct consumption. Some less affluent households in urban areas (townships) also have taps in their houses, while a larger proportion have taps in the yard or within walking distance within their community. Less affluent households in rural areas sometimes have longer distances to drinking water. A minimum amount of water is provided free in less affluent urban areas through the municipal water system. Since it is not possible to monitor water taken from communal taps this is free. Piped water is also used for sanitary purposes in urban areas.

After mapping the system of what the stakeholders express as valuable and important to protect, the next stage is to identify the events that can have a negative impact on this system (questions 4-6). The location and spatial extent, the speed of onset and duration, and the magnitude or intensity are defined for each event. The likelihood of the event is also estimated, including potential seasonal patterns. It is not possible to present all the identified events in detail here, but the result of this step shows that human life can be affected directly by different types of events, leading to premature death through trauma, asphyxiation, toxicity, radiation or disease, or indirectly, through the deterioration of access to critical services. The types of events are floods (fluvial and pluvial), hailstorms, drought, fires (veldt and urban), sinkholes, HAZMAT accidents (transport and depot), disease, transport accidents, violent crime and xenophobic violence. The factors contributing to each of these types of events are presented in Figures 13-24.

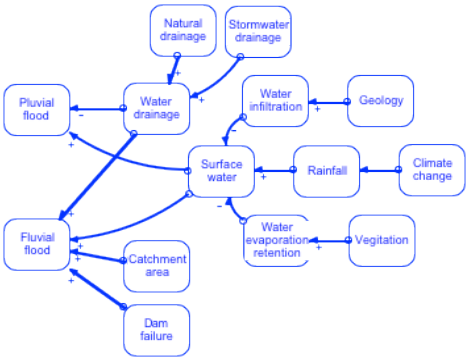

Figure 13. The subsystem for floods

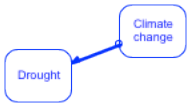

Figure 14. The subsystem for drought

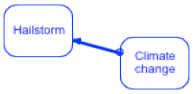

Figure 15. The subsystem for hailstorms

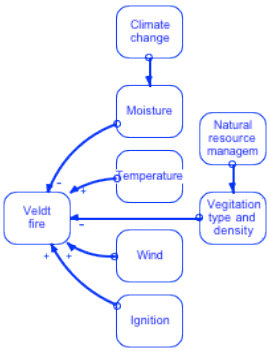

Figure 16. The subsystem for veldt fires

Figure 17. The subsystem for urban fires

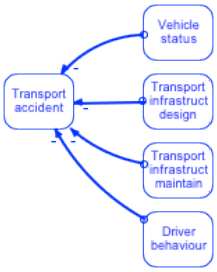

Figure 18. The subsystem for transport accidents

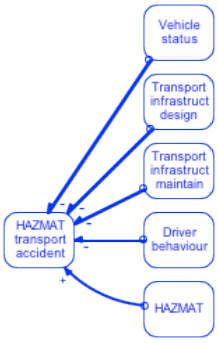

Figure 19. The subsystem for HAZMAT transport accidents

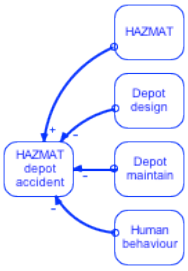

Figure 20. The subsystem for HAZMAT depot accidents

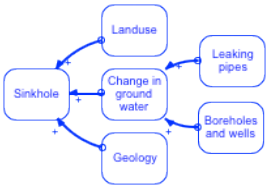

Figure 21. The subsystem for sinkholes

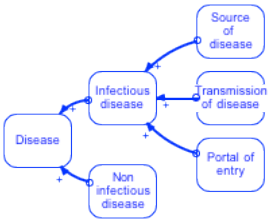

Figure 22. The subsystem for disease

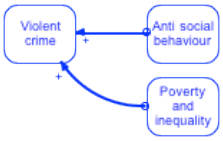

Figure 23. The subsystem for violent crime

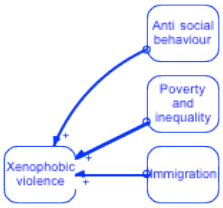

Figure 24. The subsystem for xenophobic violence

Let us consider the example of drinking water for the less affluent, urban communities of one of the larger townships. Part of this township is situated on carbonate rocks, mainly dolomite and limestone, and an even larger part of it depends on drinking water supplied through underground pipes that cross these areas. A sinkhole may have an impact on the supply of drinking water to many households. The factors contributing to sinkhole formation include not only geology, but also land use and changes in ground water. In the case of the township considered here, there is no heavy construction or infrastructure causing vibration. However, some of the water and sewage pipes that run through the area are old, and may leak. This creates a loop in which the water pipes that are necessary for the distribution of water, may cause sinkholes, which in turn may have a devastating impact on the same water distribution system.

An example of a sinkhole event included in the analysis is a 5-10 m diameter sinkhole, which is classified as large (Buttrick and van Schalkwyk, 1998:174), somewhere along the main water pipe running through the township. The speed of onset is immediate and the collapse is permanent, very steep (70-90°) and deep (5-10 m). The likelihood is estimated to be 1 event per 100 m pipe per 20 years (Buttrick and van Schalkwyk, 1998) and the assumption that sinkholes are most likely to form along the pipe as leaking water is one of the main contributing factors.

Having defined the events that may impact what human beings value, the next step is to establish how susceptible these elements are to the impact of these events (questions 7-10). Considering each hazardous event defined above, and establishing the direct and indirect impact that event would have on each element of the human–environment system is too lengthy a process to present in full here. The sinkhole event and the water distribution system in the township will again be used as an example.

If the defined sinkhole event occurs, the main water pipe may rupture. Whether it ruptures or not depends on the quality of the pipe itself, and there is no way in which any actor can respond to stop the pipe from rupturing. Assuming that the sinkhole event occurs, the stakeholders estimated an 80% likelihood of the pipe rupturing. This will cut off the supply of water to the

entire population in the township. Water is necessary for drinking and for sanitary purposes and, if we follow the relations in the human–environment system illustrated above, this will result in a risk of health problems; increasing the longer the population is without access to water. Poor health will in turn result in reduced income as it prevents people from working, and may even result in premature death. Prolonged loss of income will reduce people's possibility to access vital services. The sinkhole may not only affect the water distribution system, but also houses, the sewage system, a health clinic or a school, all with a range of potential indirect consequences. Although this event may also cut off a road, it is unlikely to affect transport, as alternative routes are likely to be opened. In the improbable case of the event hampering transportation, it may generate direct consequences regarding access to food, health care and education, as well as for income generation and solid waste removal.

Discussion

The first application of these initial ideas for the framework is limited, and additional applications in other contexts are needed to develop a framework adequate for the intended purpose. However, the process for scientifically designing a framework provides a cyclic process in which the evaluation of the framework after use should guide further development before it is used in another context. It is therefore interesting to evaluate the application of the framework in South Africa against the six requirements.

1. Integrating phenomena on various spatial and temporal scales, and structural and functional complexity

The approach of constructing an explicit human–environment system seems to be beneficial in capturing the complexity of risk in relation to sustainable development. In its current state the framework makes it possible to qualitatively analyse how a change in the system may propagate, reinforce or balance itself, and combine with other changes, creating nonlinear dynamics that might have eluded, or even deluded, stakeholders in more traditional risk analyses. The focus on relations between elements in the human–environment system, together with the integration of delays, also makes it possible to track the indirect consequences of a change on spatially and temporally distant parts of the system.

Although risk analysis must be carried out over a defined period of time, this framework allows for analysis over multiple time periods, thus facilitating the integration of long-term or delayed consequences of an immediate impact, as well as the consequences of gradual changes. The framework also seems to facilitate the integration of various spatial scales, as the human–environment system can be organised hierarchically. In other words, the representation of the local level may be aggregated and represented as a subsystem of the global level. This means that the framework makes it possible to include local consequences of global events and processes, as well as global consequences of local events and processes.

Although the framework would benefit immensely from the quantitative modelling of stock-and-flow diagramming and microworlds, this is something that lies in the future as many complex relations have yet to be quantified. The use of systems archetypes (e.g. Jackson 2003:70-73), on the other hand, may be a more feasible step in the development of the framework. A systems archetype in this context is a set of elements and relations that can be generalised and used in the analysis of the behaviour of a system or in guiding the construction of the human–environment system. Considering the increasingly abstract and general nature of the human–environment system, it appears that it may be possible to generalise systems archetypes for the higher systems levels, i.e. human beings need water, food, shelter, sanitation etc., regardless of

context, but the details concerning how they acquire these basic amenities are highly contextual. If it were possible to develop generalisable systems archetypes including the most common stakeholder values, events etc., for the upper hierarchical levels, this would greatly benefit the framework as they would guide the future construction of human–environment systems. Although the results of this study indicate this possibility, more applications of the framework are necessary to further explore the possibility and to develop systems archetypes.

2. Accommodating different stakeholder values

It appears that the framework can accommodate different stakeholders' values in the sense of the differences in what stakeholders express as valuable. As the objective of the explicit dialogue on this issue is not only to identify individual elements of value to stakeholders, but also to construct a system clarifying the ways in which these elements are related to each other, this appears to reduce the potential for debate and conflict. The reason for this is that most things that stakeholders express as valuable are somehow connected to each other, making the things that others express less conflictual, in the sense of competing priorities, and more inspirational as it may trigger new thoughts concerning what else is valuable (Nilsson and Becker, 2009). That is to say, the importance of protecting one element does not make protecting another element less important, as one may be a means of reaching the other. However, this does not mean that all the elements identified are connected to each other, nor that they are automatically reconcilable. Although this study gives no such examples, related research has identified protecting democracy as a fundamental objective in several contexts parallel to protecting life (Nilsson and Becker, 2009). These two objectives are, however, not contradictory in any way, but it is possible to envisage pairs that are, for example: protecting marine life or building a new jetty, protecting human life or new employment opportunities in a chemical plant, etc. Constructing an explicit system of what stakeholders deem to be valuable may, nevertheless, be helpful in these cases as it makes potential clashes visible and transparent, and provides the possibility to see the whole picture before deciding which valuable element to focus on.

Having an explicit dialogue concerning what is valuable also seems to mobilise stakeholders who may not normally consider themselves important actors in risk management, e.g. local education authorities, social welfare departments etc. Once they realise that their input is important in analysing risk, it may reinforce their awareness of the importance of managing risks in general, as well as their interest in supporting such activities.

3. Incorporating a wide range of events that have an impact on the things stakeholders value

Specifying what is deemed valuable and important to protect also seems to facilitate the incorporation of many different events into the analysis. The main reasons for this are that including the input of multiple stakeholders provides a wide range of elements that may be affected by different events, and bringing each specific element systematically to mind facilitates the identification of these events. As the framework also aspires to include the contributing factors to each event, it also facilitates the identification of events, as these factors may arise from what stakeholders deem to be valuable in the first place. This also indicates the need to include secondary events triggered by the impact of the initial events, in the analysis.

4. Integrating factors and processes contributing to the susceptibility of the things stakeholders' value to the impact of the events

The framework emphasizes the analysis of the susceptibility of specific elements to the impact of specific events, also referred to as vulnerability. It is widely assumed among both researchers and practitioners that numerous factors and processes contribute to this susceptibility. However, the framework takes this further than simply stating wide-sweeping categories, to demanding more detailed descriptions of these factors and processes, as well as providing a systematic approach to integrating them into the analysis. The framework also indicates that it is vital to include the capability of individuals, organisations and societies to act in specific scenarios when analysing vulnerability to events in which such activities influence the outcome. Since the framework allows multiple stakeholder values, it also allows multiple types of consequences in the analysis of risk. Similarly, analysing risk over multiple time periods generates different sets of consequences for each specific time period. The main challenge in using the framework therefore lies in managing the vast amount of information, both input and output.

This challenge is not in any way met by the framework in its current state, and a great deal of development is required. Although the development of systems archetypes may somewhat reduce this problem, by providing a scaffold for a more systematic construction of human–environment systems, the main solution is to integrate the framework into some kind of tool for information management. Considering the importance of spatially distributed data in analysing risk, geographical information systems (GIS) may provide an interesting option. GIS are also particularly interesting as they show many parallels with systems approaches (Heywood *et al.*, 2006:284) and an aptitude for managing spatial data (structural complexity), as well as conceptual models (functional complexity), which are both necessary when analysing risk in this context.

5. Involving various stakeholders over functional, administrative and geographical borders

The framework appears to be well suited to including a wide range of stakeholders. The explicit dialogue concerning what is considered valuable and important to protect demands direct interaction between various stakeholders over functional boundaries, and provides the opportunity to involve the public, if resources are available. This broad range of stakeholders can also be involved in identifying events that can affect what they value, as well as experts who may be more capable of adding scientific background to the dynamics of the events and their contributing factors. The framework also seems to facilitate the involvement of stakeholders over administrative and geographical borders, as the hierarchical structure of human–environment systems allows them to be aggregated and disaggregated. However, the multifarious nature of our world leads to challenges associated with aggregation that require further attention in the development of the framework.

6. Integrating several risk analyses performed by different stakeholders

Since we did not use multiple risk analyses performed by different stakeholders in our test in South Africa, we cannot draw conclusions concerning the framework's ability to facilitate the integration of several analyses. However, the sinkhole example referred to above can be used to illustrate why the requirement in question is justified, and why the framework is expected to facilitate the process of integrating risk analyses. Although the analysis of the sink hole risk in the South African case was performed by one group of people, it is not unreasonable to expect that several groups of people would be involved in different risk analyses in a real case. For example,

there may be a geological risk analysis focusing only on describing what could happen to the ground, how likely a particular event is, etc., and another analysis of what might happen to the water distribution system if it is destroyed at a specific location. Together with an analysis of the consequences of disruption of the water distribution system in different areas of the community, such analyses may be used to produce a risk analysis for the community in question.

Conclusions

The purpose of this article was to present our initial ideas for, and the evaluation of, a framework for analysing risk to inform efforts in developing the capacity for risk management to facilitate sustainable development. Although the initial framework seems to meet the six stated requirements to certain extent, further development and modifications are necessary. However, representing the world as an explicit human–environment system seems to be essential in analysing risk in the complex context of sustainable development. Constructing a framework in a systematic way, by analysing what is valuable and important to protect, which events can have a negative impact on them, and how susceptible they are to the impact of the events, involving many different kinds of stakeholders, seems to be an viable path to follow for further development of the framework.

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