

**Social-ecological resilience thinking in Environmental
Management Systems for municipal strategic planning**



Linköping University

Viktor Andréen

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Supervisor at Linköping University: Sara Gustafsson

Supervisor at Stockholm Resilience Centre: My Sellberg

Examiner at Linköping University: Stefan Anderberg

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Division of Environmental Technology and Management

Linköping University

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Abstract

Human actions are significantly affecting natural environments from local to global scales. At the same time, our current and future well-being is not decoupled from the continuous function of the natural ecosystems. An emerging issue, from an anthropocentric point of view, is then under what conditions the ecosystems will be able to continue delivering services that we as humans benefit from. A concept within the theory of social-ecological resilience that deals with this issue is *thresholds*.

This thesis addresses how the concept of thresholds can be operationalized in a local authority and what gains and challenges that could entail for strategic planning in the municipality. The thesis also addresses how the operationalization of thresholds could benefit from a standardized Environmental Management System (EMS) in a local authority, and if there are any difficulties in doing so. My research questions are addressed by studying Eskilstuna municipality, a local authority in Sweden that uses both an EMS and is part of an on-going resilience assessment in collaboration with Stockholm Resilience Centre. The studied case and issues described above are approached interdisciplinary by using literature and document studies, participant observations, a survey, and semi-structured interviews with actors at the municipality.

My research shows that thresholds potentially could be operationalized in a local authority either through strategic action plans, or as a way of constructing scenarios in comprehensive planning. Both ways of operationalizing thresholds need to occur in early stages of strategic planning. The thesis shows that thresholds could entail a potential comprehensive gain for strategic planning by providing an argument as to why it is important that certain development trajectories within the municipality are changed. The results also show synergistic effects between the EMS and thresholds in the sense that the EMS could systematize the implementation of overarching strategic plans, influenced by the concept of thresholds, in the municipality's organization. Challenges in using thresholds in a local authority related mainly to the issues of quantifying thresholds, and to a tension between the different system boundaries suggested by resilience theory and continuous improvement in an EMS.

Key words: environmental management systems, social-ecological resilience, thresholds, local strategic planning, Eskilstuna municipality, participatory processes.

Sammanfattning

Mänskligt handlande leder idag till miljöpåverkan ur ett såväl lokalt som globalt perspektiv. Samtidigt beror människans fortsatta välmående av hur de naturliga ekosystemen mår. Utifrån ett antropocentriskt synsätt uppstår då frågan om vilka villkor som gäller för att naturens förmåga att leverera tjänster som vi människor drar nytta av ska kunna bevaras. Ett koncept inom social-ekologisk resiliensteori som tar denna problematik i beaktande är begreppet *trösklar*.

Denna uppsats behandlar hur konceptet trösklar kan operationaliseras på lokal nivå, samt vilka fördelar och svårigheter det skulle kunna medföra för strategisk planering i en kommun. Vidare behandlar uppsatsen hur operationaliseringen av trösklar skulle kunna dra nytta av en kommuns miljöledningssystem, och vilka svårigheter som följer med detta. Uppsatsens frågeställning angrips genom att studera fallet Eskilstuna kommun som i nuläget både använder ett miljöledningssystem och genomför en resiliensanalys i samarbete med Stockholm Resilience Centre. Fallet Eskilstuna och problematiken som beskrivs ovan studeras utifrån ett tvärvetenskapligt perspektiv via dokument- och litteraturstudier, deltagandeobservationer, en enkätundersökning, och semi-strukturerade intervjuer med aktörer i kommunen.

Min forskning visar att trösklar potentiellt skulle kunna operationaliseras via kommunens övergripande strategiska handlingsplaner, eller genom arbetet med scenarier i skapandet av en ny översiktsplan. Båda sätten att operationalisera trösklar behöver ske tidigt i planeringsprocessen och på en strategisk nivå. Att använda trösklar i strategisk planering sågs kunna skapa ett argument till varför vissa beslut och utvecklingsvägar inom lokal strategisk planering är viktiga. Mina resultat visar också på möjliga synergieffekter mellan kommunens miljöledningssystem och trösklar genom att miljöledningssystemet kan bidra med att systematisera implementeringen av strategiska handlingsplaner, inspirerade av idén om trösklar, i kommunorganisationen. De utmaningar som identifierades med att använda trösklar i en kommun var främst kopplade till problem med kvantifiering, samt till en möjlig motsättning i systemgräns mellan resiliensteori och miljöledningssystemets krav på ständig förbättring.

Nyckelord: miljöledningssystem, social-ekologisk resiliens, trösklar, lokal strategisk planering, Eskilstuna kommun, deltagandeprocesser.

Table of Contents

1	Introduction	1
1.1	Aim and research questions	3
1.2	Outline	4
2	Theoretical background.....	5
2.1	Systems perspective and resilience thinking.....	5
2.1.1	Understanding thresholds.....	9
2.1.2	Resilience assessment	12
2.1.3	Management implications for social-ecological systems within the resilience thinking framework.....	13
2.2	Environmental management in Swedish municipalities.....	15
3	The case of Eskilstuna.....	18
3.1	Eskilstuna municipality	18
3.2	Eskilstuna's Environmental Management System	18
3.3	The on-going resilience assessment.....	19
4	Methods	22
4.1	Research approach and epistemology	22
4.2	Research design	22
4.3	Collection of data.....	24
4.4	Data analysis	27
4.4.1	Working process for the resilience assessment.....	27
4.4.2	Thematic analysis.....	28
5	Results and Analysis	31
5.1	RQ1a: Operationalization of thresholds	31
5.2	RQ1b: Gains and challenges for strategic planning	34
5.2.1	Gains for strategic planning	34
5.2.2	Challenges for strategic planning.....	38
5.3	RQ2a: Benefits from having an EMS when operationalizing thresholds	42
5.4	RQ2b: Difficulties of operationalizing thresholds in an existing EMS	43
5.5	Summary of results and analysis	46
6	Discussion.....	48
6.1	Thresholds and resilience as a radical agenda	48
6.2	Environmental Management Systems and adaptive management.....	48
6.3	Quantifying threshold effects in a complex world	51

6.4	Transforming the sustainability discourse.....	52
6.5	Conceptual differences between domains	54
6.6	Strategic introduction of thresholds	55
6.7	Thresholds as integrated within resilience thinking	55
6.8	Specified vs. general resilience	56
6.9	Method discussion	57
7	Conclusions	60
7.1	Future research	61
8	Works Cited.....	62

Appendix I – Values connected to Eskilstuna’s food system

Appendix II – Potential thresholds in Eskilstuna

Appendix III – Interview guide

Appendix IV – List of documents

Appendix V – Survey from the workshop at Eskilstuna

Appendix VI – Additional quotes

1 Introduction

The earth's natural ecosystems have historically provided a resourceful foundation for human civilizations to develop upon. More recently however, human activity has started to significantly change the surrounding environment at a global scale (Folke et al., 2004; Cole et al., 2014). Environmental changes and their consequences are now increasingly unpredictable (Steffen et al., 2004). When the ecosystems that we heavily depend on are continuously exposed to shock after shock, a critical question emerges: "How much can they take and still deliver the things we want from them?" (Walker & Salt, 2012, p.xi).

Human actions are in many disciplines pictured as external drivers affecting ecosystem dynamics. In contrast to that, some scholars (e.g. Folke et al., 2010; Walker et al., 2004) suggest that social systems and ecosystems instead should be viewed as inextricably linked. This way of thinking assumes that system dynamics are not determined by the social and ecological system detachedly, but instead set by the feedback loops among them (Folke et al., 2010). According to e.g. Folke et al. (2010) and Fazey (2010), a framework that embraces such system dynamics is *resilience thinking*. Instead of picturing ecosystems and the social systems that depend upon them as separate, a resilience perspective assumes that they are linked *social-ecological systems* (Berkes & Folke, 1998). Resilience in social-ecological systems is defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks" (Walker et al., 2004, p.2). The concept of resilience is according to Porter & Davoudi (2012) more and more used in government policy and strategies. An example of this is the 100 Resilient Cities challenge, pioneered by the Rockefeller Foundation (Rockefeller Foundation, 2015). Within a Swedish context, the resilience concept is also part of the national environmental objectives (Naturvårdsverket, 2012).

When working towards operationalizing resilience theory in social-ecological systems, the concept of *thresholds* is according to Walker & Salt (2012) and Resilience Alliance (2010) important. A threshold, within resilience theory, is a level of a certain system variable after which the system starts behaving fundamentally different (Walker et al., 2004). One example of this is that freshwater systems after a certain amount of nutrient

input can “flip” from a clear water oligotrophic lake into a turbid eutrophic lake (Walker & Salt, 2012; Gunderson & Holling, 2002).

The question regarding how much disturbances the natural systems can handle is from a resilience perspective therefore very much linked to the concept of thresholds. A participatory approach of assessing resilience in social-ecological systems (resilience assessment), described in the Resilience Assessment Workbook for practitioners (Resilience Alliance, 2010), emphasizes that the concept of thresholds is an important step in revealing what is building or eroding the resilience of a system. According to Resilience Alliance (2010), “being aware of critical thresholds between system states can potentially provide advance warning of impending change as well as opportunities for preventing undesirable shifts in system states” (p.7). Furthermore, Sellberg et al. (2015) found, based on a study of a resilience assessment in Eskilstuna municipality, that the municipality’s strategic environmental planners perceived the concept of thresholds as potentially very useful. Thresholds are in resilience theory clearly suggested as being an important component of assessing resilience in practice, but at the same time also potentially useful as both a building block in strategic planning and for environmental management.

However, more empirical studies are needed on how to translate resilience theory into practice (Mitchell et al., 2014). Both in the book on how to manage resilience in practice (Walker & Salt, 2012) and in the Resilience Assessment Workbook for practitioners (Resilience Alliance, 2010), thresholds are pictured as being difficult to deal with in practice. Often, thresholds are discovered first when they have been crossed (Resilience Alliance, 2010). Even though Sellberg et al. (2015) saw the concept of threshold as potentially useful for local strategic planning, they also found challenges in working with thresholds in practice. Despite the fact that efforts have been made to operationalize resilience in social-ecological systems, e.g. Haider et al. (2012) and Wilkinson (2012), there still remains a gap between social-ecological resilience as a theoretical concept on the one hand, and empirical studies on how to in practice govern for resilience on the other (Wilkinson & Wagenaar, 2012). The gap consists of both a practical and an empirical dimension; practical in the sense that thresholds are suggested as being difficult to work with in practice, and empirical due to the fact that there are few studies carried out on how to operationalize resilience theory in practice.

At the same time as the resilience concept is being more and more used (e.g. (Rockefeller Foundation, 2015; UN, 2014), other ways of addressing environmental concerns are also widely spread. One example is the use of standardized Environmental Management Systems (EMSs) which, according Emilsson & Hjelm (2002a, 2002b), are common within a Swedish municipality context. Even though the Swedish government has not put any pressure on local authorities to implement EMSs (Emilsson & Hjelm, 2005), the study by Emilsson & Hjelm (2002b) showed that in the year 2000 almost half of municipalities in Sweden used EMSs in their organizations.

A Swedish municipality that currently is working with both resilience and an EMS is the local government of Eskilstuna. Eskilstuna municipality started working with EMSs as early as 1996 (Wiklund, Personal communication, April 2015), and the municipality is also currently working with a resilience assessment in collaboration with Stockholm Resilience Centre¹ (Sellberg et al., 2015). Both the on-going resilience assessment and the EMS in Eskilstuna are strategic in the sense that they are based in the highest office of civil servants in the municipality. Furthermore, the new version of Eskilstuna's environmental policy document (currently under consideration) includes the resilience concept (Birath, Personal communication, April 2015), which indicates a potential relation between the EMS and resilience theory in the municipality.

1.1 Aim and research questions

This thesis aims at addressing the practical and empirical gap regarding how to use thresholds in a local planning context. Furthermore, the goal is also to study the relationship between operationalizing the concept of thresholds on the one hand, and a municipality's EMS on the other. By examining the on-going resilience assessment in the local government of Eskilstuna in Sweden, thresholds as a potentially useful concept in local strategic planning, and how the concept correlates with the already existing EMS in the municipality, will be explored. The aim of this thesis is operationalized in two research questions related to the on-going resilience assessment in the local government of Eskilstuna:

¹ An international, interdisciplinary research centre at Stockholm University with focus on resilience in social-ecological systems. See <http://www.stockholmresilience.org>.

1 a) How can the concept of thresholds be operationalized in strategic planning at a local government, and b) what potential gains and challenges could that entail for the strategic planning?

2 a) In what ways can the operationalization of thresholds in strategic planning benefit from a municipality's existing Environmental Management System, and b) what are the difficulties of operationalizing thresholds in an existing Environmental Management System?

The term “strategic planning” here refers to overarching sectorial plans and strategic action plans, comprehensive plans, and policy documents in the local government of Eskilstuna. Standardized Environmental Management Systems is in this context seen a tool for implementing systematic environmental management in organizations.

1.2 Outline

I will answer my research questions through an inductive approach, using literature and document studies, participant observations, a survey, and semi-structured interviews with actors at the municipality. The thesis will follow the subsequent disposition:

- *Chapter 2 Theoretical background:* presenting the framework of resilience thinking, theory about the threshold concept, and the use of Environmental Management Systems in Swedish local authorities.
- *Chapter 3 The Case of Eskilstuna:* explaining the background for the studied case of Eskilstuna.
- *Chapter 4 Method:* presenting my overall research approach and research design, methods for data collection, and data analysis.
- *Chapter 5 Results and Analysis:* answering my research questions in a combined results and analysis chapter.
- *Chapter 6 Discussion:* presenting a set of discussion topics regarding the analyzed results in relation to the theoretical background.
- *Chapter 7 Conclusions:* presenting a set of final conclusions regarding the analyzed results and discussion topics in relation to my research questions, and additionally giving further research recommendations.

2 Theoretical background

This chapter provides a theoretical background of various concepts and ideas that are used in this thesis. First, I introduce the theory of social-ecological resilience, followed by a few remarks from scholars that question this way of thinking about systems. I thereafter present theory about the concept of thresholds, which is suggested as being an important part of translating resilience into practice. After that, I outline theory regarding how resilience translates into management practices. Lastly, I present theory about the use of EMSs and how they have developed over time within Swedish local authorities.

2.1 Systems perspective and resilience thinking

The resilience concept has its roots in the field of ecology and was first introduced by Holling (1973). More recently, resilience is also being used in interdisciplinary contexts to conceive a way of thinking regarding how to analyze linked social-ecological systems (Folke, 2006; Walker & Salt, 2006; Anderies et al., 2006). Resilience in social-ecological systems is defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks" (Walker et al., 2004, p.2).

Resilience as a concept also appears in other settings where its meaning and definition are interpreted otherwise (Walker & Salt, 2012; Gunderson, 2003). From a downright engineering system perspective, resilience focuses on how long it takes for a system to return to its equilibrium state after a disturbance (Brand & Jax, 2007). It is vital to stress that resilience in a social-ecological context is about the capability to recover at all from a disturbance (Walker & Salt, 2012; Brand & Jax, 2007; Walker et al., 2004). In other words, the time it takes for a system to recover is, in a social-ecological context, not as important as the ability to maintain system identity itself (Folke, 2006). The resilience concept can hence mean different things within different settings, but from here on I refer to "social-ecological resilience" as "resilience".

For the sake of clarity regarding concepts, I choose to separate *resilience* from *resilience thinking*. Resilience thinking is captured as a theoretical framework consisting of a set of underlying key assumptions as well as related concepts (Fazey, 2010), centered around the idea of resilience (Folke et al., 2010). Resilience, around

which resilience thinking revolves, is apprehended as a property of a (social-ecological) system (Allen & Holling, 2010; Slootweg & Jones, 2011), characterized by the definition from Walker et al. (2004).

Assumptions in the resilience thinking framework

There are three key assumptions related to the framework of social-ecological resilience (Resilience Alliance, 2010). First of all, *ecological and social systems are fundamentally linked*, and are thus social-ecological systems (Folke, 2006; Resilience Alliance, 2010; Folke et al., 2010; Walker & Salt, 2012). That is, an "integrated system of ecosystems and human society with reciprocal feedback and interdependence" (Folke et al., 2010, p.3). According to Berkes & Folke (1998), the linkage between the natural and the social systems has not been defined and formulated in a single, universally accepted way. However, the delivery of ecosystem services from the natural systems to the social systems is one way to understand the first assumption and hence the linkage between the two domains (Grimm et al., 2008).

The second assumption is that social-ecological systems are to be viewed as *complex adaptive*, or *self-organizing systems* (Folke, 2006; Resilience Alliance, 2010; Walker & Salt, 2012). What is significant for complex adaptive systems is that they possess emergent behavior, i.e. their overall behavior cannot be understood by studying single components of the system (Walker & Salt, 2006). Another attribute of such systems is that they can exist in multiple states with different sets of stabilizing feedback mechanisms (Walker & Salt, 2012; Folke et al., 2010; Berkes et al., 2003). Holling (1973) considers complex adaptive systems to not exist in a static equilibrium state, but instead in a landscape of stability that allows for re-organization around changing circumstances. According to Berkes et al. (2003), complex systems tend to organize around one of the possible equilibrium states until a certain level of change is reached, which then causes the system to rapidly start behaving fundamentally different. A system reaching "a certain level of change" and thus starting to behave fundamentally different implies, within resilience theory, that the system has reached a threshold (Slootweg & Jones, 2011; Walker & Salt, 2012; Folke, 2006). This is an example of the non-linearity and inherent uncertainty that are attributes of complex systems (Berkes et al., 2003). Thresholds will be further discussed later on in this chapter.

The third and final assumption concerns *cross-scale* interactions in social-ecological systems (Resilience Alliance, 2010). Resilience thinking assumes that social-ecological systems are linked across scales in both time and space (e.g. Gunderson & Holling, 2002; Folke et al., 2010; Slootweg & Jones, 2011). Resilience at one scale should not be enhanced at the expense of eroding other systems resilience at scales above or below (Wilkinson & Wagenaar, 2012).

Concepts within the framework of resilience thinking

When turning resilience thinking into practice, *specified resilience*, i.e. the resilience “of what” “to what” has to be defined (Carpenter et al., 2001; Resilience Alliance, 2010). Specified resilience relates to a specific shock or disturbance to a particular aspect of the system (Folke et al., 2010; Walker & Salt, 2012), e.g. the resilience of a food production system to the effects of climate change. The resilience to withstand all types of disturbances, even unforeseen and novel ones, is referred to as *general resilience* (Walker & Salt, 2012; Folke et al., 2010). General resilience is therefore about dealing with all kinds of uncertainties (Folke et al., 2010). In practice, there could be a trade-off between general and specified resilience. According to Walker & Salt (2012), when enhancing a system’s ability to deal with a certain shock, e.g. climate change, there is a risk that the capacity to deal with uncertain ones diminishes. When building resilience in a social-ecological system, it is therefore important to consider both specific and general resilience (Walker & Salt, 2012; Folke et al., 2010). Table 1 below summarizes key assumptions and concepts within resilience thinking as a framework.

Table 1. Summary of the resilience thinking framework

Resilience thinking	
Key assumptions	1) Social systems and ecosystems are fundamentally linked (social-ecological systems) (e.g. Folke et al., 2010; Walker & Salt, 2012), 2) these systems are complex adaptive (e.g. Folke, 2006; Walker & Salt, 2012), and 3) they interact across scales (e.g. Gunderson & Holling, 2002; Folke et al., 2010).
Concepts	<i>Social-ecological resilience</i> – “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Walker et al., 2004, p.2). <i>Specified resilience</i> – the resilience “of what” “to what” (e.g. Carpenter et al., 2001).

	<i>General resilience</i> – the ability to withstand unforeseen shocks (e.g. Folke et al., 2010).
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Criticism against the social-ecological resilience framework

Adopting a social-ecological resilience lens is not an unchallenged way of thinking about systems. Resilience as a concept stems from the field of ecology (Holling, 1973), but in a social-ecological context, it is being applied to both the social and the natural world (Davoudi, 2012). Its strong ties to ecology has, according to Cote & Nightingale (2012), lead to an assumption that the social and natural systems operate in essentially similar ways.

Davoudi (2012) discusses a critical issue connected to the purpose of the resilience concept, and how that purpose differs when it comes to comparing desirable outcomes in the natural and the social world. In an ecological sense, the idea of resilience aims at striving towards sustainability (Davoudi, 2012). The book on how to manage resilience in practice by Walker & Salt (2012) also stresses that an important aspect of resilience is for humans to preserve ecosystem function in order to still receive the benefits from ecosystem services. But as Davoudi (2012) points out, “desirable” in the social world is very much tied to value laden, normative judgments. There are needs to question what is being maintained, and for whom (Cretney, 2014). According to Hornborg (2013), the current discussions on the concept of social-ecological resilience tend to mask societal inequalities, power relations, and the inherent contradictions of interest that form how humans utilize the natural ecosystems. Christensen & Krogman (2012) discuss that resilience theory literature often is concerned with how to manage ecosystems, without giving much attention to how system configurations affect those living in the system but who may not be involved in the decision making. However, Hornborg (2013) also note that resilience theory has the potential to be used more radically than it is today, by challenging mainstream neo-liberal assumptions in the economic system.

Resilience is also a multifaceted concept in the sense that it can mean many different things depending on context (e.g. engineering resilience versus social-ecological resilience) (Cretney, 2014). Engle (2011) note that even though the resilience concept is considered to be defined from a social-ecological perspective, the mainstream use of it often embraces the engineering definition of bouncing back quickly from a disturbance.

2.1.1 Understanding thresholds

In resilience theory, social-ecological systems have, within limits, the ability to undergo change while still recover and maintain the same basic functions (Walker & Salt, 2012). These limits are determined by so-called thresholds (Walker & Salt, 2006; Walker & Salt, 2012; Folke et al., 2010; Walker & Meyers, 2004; Folke et al., 2004). Thresholds are by Folke et al. (2010) defined as “a level or amount of a controlling, often slowly changing variable in which a change occurs in a critical feedback causing the system to self-organize along a different trajectory” (p.3). The controlling variables in a social-ecological system shape the variables that are of concern for ecosystem managers. For example, nutrient levels (a controlling variable) shape algal density or soil fertility (variables of concern) (Walker & Salt, 2012). Thresholds can, according to Walker & Meyers (2004), be understood as a “breaking point” between two stable system states. Walker et al. (2004) claim that thresholds is a crucial part of the resilience concept since they constitute the maximum amount of change a system can deal with before losing its ability recover. Crossing critical thresholds can have a significant impact on ecosystems and the well-being of human societies (Rockström et al., 2009; Blythe, 2014).

Thresholds within the theory of social-ecological resilience occur in the biophysical, social, and economic domain (Walker & Salt, 2012). However, according to Blythe (2014), the body of knowledge regarding how social thresholds operate is not well developed, and most research related to thresholds has been conducted within the natural science sphere.

Threshold characteristics

Most variables in a social-ecological system do not have thresholds, which in practice means that they exhibit a linear or exponential (i.e. no dramatic step-wise behavior) response to changes in underlying controlling variables (Walker & Salt, 2012). For the variables that have thresholds, crossing such limits means, within resilience theory, that the system will self-organize along a different trajectory with other stabilizing feedback mechanisms (Folke et al., 2004; Scheffer & Carpenter, 2003; Walker & Salt, 2012). If that happens, the system is said to exist in a new regime (Walker & Salt, 2012; Folke et al., 2010).

The effect of a social-ecological system reaching a threshold is illustrated below in figure 1, modified from Folke et al. (2004, p.568). The two basins in step 1 to 4 (figure

1) can be understood as two possible regimes for the social-ecological system, where the position of the ball describes the current state of the system (Folke et al., 2004). The edge between the two basins represents a threshold of a certain controlling variable (Walker & Salt, 2006).

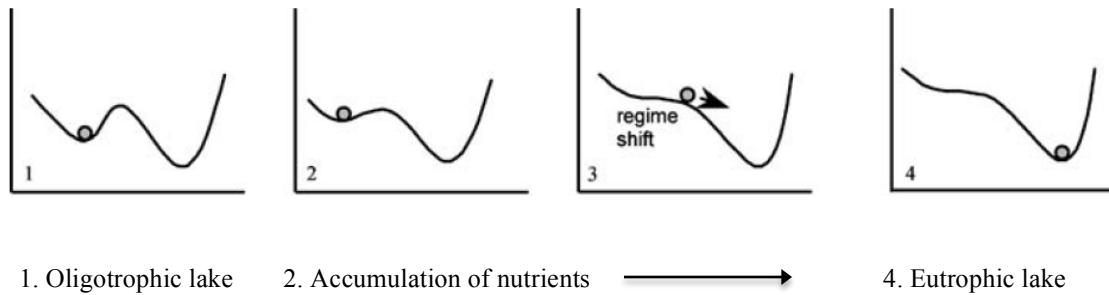


Figure 1. Visualization of a regime shift process, modified from Folke et al. (2004, p.568).

The cause and effect chain in figure 1 above can be illustrated by the example of a lake going through a regime shift from a clear oligotrophic lake to a eutrophic turbid lake (e.g. Gunderson & Holling, 2002; Walker & Salt, 2012). At a low enough level of nutrients accumulated in the lake sediments, the lake is in a relatively stable oligotrophic clear water regime (step 1). This is associated with e.g. delivery of ecosystem services such as water purification and recreational values for humans (Rocha et al., 2013). As nutrients accumulate in the lake sediments, the system's resilience is eroded (step 2). At a high enough amount of nutrient input, or through an external shock such as a storm, a regime shift is triggered (step 3), which transforms the lake into a eutrophic turbid system (step 4). The eutrophic regime is associated with loss of ecosystem services provided in the previous oligotrophic state (Rocha et al., 2013).

A system reaching a threshold (see step 1 to 4 in figure 1) can be either irreversible or reversible (Walker & Salt, 2012). Entering a new regime by crossing a reversible threshold enables going back to the previous system state, while the crossing of an irreversible threshold makes it impossible to go back. Even though a threshold effect sometimes is reversible, going back to the previous state can demand that the level of controlling variable (e.g. nutrient levels in a lake) is reduced to much larger levels than before the thresholds was crossed (Kinzig et al., 2006; Walker & Salt, 2012).

Identifying and understanding thresholds in different domains

Both the Regime Shifts Database (Stockholm Resilience Centre, n.d.) and the Resilience Alliance's Threshold Database (Resilience Alliance, n.d.) contain a number of cases where thresholds, mainly in the biophysical domain, have been identified. A few examples of this are freshwater eutrophication (Rocha et al., 2013; Weisner et al., 1997) and soil salinization (Giusti et al., 2013). Compared with biophysical thresholds, the social and economic ones are suggested as often being more difficult to identify (Walker & Salt, 2012). For thresholds in the economic domain, there are, according to Walker & Salt (2012), repeatable examples between equivalent systems facing similar trends. Hence, studying systems similar to the one of interest can provide useful information regarding where economic thresholds might lie (Walker & Salt, 2012). One example is the threshold for (economic) farm viability. According to Walker & Salt (2012) and Walker et al. (2009), such thresholds can be identified by examining debt and income ratios, which at a certain point reaches a level where the farm no longer is financially viable. The social ones are however, according to Walker & Salt (2012), often even more context dependent. It is therefore unlikely that examples from other systems could be used to inform where such thresholds might lie in the system of interest.

Walker & Salt (2012) write that social thresholds can be described as “tipping points”, e.g. significant changes in voting pattern, fashion, riot behavior, or markets. According to Christensen & Krogman (2012), social thresholds need to be understood in terms of what a community recognizes as collectively desirable or acceptable. One example of such a threshold could be that society holds a preference towards small-scale development over more large-scale, capital intense projects (Christensen & Krogman, 2012). Thresholds in the social domain are sometimes also referred to as “utility thresholds”, determined subjectively by stakeholder value (Martin et al., 2009; Walker & Salt, 2012). A common denominator in the studied literature on thresholds in the social domain is that they focus on what is actually desirable in a system, rather than just function itself (Christensen & Krogman, 2012; Martin et al., 2009; Walker & Salt, 2012; Walker et al., 2009; Blythe, 2014).

One method of identifying thresholds in the social domain is described by Blythe (2014), through a study of two fishing communities in Mozambique. The study used

semi-structured interviews and asked the interviewees (mainly fishermen) to describe: (i) critical components of the system (human and non-human), (ii) the most severe drivers of change and how they would respond to them, and (iii) possible future scenarios and preferred system state. Finally, through a participatory workshop, the amount of acceptable change without altering the system to a fundamentally new one was determined.

2.1.2 Resilience assessment

A resilience assessment is “a specific methodology and framework for analyzing and managing the dynamics of resilience in social-ecological systems” (Haider et al., 2012, p.312). According to Haider et al. (2012), the resilience assessment method operationalizes the different concepts embedded in resilience thinking in a way that makes the assessment accessible for researchers as well as for practitioners.

The method is described in the Resilience Assessment Workbook for practitioners (Resilience Alliance, 2010), published by the Resilience Alliance² (Haider et al., 2012). The workbook emphasizes a participatory approach, and provides a set of strategic questions and tools to identify what is building or eroding the resilience of a social-ecological system (Resilience Alliance, 2010). According to Haider et al. (2012), the ecology-rooted origin of resilience (Holling, 1973) has in the workbook been mixed with more institutional approaches to social systems such as e.g. Ostrom (1990) and her work on governing the commons. The workbook is constantly developing, and is used by both practitioners and researchers (Haider et al., 2012).

The research body on carried out resilience assessments is not exhaustive. Walker et al. (2009) presented the first paper on a comprehensive assessment in the Goulburn-Broken region in Australia. Beyond that, there are only a few more resilience assessments that have been studied and published, at least that are based on the workbook; a pasture management in northern Afghanistan (Haider et al., 2012), the Swedish municipality of Luleå (Wilkinson, 2012), Murray Catchment Management Authority in Australia (Mitchell et al., 2014), the town of Caledon in Canada (Liu, 2014), and finally the on-going assessment in Eskilstuna municipality, Sweden (Sellberg et al., 2015).

² An inter- and multidisciplinary research organization established by practitioners and scientists who explore the dynamics of social-ecological systems collaboratively. See <http://www.resalliance.org>.

The resilience assessment workbook deals explicitly with the identification of thresholds (Resilience Alliance, 2010, p.28), where three main steps are presented:

1. *Identify how your current system could experience a shift towards an alternate regime.* Possible future, and historical, alternate regimes are identified earlier in the workbook.
2. *Characterize thresholds that are of potential concern* with respect to its main drivers, reversibility, and possible consequences of crossing it. As discussed earlier, the drivers for crossing a threshold is often associated with slow changing, controlling, variables.
3. If possible, *estimate the location of potential thresholds* by using existing data describing the trajectory of the system over time.

It is important to point out that the workbook explains the resilience assessment method as a whole. The three steps above describe only the part that explicitly deals with the identification of thresholds.

2.1.3 Management implications for social-ecological systems within the resilience thinking framework

When managing for resilience in social-ecological systems, Holling (2001) suggests that an adaptive management approach is preferable compared to tactics that seek stable targets. Due to self-organizing features of social-ecological systems, management approaches for such systems should be continuously updated and adapted to the changing circumstances (Folke et al., 2005). Uncertain possibilities of anticipating a system's exact behavior, and also adding the fact that stakeholders in the system might hold divergent values, implies that successful management actions should (i) be created together with relevant partners, and (ii) with a condition to learn and adapt (Roux & Foxcroft, 2011). Desirable management practices for resilience in social-ecological systems should therefore, according to e.g. West & Shultz (2015) and Smith & Stirling (2010), promote on-going learning in an iterative process. Due to the fact that resilience theory assumes social-ecological systems to be complex adaptive (the second assumption in resilience thinking), management in such systems is very much about managing thresholds (Folke et al., 2004; Folke et al., 2009; Christensen & Krogman, 2012).

Within adaptive management, there is a distinction between *active* and *passive adaptive management*. According to Allan & Curtis (2005) active adaptive management includes all of the above-mentioned principles, and explicitly the following:

- Management is designed to test hypothesis through experiments in e.g. ecosystems.
- Embracing complexity.
- Providing involvement of multiple stakeholders.
- Emphasizing social learning.

Allen & Gunderson (2011) suggest that an important feature of active adaptive management approaches is to develop "safe to fail management", which relates to testing hypotheses in the form of experiments. They further claim that active adaptive management is not appropriate to adopt in all circumstances. Instead, it is more suitable for a subset of problems related to management of natural resources (Allen & Gunderson, 2011).

Strategic Adaptive Management

According to Allan & Curtis (2005), there are few published examples of actually implemented adaptive management approaches. However, within South African National Parks, a version of adaptive management has successfully been implemented and is now an integrated part of the current management system in Kruger Park (Roux & Foxcroft, 2011; Kingsford & Biggs, 2012; Freitag et al., 2014). This version is called Strategic Adaptive Management (SAM), and is by Walker & Salt (2012) claimed to be a useful framework when dealing with thresholds from various domains. According to Kingsford & Biggs (2012), SAM is a step-by-step process that takes into account the existing uncertainties of dynamic and unpredictable systems, while progressively improving management actions. In short, the process can be described as learning by doing in a structured scientific way while adapting behavior and actions as new information becomes available (Roux & Foxcroft, 2011).

The process of SAM is by Roux & Foxcroft (2011) divided into three main parts: *adaptive planning*, *adaptive implementation* and *adaptive evaluation*. Adaptive planning consists of building stakeholder consensus regarding what values to manage in the system, i.e. creating a common goal (Roux & Foxcroft, 2011). The planning step

also includes breaking down the common goal into more concrete objectives, and finally measurable endpoints that define the boundaries for the desired system state (Biggs & Rogers, 2003; Roux & Foxcroft, 2011). The measurable endpoints are also referred to as “Thresholds of Potential Concern” (TPCs) (Roux & Foxcroft, 2011). TPCs are hypotheses regarding the amount of tolerated change in a system’s structure. These hypotheses could at times be invalid, and the TPCs need to be continuously revised as new knowledge becomes available (Freitag et al., 2014). TPCs are accordingly a way of taking into account that there might exist a critical threshold that could push the system into a new regime, instead of either ignoring that there might be a threshold or setting static boundaries that are never updated.

Adaptive implementation consists of implementing suitable management options for the system with respect to the common goal, including monitoring the measurable endpoints (i.e. the thresholds) (Roux & Foxcroft, 2011; Freitag et al., 2014). Adaptive evaluation consists of constantly evaluating the management system, including updating threshold levels as new information becomes available (Roux & Foxcroft, 2011).

2.2 Environmental management in Swedish municipalities

Aside from resilience thinking and adaptive management, other approaches to environmental issues exist as well. According to Emilsson & Hjelm, (2005), Swedish municipalities in general have a long-going history of working with environmental management in one way or the other. The use of standardized Environmental Management Systems (EMSs) is, according to Emilsson & Hjelm (2002a, 2002b), fairly common within local authorities in Sweden. A survey carried out by Emilsson & Hjelm (2002b) showed that in the year 2000, almost half of the Swedish municipalities worked with EMSs. According to Gustafsson & Hjelm (2011), the survey has not yet been followed up and it is therefore difficult to estimate how many municipalities that work with EMSs today.

In Sweden, there is no general standard for EMSs adopted by local authorities, but instead both formalized and more simplified versions exist (Emilsson & Hjelm, 2005). The formalized EMSs follow international guidelines in line with EMAS (Eco Management and Audit Scheme) and ISO 14001 (von Malmborg, 2003; Emilsson & Hjelm, 2005; Emilsson & Hjelm, 2002a). The International Organization of Standardization established ISO 14001 in 1996, while EMAS was introduced by the

European Union in 1993 (Nikolaou et al., 2012). These standards support the overall aim to structure organizations' environmental work so that it is continuously improving (ISO, 2004). The organization's environmental ambitions are formulated in a public available policy document, which is used as a framework for environmental improvement and as an outset for setting targets and objectives (Emilsson & Hjelm, 2002a). The scope of a mature EMS is, according to Emilsson & Hjelm (2009), to cover direct and indirect environmental impact. For less mature EMSs, the scope is rather the direct environmental impacts. (Emilsson & Hjelm, 2009).

Ideally, the steps in an EMS follow an iterative loop according to the Plan-Do-Check-Act (PDCA) Cycle (von Malmberg, 2003; European Commission, 2015). However, according to Emilsson & Hjelm (2005), local authorities sometimes struggle with seeing EMSs as a continuously improving process. They instead tend to view the management system as a project with a defined beginning and end-point. The general PDCA Cycle for an EMS is illustrated below in figure 2, modified from European Commission (2015).

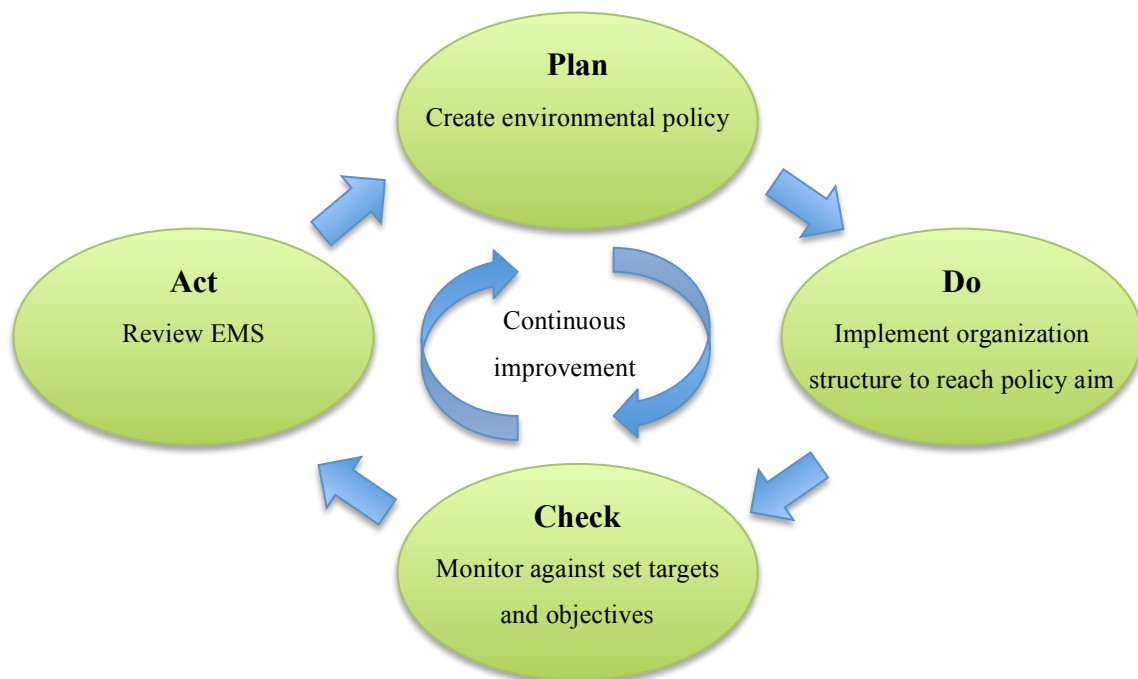


Figure 2. An EMS as steps in the PDCA Cycle, modified from European Commission (2015).

The implementation of EMSs in Swedish local authorities was from the beginning mainly focused on the technical sector that has rather obvious and direct environmental

impacts (e.g. emissions from transportation) (Emilsson & Hjelm, 2005; Emilsson & Hjelm, 2002a). More recently however, Emilsson & Hjelm (2005) notice a trend in using more simplified versions of the formalized ISO- and EMAS-standards. Emilsson & Hjelm (2005) also note that over time, simplified versions of EMSs have been increasingly, and successfully, applied to the "soft sector" (e.g. education and social services).

3 The case of Eskilstuna

3.1 Eskilstuna municipality

Eskilstuna municipality is situated in Södermanland County, in the south east of Sweden between the two lakes Mälaren and Hjälmaren (see figure 3). The municipality covers an area of 1 250 km² (SCB, 2015). The largest city in the county is Eskilstuna, which has around two thirds of the 100 000 inhabitants living in the municipality (SCB, 2014; SCB, 2013).



Figure 3. Eskilstuna municipality in Sweden, adopted from (Sellberg et al., 2015).

The municipality is, together with actors in industry, actively pushing for a transition to become a climate neutral municipal group (Eskilstuna kommun, n.d.a). In addition to that, Eskilstuna is working towards enhancing knowledge about environmental issues, both with citizens and the municipal group itself (Eskilstuna kommun, n.d.a). In 2012, Eskilstuna was appointed the “Environmentally best municipality” in Sweden, followed by being ranked as number two in the same competition in 2013 and 2014 (Miljöaktuellt, 2014).

3.2 Eskilstuna’s Environmental Management System

Eskilstuna municipality decided to start working with Environmental Management Systems (EMSs) as early as 1996 (Wiklund, Personal communication, April 2015).

From the beginning of 2006 and onwards, the municipal administration offices work independently with the EMS (Eskilstuna kommun, n.d.b). Due to that, there is a diverse set of approaches to environmental management in the municipality. The common idea however is that the municipal administration offices formulate their own environmental goals with connection to the municipality's overarching strategic action plans (e.g. Water plan, Climate plan), and that the goals are followed up internally (Birath, Personal communication, March 2015).

Eskilstuna uses a simplified certification standard called "Miljödiplomering". The association "Svensk Miljöbas" provides the "Miljödiplomering" standard, which is built upon parts of both EMAS and ISO 14001 but with lower requirements for document management, handling of deviations, and routines (Svensk Miljöbas, 2014). Eskilstuna has set the goal that all municipal administrations offices should be certified according to at least "Miljödiplomering" before the end of 2015 (Wiklund, Personal communication, March 2015).

A few of the administration offices and municipal corporations have decided to extend their effort and are now certified according to ISO 14001 (Wiklund, Personal communication, March 2015). One example of such a corporation is Eskilstuna Energi och Miljö, which has been certified according to the ISO 14001 standard since 2002 (Eskilstuna Energi och Miljö, n.d.a). Eskilstuna Energi och Miljö is the municipality's local provider of electricity, district heating, water, sewage and waste services, and broadband networks (Eskilstuna Energi och Miljö, n.d.c). For Eskilstuna Energi och Miljö, environmental goals are formulated with basis on both the municipality's overarching strategic action plans and identified significant environmental impacts (Thörn, Personal communication, March 2015). Eskilstuna Energi och Miljö is an approved issuer of the standard "Miljödiplomering" (Eskilstuna Energi och Miljö, n.d.b). When the goal of having the whole municipal EMS certified according to "Miljödiplomering" is achieved, yearly revisions of all the public administration offices will take place in line with the standard (Thörn, Personal communication, March 2015).

3.3 The on-going resilience assessment

Two environmental planners at Eskilstuna municipality initiated the resilience assessment by contacting Stockholm Resilience Centre in 2011 (Eskilstuna kommun, 2013; Sellberg et al., 2015). Their reason for doing so was a concern that conventional

planning in the municipality was not taking into account threats on a global level, e.g. climate change, peak oil, financial crises, and the subject of planetary boundaries (Sellberg et al., 2015).

The on-going resilience assessment in Eskilstuna municipality is based on the Resilience Assessment Workbook for practitioners (Sellberg et al., 2015), and was launched as a pre-study in 2013. The focus was then on the resilience of food supply, water supply, transportation and employment (the resilience ”of what”), to energy crisis, financial crisis, climate crisis and planetary boundaries (the resilience “to what”) (Eskilstuna kommun, 2013). In 2014, after the pre-study was completed, the resilience assessment continued, but focused on the resilience of food supply in the municipality (Eskilstuna kommun, 2014a). The rationale for doing so was due to an emerging concern in the first workshop regarding to what extent the municipality actually could influence the food system, and also due to the fact that the lack of a national food strategy was actualized in media (Sellberg, Personal communication, June 2015). Figure 4 below illustrates specified resilience in the on-going assessment in Eskilstuna.

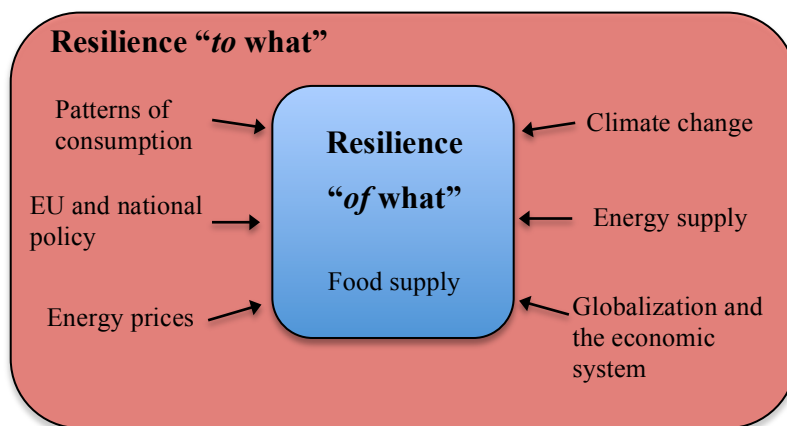


Figure 4. The resilience “of what” “to what” (specified resilience) in the Eskilstuna resilience assessment process, modified from Sellberg & Hård af Segerstad (2015).

So far, the assessment focusing on food has consisted of one “pre-workshop” in February 2014, and two resilience assessment workshops in 2014, all held in Eskilstuna (Eskilstuna kommun, 2014a; Eskilstuna kommun, 2014b). The previous workshops in the resilience assessment process in Eskilstuna allowed for stakeholders to discuss what values they related to food supply in the municipality. Values related to the food system found in the workshops were categorized according to the Millennium Ecosystem

Assessment framework (Millennium Ecosystem Assessment, 2005) by two of the workshop leaders (Eskilstuna kommun, 2014a). These values can be found in Appendix I. Based on a shared interest among the stakeholders, a common goal was set to strengthen local food production and consumption in Eskilstuna. It should be noted that the resilience assessment in Eskilstuna is directed towards the food system, while my research questions is more general and on a higher level of abstraction. Therefore, even though the studied thresholds in this thesis are connected to food production, the research questions will be answered at a general level.

4 Methods

4.1 Research approach and epistemology

I chose to adopt a qualitative and interpretive research approach. Following Klein & Myers (1999) and Rowlands (2005), interpretive qualitative research rests on the assumption that knowledge is gained through social constructions such as language, consciousness, and shared meanings. In addition to that, I chose to adopt inductive research methods. Inductive research implies an intention to produce theory and knowledge inductively, instead of deductively testing and verifying/falsifying an existing theory (Kvale & Brinkmann, 2009; Charmaz, 2014).

4.2 Research design

My research is based on a participatory resilience assessment in Eskilstuna municipality, in which I took part from January 2015 to June 2015. The resilience assessment process consisted of two workshops; one at Stockholm Resilience Centre and one at Eskilstuna municipality. The workshop at Stockholm Resilience Centre involved researchers at the centre, and focused on discussing what could be potential thresholds in relation to food supply in Eskilstuna. In the workshop at Eskilstuna, key stakeholders at the municipality participated in trying to identify thresholds that could be of potential concern for the food system.

Research focusing on “how much of a kind” benefits from quantitative methods, while qualitative methods are more suited for research concerning “what kind” (Kvale & Brinkmann, 2009). I choose to adopt qualitative methods, since my research questions refer to “what kind” instead of focusing on “how much of a kind”. In addition to choosing qualitative methods for my research, I adopt a case study approach by studying the on-going resilience assessment process in Eskilstuna municipality. According to Yin (2014), a case study approach is appropriate when the research questions focus on investigating a contemporary phenomenon within a real-life context. Furthermore, a case study is suitable where questions of the type “how” or “why” are asked (Yin, 2014). The remarks from Yin (2014) resonate well with my intended aim and research questions.

The fieldwork took place mainly in March and April 2015 and consisted of participant observations in the resilience assessment process, doing semi-structured interviews with

key stakeholders at the municipality, and conducting a survey with stakeholders in the municipality. Where and when my fieldwork took place is illustrated below in figure 5.

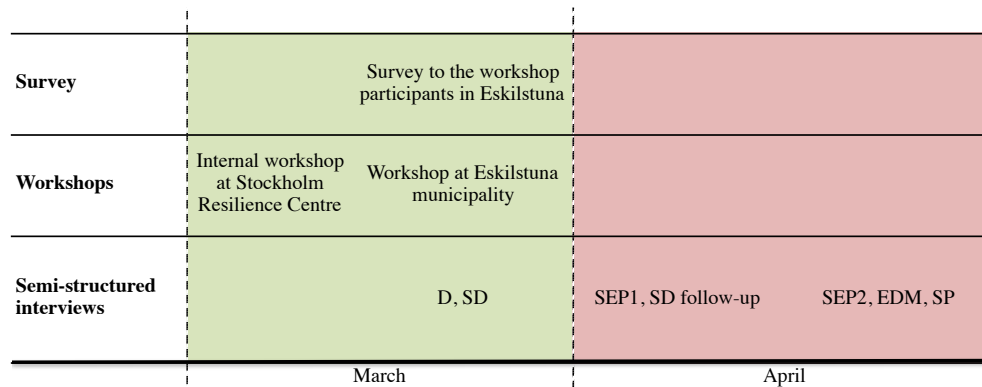


Figure 5. Illustration over when, and where, fieldwork activities took place. Acronyms used:
 SEP1 – *Strategic Environmental Planner 1* SEP2 – *Strategic Environmental Planner 2*
 EDM – *Economic Development Manager* SD – *Sustainability Developer*
 SP – *Spatial Planner* D – *Developer*

Different methods corresponded with either one, or several, of my research questions. Table 2 below explains how my research questions relate to methods used in this thesis.

Table 2. Corresponding method(s) for each of my research questions.

Research question	Corresponding method(s)
1 a) How can the concept of thresholds be operationalized in strategic planning at a local government?	<ul style="list-style-type: none"> • Document review. • Literature review. • Participant observations. • Semi structured interviews and data analysis.
And 1 b) what potential gains and challenges could that entail for the strategic planning?	<ul style="list-style-type: none"> • Survey. • Semi-structured interviews and data analysis
2 a) In what ways can the operationalization of thresholds in strategic planning benefit from a municipality's existing Environmental Management System, and b) what are the difficulties of operationalizing thresholds in an existing Environmental Management System?	<ul style="list-style-type: none"> • Literature review • Semi structured interviews and data analysis

4.3 Collection of data

Data collection consisted of a literature review, reviewing existing documentation from the Eskilstuna resilience assessment process, semi-structured interviews with key stakeholders and actors, a survey to the workshop participants, and participant observations. Case study research usually relies upon multiple sources of information and methods (Yin, 2014; Neale et al., 2006). Each method for data collection is described in more detail below.

Literature review

The literature review was needed in order to build a solid theoretical background chapter. In the review I used the databases Scopus and Academic Search Premier, as well as Google Scholar. For the theoretical background chapter containing theory about resilience thinking, thresholds, and adaptive management, I used the search words “resilience” combined with “social-ecological”, “thresholds”, and “adaptive management”. The chapter about EMSs within a Swedish context was formed based on the search words “environmental management system” in combination with “Sweden” and “local authorities”. In both the literature review of EMSs and resilience theory, I received suggestions of relevant literature from researchers at both Stockholm Resilience Centre and Linköping University.

In addition to help forming the theoretical background chapter, the literature review also provided information about thresholds that had been identified in other case studies via mainly The Regime Shifts Database (Stockholm Resilience Centre, n.d.), and the Resilience Alliance Thresholds Database (Resilience Alliance, n.d.).

Document review

The document review was carried out in order to familiarize myself with both the resilience assessment process, and with the overarching steering documents in the municipality’s EMS. The document review included all existing material from previous workshops in the Eskilstuna resilience assessment process, policy and steering documents related to the environmental management system, and material from a prior PhD course at Stockholm Resilience Centre that had Eskilstuna as a case. A list of documents can be found in Appendix IV. The workshop material consisted of reports from the resilience assessment process written by both researchers at Stockholm

Resilience Centre and communication strategists at Albaeco³. Material from the PhD course included synthesized writings from students discussing potential thresholds in Eskilstuna. While going through the material, I took notes and made comments on how the material related to my research questions.

Semi-structured interviews

According to Kvale & Brinkmann (2009), “interviews are particularly well suited for studying people’s understanding of the meanings in their lived world, describing their experiences and self-understanding, and clarifying and elaborating their own perspectives on the lived world” (p.116). Interviews could thus provide me with the qualitative, in-depth data I needed in order to answer my research questions. Furthermore, case study research with focus on a specific situation, person or institution often involves interviews (Kvale & Brinkmann, 2009). I decided to adopt a semi-structured approach to interviews following Kvale & Brinkmann (2009). According to Kvale & Brinkmann (2009), semi-structured interviews “attempts to understand themes of the lived everyday world from the subjects’ own perspectives” (p.27). This went well in line with the underlying assumption in interpretive, qualitative research. A semi-structured interview approach also allows for flexibility to ask unplanned follow-up questions related to the topic of concern (Kvale & Brinkmann, 2009).

A semi-structured interview involves using an interview-guide, which according to Kvale & Brinkmann (2009) consists of “an outline of topics to be covered with suggested questions” (p.130). My interview guide consisted of broad themes with respect to my research question, as well as suggested follow-up questions. The main themes were *if*, and in that case *how*, the interviewee thought that thresholds could benefit strategic planning, how the municipality’s EMS operated, and if the interviewee could see any connection between thresholds in the resilience assessment process and the EMS. My interview guide can be found in Appendix III.

All together I conducted seven semi-structured interviews (see figure 5). The interviewees that were chosen for this study had different backgrounds and positions

³ Albaeco is an independent organization, created by an initiative from researchers in natural resource management at Stockholm University in 1998. The organization works with mediating the results of interdisciplinary research regarding the connection between ecology, economy and society. See <http://www.albaeco.se>.

within the municipal group, which enabled me to cover a wide set of perspectives in relation to my research questions. Depending on what information I assumed that the interviewee possessed, I adapted the interview guide in order for it to match the specific interview. Based on Jorgensen (1989) and Kvale & Brinkmann (2009), I started each interview by informing the interviewee about the basic background for my research. Five of the interviews were face-to-face interviews, carried out in Eskilstuna, and two of them were telephone interviews. They all lasted between 45 minutes and 1.5 hours. All interviews were recorded and then transcribed. I also recorded and transcribed the final reflection round during the workshop at Eskilstuna, where all participants' were asked to elaborate on what he or she thought about the content and usefulness of the workshop in general.

Survey

After the workshop in Eskilstuna, all eight participants were asked to fill out a survey regarding their individual reflections on the workshop and its content. This was a way of triangulating data between the interviews and the workshop participants' general opinions. The survey also captured reflections from the participants that had not been articulated during the exercises or in the concluding reflection round.

A survey can according to Esaiasson et al. (2007) consist of both standardized questions, and questions of a more open character. In standardized questions, the respondent is able to choose between several options. This stands in contrast to more open questions where the respondent is allowed to elaborate more on what he or she want to say. My survey consisted of both standardized and open questions. The reason was that I wanted to capture both general opinions from the participants regarding *to what extent* they thought the content of the workshop was good or not (standardized questions, multiple choice), as well as *how* they perceived the content (open questions). The survey can be found in Appendix V.

Participant observations

The observations took place during the two workshops described earlier. As suggested by Jorgensen (1989), during and after each day of fieldwork I took notes consisting of who were present, what happened, where we were, and additionally made a few analytic reflections about my own experiences. As my research progressed, the field notes went from covering more or less anything I thought could be of interest for the project's aim

to being more condensed. This was a way of "constantly seeking to refine and focus the issues being studied" (Jorgensen, 1989, p.97).

4.4 Data analysis

Throughout my whole research project, I engaged in memo-writing as an intermediate step between collecting data and writing the final version of the thesis. All my field notes included memos. According to Charmaz (2014), memo-writing is a pivotal part of inductive research approaches since it allows for an early and continuous process of data analysis. Writing memos helped me to frequently gain new perspectives and analytic insights regarding the data by capturing my thoughts and reflections on paper. As my research progressed and I obtained more data to work with, the memos became progressively more analytic, as suggested by Charmaz (2014).

My data analysis was carried out as two main principal processes: (i) the working process in the resilience assessment, and (ii) a thematic analysis of the data. In practice, these two parts were not fully separated. However, here I chose to describe them as rather distinct in order for the analysis to be comprehensive for the reader.

4.4.1 Working process for the resilience assessment

A comprehensive remark is that we considered Thresholds of Potential Concern in line with Strategic Adaptive Management (SAM) and as described by Walker & Salt (2012). In practice, this meant that we took into account variables that were associated with *potential* threshold effects.

First, I identified a set of variables with potential threshold effects related to food production and consumption in Eskilstuna based on other case studies in the literature. This list of potential thresholds was then discussed during an internal workshop at Stockholm Resilience Centre, and afterwards revised with respect to the outcome of the workshop. The workshop at Stockholm Resilience Centre resulted in an iteration of the suggested thresholds from the literature review.

In the next step, we gathered inspiration from the method described by Blythe (2014). Based on the common goal of strengthening food production, critical components of the system were identified and expressed as alternate system states. The relevance of these alternate states was then verified in the workshop in Eskilstuna. Thereafter, the workshop participants discussed what the most critical drivers of change were in the

system with respect to the suggested alternate states. The drivers of change were represented as variables connected to potential threshold effects. The overall process is illustrated below in figure 5.

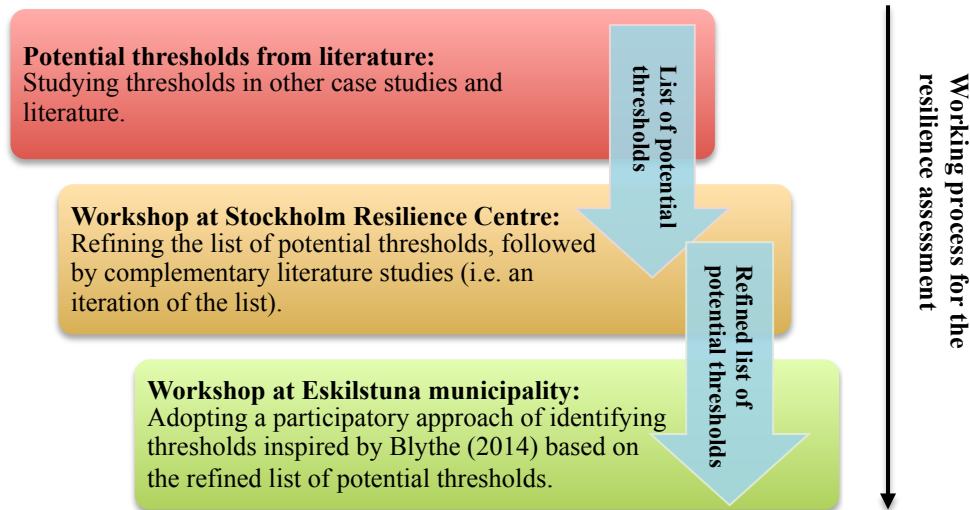


Figure 6. Working process for the resilience assessment in Eskilstuna. The figure illustrates the working process for the resilience assessment in Eskilstuna, focusing on thresholds. The boxes represent the three main steps in the process, while the arrows symbolize the output from each step.

The output from the workshop in Eskilstuna was a refined list with potential thresholds for the municipality's food system. When finalizing this thesis, the resilience assessment is still an on-going process, and the list of identified potential thresholds is therefore still very preliminary. Variables associated with potential threshold effects for the food system in Eskilstuna are presented in Appendix II (note that this list is still a work in progress). Furthermore, as mentioned earlier, the research questions in this thesis goes beyond thresholds related to only the food system, and instead operates on a broader level by asking the interviewees to reflect on the use of thresholds in general.

4.4.2 Thematic analysis

The data was analyzed through a *thematic analysis*. Thematic analysis is, according to Braun & Clarke (2006), "a method for identifying, analyzing and reporting patterns (themes) within data" (p.79). An initial part of the method is to transparently make assumptions within the analysis explicit (Braun & Clarke, 2006). This corresponds to the adopted interpretative qualitative research approach based on the assumption that knowledge is gained through social constructions.

A "theme" within thematic analysis apprehends an important aspect of the data with respect to the chosen research questions (Braun & Clarke, 2006). In inductive versions of thematic analysis, the identified themes are linked to the collected data themselves (Patton, 1990). As discussed earlier, this stands in contrast to trying to fit the data into an existing frame of themes and hypotheses. The thematic analysis in this thesis has been conducted based on the six steps suggested by Braun & Clarke (2006). These are presented below.

1. Familiarizing yourself with your data

The first step consisted of going through earlier material from the resilience assessment process (document review), as well as transcribing the recorded semi-structured interviews and reading them through. According to Kvale & Brinkmann (2009), transcription is an initial part of analyzing the data itself. Transcribing the interviews was a way of becoming acquainted with the data and hence an important stage of the early analysis.

2. Generating initial codes

The next step was to generate initial codes. A code is a segment of text, labeled after what the segment is about (Charmaz, 2014). During my research, I coded all transcribed interviews. This was an iterative process of refining the codes in order to make sense of the interviews.

3. Searching for themes

The third step was to search for themes within the transcribed interviews. Searching for themes meant that I sorted the different codes into more overarching themes in relation to my research questions. A theme could hence consist of more than one code. This resulted in a list of initial themes.

4. Reviewing the themes

After a list of themes had been created, I read through all codes and quotes from each theme to ensure that there were enough data to support it. I also compared the themes in relation to the entire data set to verify that the relation between the theme and the data set was reasonable.

5. Defining and naming the themes

This step included further refinement of what each theme was about. For all themes, in line with Braun & Clarke (2006), I tried to identify the story told by each theme, and also how it corresponded to the entire dataset as well as in relation to my research questions. The themes, which form subheadings in my results and analysis chapter, are presented below in table 3.

Table 3. Interview themes in relation to my research questions (RQ).

Part of research question	Theme
Operationalization of thresholds (RQ1a)	Operationalization through comprehensive planning
	Operationalization through strategic action plans
Gains for strategic planning (RQ1b)	Creating more proactive planning
	Defining boundaries for the desired system state
	Emphasizing our dependence of nature
	Prioritizing actions
	Creating more coherent strategic planning
	Providing a common language
Challenges for strategic planning (RQ1b)	Providing a "false security"
	Needing concrete examples and pilot studies
	Requiring assistance
	Seeing biophysical thresholds as easier
Benefits from having an EMS when operationalizing thresholds (RQ2a)	Providing systematic environmental work
Difficulties of operationalizing thresholds in an existing EMS (RQ2b)	Suggesting different system boundaries
	Expressing a gap between municipal policy and significant environmental impact
	Complicating the usability of the EMS by introducing thresholds
	Viewing thresholds and resilience thinking as intertwined

6. Producing the report

The last step was to produce the actual report. According to Braun & Clarke (2006), “extracts need to be embedded within an analytic narrative that compellingly illustrates the story you are telling about you data, and your analytical narrative needs to go *beyond* description of the data, and make an *argument* in relation to your research question” (p.93). Following their reasoning, themes will be presented in terms of a combined results *and* analysis chapter.

5 Results and Analysis

I will answer my two research questions in a combined results and analysis chapter. Hence, extracts from the interview and survey data will be presented together with analytical comments and arguments in relation to my research questions. In this chapter, the term “planner” will from time to time occur. All interviewees in one way or the other work with strategic planning, either in the municipality or in a municipality owned business. Therefore, “planner” refers to a main part of their job assignment, and hence also to their role in this study.

5.1 RQ1a: Operationalization of thresholds

The two main themes that emerged during the interviews were that the threshold concept potentially could be operationalized either in the municipality’s strategic action plans, or by integrating it in the construction of scenarios in comprehensive planning. A common denominator for both ways of operationalizing thresholds was the importance of introducing them early in the process on a highly strategic level. The two themes are presented below.

Operationalization through comprehensive planning

One of two ways in which thresholds potentially could be operationalized in a municipality was by integrating the concept early in comprehensive planning as a working procedure for constructing scenarios. This was a suggestion from the Spatial Planner (SP). For more quotes that strengthen these results, see Appendix VI. Today, comprehensive planning in the municipality uses scenarios as a method for visualizing consequences of different development trajectories, yet not in relation to thresholds. This is illustrated by this quote from the SP regarding how the municipality’s comprehensive plan was created:

We looked at four different scenarios regarding future land and water use, city sprawl and how land areas should be used for housing. We didn’t talk about thresholds. But we had a bit of that “thinking” when processing the consequences of the scenarios, that they indicated a type of development. However, not that if crossing thresholds - as a consequence - it would be hard to go back. (SP, author’s translation)

Comprehensive planning in the municipality hence discusses consequences with respect to different scenarios, but without the notion of thresholds. Going back from a certain scenario to an earlier state is in today's comprehensive planning not associated with any delay. Instead, according to the SP, the scenarios in comprehensive planning are today seen as fully reversible processes. This is different from the threshold concept (c.f. Walker & Salt, 2012), in which returning to a previous state can be impossible or at least difficult. However, the consequences that the scenarios in comprehensive planning generate through certain development paths are not very different from the resilience assessment process in Eskilstuna, inspired by Blythe (2014). In that process, scenarios, expressed as system states, were connected to thresholds that separated the different states. The SP expressed the possibility of integrating thresholds in scenarios explicitly in this quote:

To discuss consequences of different scenarios and how to achieve a desirable outcome, and use thresholds as part of the process/.../ During a revision of the comprehensive plan, it would be really interesting to consider that way of thinking as part of the scenarios. /.../ It might be easier if one described it (thresholds) with different scenarios, and avoid going into the resilience concept and thresholds as such during the public hearing process. (SP, author's translation)

Thresholds (and resilience) as a concept should in that case not be articulated to the public, but the threshold concept instead becomes a part of the earlier analysis in the process of creating a comprehensive plan. The SP explicitly emphasized the importance of introducing thresholds early in the process. The quote above shows that thresholds could be interesting in the process of *revising* the comprehensive plan, hence not as an add-on to an already existing plan. The importance of why thresholds needs to be introduced early in the process is illustrated by the quote below:

I would say that it is an advantage if they (thresholds) are there from the beginning because that's when we discuss scenarios and how we want to develop the municipality in the long run, so that's when the large "brushstrokes" are made. (SP, author's translation)

Operationalization through strategic action plans

The other identified way of operationalizing thresholds in a municipality context was to channel them through strategic action plans. This was a suggestion from the two Strategic Environmental Planners, the Economic Development Manager, the Developer, and the Spatial Planner. For more quotes that strengthen these results, see Appendix VI. The interviewees emphasized that the analysis part, where the concepts of resilience and thresholds should be used, is separated from the more practical level. There are thus two distinct steps in operationalizing thresholds in strategic action plans; first an analysis where thresholds are identified (e.g. through a resilience assessment process), and then the outcome of the first step is expressed as a strategic action plan inspired by the results from the analysis. The action plan is then adopted politically. This is illustrated through the following quote from one of the Strategic Environmental Planners (SEP):

It is basically two steps. If we take the food system, then we have made a resilience assessment first where we use the different parts of the resilience method. The food strategy is then based on conclusions from the resilience assessment, "how should we do this", so more action-based. I see this as two separate...the latter is more like a traditional municipal planning instrument. Because in the food strategy you don't do a resilience assessment, this you have already done so to speak. (SEP1, author's translation)

Thresholds and resilience should be used as a basis for the early analysis through for example a resilience assessment. For many municipal employees, the concept of thresholds would be something new and difficult to understand, and planning in a municipality needs to be comprehensible. Therefore, thresholds should occur early in the process. The SEP2 said the following during the interview:

What do our municipal citizens, such as property owners, constructors, other actors, what do they expect from a municipality? It's that you should serve with a basis for decisions, complete plans for "can we build here". /.../ Then, these questions (thresholds) are not discussed much. It is more a result of an earlier "thinking". (SEP2, author's translation)

5.2 RQ1b: Gains and challenges for strategic planning

5.2.1 Gains for strategic planning

In the survey to the eight workshop participants in Eskilstuna (see Appendix V), three people said that thresholds absolutely could be useful in their daily work (alternative 5/5), four people selected 4/5, and one chose 3/5. Hence, the workshop participants saw the concept of thresholds as useful for their daily work. The interviews showed that thresholds potentially could be useful for strategic planning in six fairly distinct themes; creating more proactive planning, defining boundaries for the desired system state, emphasizing our dependence of nature, prioritizing actions, creating more coherent strategic planning, and providing a common language. These themes are explained in more detail below.

Creating more proactive planning

Thresholds were in the interviews suggested as having the potential to create more proactive planning by illustrating the consequences and risks of not acting in time. This was the most frequently suggested gain for strategic planning, and was expressed by all the interviewees. For more quotes that strengthen these results, see Appendix VI. The idea of alternative system states (separated by thresholds) raised a concern that acting too late could lead to high monetary costs and also loss of ecosystem services. The Economic Development Manager (EDM) said during the interview the following:

It is probably cheaper to take measures before one crosses a threshold and end up on the wrong side. /.../ It is all about money in the end. If we take action now it will be cheaper than if we end up on the wrong side of the threshold, because in that case we will have to put even more energy on restoration. (EDM, author's translation)

Introducing thresholds created motivation for acting in time, and through that avoiding higher costs compared to taking measures later on. The same reasoning also applied to the loss of ecosystem services. Thresholds was seen as a way of illustrating that “business as usual” could lead to both higher monetary costs and a loss of other values (e.g. ecosystem services). Transcending critical boundaries was seen as a risk for the municipality. Knowing about potential threshold effects was a way of motivating

proactive action in order to avoid a transition to a more undesirable state. This is illustrated in the following quote:

I think that is the purpose then, to warn, to show that what we're doing is actually really risky. It can happen very fast. It is not linear dynamics all of this, but suddenly it can change into something which is very hard to return from. /.../ Dramatic change is almost always negative for us. We have adapted our society to how it is today. And when fast change occurs it is usually for the worse. (SEP1, author's translation)

The concept of thresholds was thus a way of creating more proactive planning as a means to avoiding high costs connected to restoration, loss of ecosystem services, and risks associated with dramatic change.

Defining boundaries for the desired system state

Another theme that emerged during all the interviews was that thresholds defined boundaries for a desired system state. For more quotes that strengthen these results, see Appendix VI. This resonates well with e.g. Freitag et al. (2014), who argue that thresholds define the amount of change tolerated before changing the state of the system. Regarding if thresholds introduced something new for planning, the SEP2 said the following:

We use nature to produce things. /.../ But there is no connection to on what terms, or to how this corresponds with the whole ecosystem, or to how it harmonizes with the whole system so to speak, there is nothing like that. (SEP2, author's translation)

The SEP2 talks about boundaries by referring to “on what terms” we can continue to carry out activities that we value in society. These terms, or boundaries, are by the planner connected to the concept of thresholds. Thresholds introduced the idea of critical boundaries that define conditions for how much change e.g. an ecosystem can deal with before transforming into something less desirable. The planners saw this as something important to take into account in strategic planning in the municipality. Thresholds were in this sense seen by the SEP2 as a crucial part of the sustainability concept. The following quote illustrates this:

I guess you can say that when you start to talk about sustainability and some kind of long-term balance thinking and that we do things that are more in line with the cycles of nature in different ways, then a question-mark rises, how does this look like and how do you do this, what is this? And then all of this with thresholds and that discussion becomes present.
(SEP2, author's translation)

The planner related the sustainability concept to living in balance with the cycles of nature, and that the threshold concept was defining boundaries for such a way of living.

Emphasizing our dependence of nature

The interviews also showed that the concept of thresholds could be a way of articulating our dependence of ecosystem function. This theme was mainly suggested by one of the Strategic Environmental Planners through connecting thresholds to ecosystem services, and by the Economic Development Manager. For more quotes that strengthen these results, see Appendix VI. This theme is illustrated through the following quote:

We are organically connected to it (ecosystem services) as a species among all species, you can't only see it from a natural science perspective, but you have to look wider and say that it has a large impact on our well-being as humans. (SEP2, author's translation)

Introducing the idea that some variables in social-ecological systems could have thresholds was associated with that benefits from ecosystem services could be lost through non-linear processes. Due to that the planners saw ecosystem services as pivotal for human well-being, they saw thresholds as a way of articulating our dependence of nature.

Prioritizing actions

The concept of thresholds was conceived of as playing an important role in prioritizing actions in strategic planning, which was mentioned by all interviewees. For more quotes that strengthen these results, see Appendix VI. The following quote illustrates this theme:

It is sort of different questions; some of them are maybe linear. There are no thresholds, there is no clear before or after, and it's a smooth scale. But for other questions it might be so that there is a risk of crossing this threshold, or eroding it or what you should say, something happens...another equilibrium appears that probably is for the worse. And in that case it's important to identify this, what could it be. (SEP1, author's translation)

The interviewees found it important to identify the variables that were associated with thresholds, and prioritize what actions to take based on that. As suggested by Walker & Salt (2012), not all variables in a social-ecological system have thresholds. Introducing the concept of thresholds through a resilience assessment processes seems to have influenced the planners in the sense that they now conceive variables with thresholds as important to focus on.

Variables that determine the state of a social-ecological system can be at different distance to thresholds. In line with resilience theory; it might be more urgent to focus on those that are close to critical boundaries. The Economic Development Manager said regarding the topic of what thresholds potentially could contribute to in strategic planning, that “this area might be within ‘green light’ while this area is closer to ‘yellow light’ instead” (author's translation). In that sense, the concept of thresholds was seen as a way of prioritizing actions with respect to where the largest risks for regime shifts could be.

Creating more coherent strategic planning

The Spatial Planner (SP) saw that the threshold concept could add value to strategic planning by acting as a “dialogue tool” between politics and planning. A “dialogue tool” here refers to a way of communicating *why* it is important that all decisions are coherent with the municipality's more long-term goals. For more quotes that strengthen these results, see Appendix VI. Regarding how thresholds could be of use for strategic planning, the SP said the following:

Visually, we communicate with decision-makers by describing a “large arrow”, with a current situation and then a future scenario. Sometimes, decisions are taken in an unsustainable direction for example city sprawl;

if you assign a building permit on the country side you might not think that it's a big deal, but if you grant many of these it might even be so that a new urban area emerges where we have not planned to have one. So, thresholds could be used as a "dialogue tool", to show that all, even the small decisions can be of importance for the "large arrow". (SP, author's translation)

This quote illustrates that the concept of thresholds could be used as a way of communicating why even minor decisions need to be consistent with more long-term goals. Many small decisions taken in the wrong direction (in relation to the municipality's long-term goal) could push the system over a threshold, and thus alter the "large arrow". The concept of threshold was by the SP seen as way of expressing the importance of coherence in decisions connected strategic planning.

Providing a common language

During the workshop in Eskilstuna, and in the interviews with the Strategic Environmental Planners, the Economic Development Manager, and the Spatial Planner, I noted that planners from different areas in the municipality talked about critical boundaries, but not explicitly in terms of thresholds. The workshop in Eskilstuna, and the threshold concept itself, became a way of providing a common language in communicating the idea of critical boundaries in a system. The concept of thresholds, and the resilience assessment as a whole, provided a forum for the municipal planners to communicate between different sectors through a common language. For quotes that strengthen these results, see Appendix VI.

5.2.2 Challenges for strategic planning

The interviews also showed that the potential use of thresholds in strategic planning comes with challenges. One challenge during the interviews was a concern that thresholds could provide a "false security" in strategic planning. The interviewees also expressed the following challenges; needing concrete examples and pilot studies, requiring assistance from e.g. Stockholm Resilience Centre, and finally seeing biophysical thresholds as easier. These themes are explained below.

Providing a “false security”

Some of the interviewees saw a potential risk that thresholds might be providing a “false security” for strategic planning. This was mainly a concern expressed by the Strategic Environmental Planners, The Sustainability Developer, and the Economic Development Manager. For more quotes that strengthen these results, see Appendix VI. Defining the exact limits to how much change a system can adapt around was seen as difficult in a complex world. To set such limits could, according to the interviewees, legitimize ignorance for gradual impacts that might also have negative effects on the environment. The following quote illustrates this:

The effects start to matter all the way from the “zero-level”. Maybe you could say that it’s better to just try and mitigate for example emissions as much as possible. Because, if you set a boundary it is pretty easy to think that this is what we will allow, but not more than this. But it can have other effects as well because everything interacts with everything else.

(SEP2, author’s translation)

The planners expressed a concern that setting boundaries could entail keeping emissions at the defined “safety level”, and not working towards minimizing harmful effects. Even though a certain substance might not be close to its own threshold level, the harmful effects start to matter all the way from zero emissions. Due to cross-scale interactions in social-ecological systems (e.g. Gunderson & Holling, 2002; Folke et al., 2010), i.e. the third assumption within resilience thinking, emissions in the focal system could lead to effects in other systems. Therefore, allowing thresholds at one scale to alone define long-term goals in strategic planning was seen as a potential risk by the interviewees.

This theme was strongly linked to an emerging topic whether or not thresholds could, and should, be quantified if used in strategic planning. At the same time as the “false security” described above stems from quantifying the boundaries, quantification makes thresholds more operative in strategic planning. The following quote illustrates this:

It is this “false security” that I’m a bit worried over. /.../ If you put numbers on them (thresholds), you think that if we just stay below this then we won’t overrun a threshold, and then BOOM you do that anyways. Because we didn’t have enough knowledge, or there were other factors

that mattered. But at the same time there is this advantage that it will be more operative and easy if you have numbers and goals. (SEP1, author's translation)

There is thus a tension between quantifying thresholds and not doing so. The planner expressed that this “false security” also was connected to the number of thresholds that you use in strategic planning, and that settling with too few might constitute a risk as well. Quantification in this context therefore also refers to the number of thresholds. Due to this tension, the interviewees found it more fruitful to instead talk about what potentially could be threshold effects. The following quote illustrates this:

I think that it's better to say that this is a way of illustrating potential risks, and how you deal with those risks. Not determining the exact point. (EDM, author's translation and underline)

Needing concrete examples and pilot studies

All interviews indicated that the usefulness of thresholds in strategic planning would benefit from rather concrete examples from other cases and pilot studies. For more quotes that strengthen these results, see Appendix VI. Both the Regime Shifts Database (Stockholm Resilience Centre, n.d.) and the Resilience Alliance's Threshold Database (Resilience Alliance, n.d.) contain examples of thresholds identified in other case studies. However, these databases contain mainly examples from the biophysical domain, and rather few (if any) from the economic and social dimensions. The Economic Development Manager said during the interview that “if you want to include social thresholds I think you need to have really concrete examples” (author's translation). Social thresholds are though suggested as being heavily context dependent (Walker & Salt, 2012). In addition to that there are few examples of carried out resilience assessments in Swedish municipality contexts (the only known finalized such assessment in Sweden is Wilkinson (2012) in Luleå municipality). A challenge for using thresholds in strategic planning found in this study was therefore the lack of examples from similar contexts as Eskilstuna.

Requiring assistance

An emerging theme during all my interviews was that the municipality needed help in working with resilience and thresholds. For more quotes that strengthen these results,

see Appendix VI. The resilience assessment processes in Eskilstuna has been on-going since 2013, and the concept of thresholds is still seen as difficult to work with in practice. Regarding if there were any knowledge gaps in the municipality regarding how to use thresholds, one of the planners said the following:

We're still in the process of getting to know this resilience concept, and we are trying to learn this way of thinking. Thresholds are difficult, and it really demands for a lot of research because I don't think that this is something that the municipality will be able to do by themselves, like "let's go out and find all thresholds". But you need to have research, so therefore it's really good to collaborate with Stockholm Resilience Centre.
(SEP1, author's translation)

This quote from one of the planners illustrates the municipality's need for assistance in working with thresholds on an operationalized level. As it is today, the municipality would most likely not be able to work with thresholds by themselves, despite the method described in the Resilience Assessment Workbook for practitioners by Resilience Alliance (2010).

Seeing biophysical thresholds as easier

An emerging theme during the interviews with the Strategic Environmental Planners, the Economic Development Manager, and the Spatial Planner, was that the interviewees were more used to think about thresholds within the biophysical domain. Therefore, the interviewees thought that biophysical thresholds would be easier to work with in practice. For more quotes that strengthen these results, see Appendix VI. The Economic Development Manager (EDM) said the following during the interview:

I think that biophysical (thresholds) are easier to understand, because you have talked about that for a long time, that species go extinct and such.
(EDM, author's translation)

Even though the interviewees demonstrated an understanding of the threshold concept with respect to the other two dimensions as well, biophysical thresholds were pictured as easier to work with mainly due to the fact that they were seen as more common.

5.3 RQ2a: Benefits from having an EMS when operationalizing thresholds

The interviewees found that the municipality's Environmental Management System (EMS) could benefit the operationalization of thresholds by providing systematic environmental work in dealing with overarching strategic action plans. For more quotes that strengthen these results, see Appendix VI. This theme is explained more in detail below.

Providing systematic environmental work

The most important synergistic effect between the EMS and the operationalization of thresholds was that the EMS could provide systematic environmental work in dealing with strategic action plans. This theme was found during the interviews with the Strategic Environmental Planners, the Sustainability Developer, and the Developer. Due to that thresholds in a municipality context need to be operationalized through either strategic action plans or in comprehensive planning, handling thresholds in a local authority like Eskilstuna requires a way of dealing with the overarching strategic plans. This quote illustrates how the EMS could function as a tool for systematizing environmental work throughout the organization, and thus handling thresholds via its operationalization in strategic action plans:

To have full knowledge of everything, and that you in every decision have to think about maybe a hundred steering documents, that's just not possible. So in some way you need some support, and here the work with the EMS can be a tool that systematizes this work, where you both look at what the municipality says, and what the city council says should apply for the whole municipal group, the overarching goals...which significant environmental impacts do we have in our business, what should we prioritize, because we can't prioritize everything. (SEP1, author's translation)

The interviewees described that the EMS had been successful in providing systematic work regarding how to handle strategic action plans and overarching environmental goals. Having a tool (in Eskilstuna the EMS) that deals with strategic action plans in a systematized way is a crucial part of being able to implement the concept of thresholds throughout the organization. If there is no linkage between the public administration offices and the strategic action plans, then the operationalization of thresholds through

strategic actions plans will have no effect in practice. The EMS in Eskilstuna seems to have the potential to serve as a systematic tool that *implements* strategic action plans (containing e.g. thresholds) in the organization. The following quote illustrates this:

The EMS is kind of how we implement it (overarching municipal environmental goals in strategic action plans) in the public administrations in practice, what do we have here in this administration office/business, what do we do, and what do we focus on. (SEP2, author's translation)

Even though the interviewees expressed that the concepts of resilience and thresholds have not yet been operationalized in Eskilstuna, the new Water plan states that “future climate conditions will be more wet and warm, and therefore the municipality needs to develop a more *resilient* and sustainable approach to planning in order to continuously adapt with respect to changing climate conditions” (Eskilstuna kommun, 2015, p.13, author's translation and italics). Through the use of the resilience concept in the new Water plan, the operationalization of thresholds through strategic action plans could hence also be on its way. In that case, the EMS could, according to the reasoning above, serve as a systematizing tool for implementing these in the municipal organization.

5.4 RQ2b: Difficulties of operationalizing thresholds in an existing EMS

The interviewees expressed the following difficulties of operationalizing thresholds in the EMS; suggesting different system boundaries, expressing a gap between municipal policy and significant environmental impacts, that thresholds might be complicating the use of the EMS, and viewing thresholds and resilience thinking as intertwined. These themes are explained more in detail below.

Suggesting different system boundaries

A potential difficulty with integrating thresholds in an EMS was that there seems to be a mismatch in system boundaries between the two. This was noted in the interviews with the Strategic Environmental Planners, and the Developer, as well as in the literature review. For more quotes that strengthen these results, see Appendix VI.

The EMS in Eskilstuna, when certified according to the “Miljödiplomering” standard, will follow up environmental goals and impacts on a regular basis, but with a rather short time perspective (e.g. one year, monthly, every quarter (Thörn, Personal

communication, March 2015)). The concept of thresholds on the other hand is mainly associated with more slow changing variables (c.f. Folke et al., 2010). The time horizon for “continuous improvement” in the EMS, i.e. yearly, might therefore differ from a relevant time scale for variables connected to threshold effects.

The concern for a mismatch in system boundaries was also expressed in the interviews, but with focus mainly on the geographical system. While the resilience assessment process (including work with thresholds) has focused on the geographical area that is Eskilstuna municipality, the EMS has instead targeted the municipal organization. The EMS was therefore seen as a more organizational and internal tool. The following quote from one of the planners expresses this concern:

When we have talked about resilience, then we have thought about the whole municipality as a geographical area, I mean it is that kind of long-term, big changes. Not only what will happen to the municipal organization, because that's what the EMS is about, it's the municipality as an organization. /.../ The EMS can go all the way down to...it can be even smaller than on the level of administration offices. It can be a specific department that has a special need for having an EMS. (SEP1, author's translation)

Additionally, the Developer expressed that for a certain department in the municipality, the EMS is about “their own travels, their own printing, and their own lighting that uses electricity” (author's translation). On a less strategic level, i.e. in the administration offices, the focus area of the EMS seems to be mainly the organization itself rather than the municipality as a geographical area.

It should be noted however that the EMS was seen as a way of systematizing the work with strategic municipal action plans. Therefore, even though the time horizon for “continuous improvement” might be shorter than the time scale for thresholds, the EMS can also contain more long-term goals via its relation to the strategic action plans.

Expressing a gap between municipal policy and significant environmental impacts

The interviewees were concerned with a potential gap between strategic municipal action plans on the one hand, and significant environmental impacts for municipal

business and administration offices on the other. This theme was found during the interviews with the Strategic Environmental Planners, the Developer, and the Sustainability Developer. For more quotes that strengthen these results, see Appendix VI.

A municipal business or administration office might have its most significant environmental impacts in areas where no thresholds on a strategic level are prioritized. There was a concern that thresholds at a strategic level could lead to a situation where less strategic operations in the administration offices (e.g. the formulation of environmental impacts) shifted focus away from their own most significant impacts. This is illustrated through the following quote:

If you in your business don't really affect an overarching goal, then it is more important that you look at what are you affecting. Where is your largest impact? (SEP1, author's translation)

Focusing on solely strategic action plans when defining significant environmental impacts could lead to perverse prioritizations on a less strategic level. However, environmental goals in the EMS are formed with basis on both strategic action plans and the most significant impact(s) in the business, i.e. a combination of strategic measures and individual impact. In practice, this gap rather expresses the need to not focus exclusively on thresholds and strategic action plans in the EMS.

Complicating the usability of the EMS by introducing thresholds

There was a concern, expressed by one of the Strategic Planners and the Sustainability Developer, that using thresholds directly in the EMS could complicate its usefulness. For more quotes that strengthen these results, see Appendix VI. The SEP1 said regarding if thresholds could be integrated in the EMS that it might be to “complicate things more than necessary” (author's translation). Introducing the concept of thresholds in all administration offices could compromise the usability of the EMS. For example, one of the planners expressed a concern that using thresholds explicitly as part of the EMS would have to resonate well with the external auditors. However, as mentioned earlier (RQ1a), a prerequisite for using thresholds is that they are introduced early at a strategic level, e.g. through strategic action plans.

Viewing thresholds and resilience thinking as intertwined

Another difficulty regarding the relation between thresholds and the EMS was that thresholds were seen as intertwined with the framework of resilience thinking. This theme emerged particularly during the interviews with the two Strategic Environmental Planners. For more quotes that strengthen these results, see Appendix VI. The following quote from one of the planners illustrates this:

I see this “threshold thinking” as a crucial part of the resilience method, so it’s nothing that I want to separate, but I see it as a part of the method in the process of working with resilience assessments. (SEP1, author’s translation)

Thresholds in itself might thus be difficult to work with in an EMS if not accompanied by the concept of resilience.

5.5 Summary of results and analysis

Figure 7 summarizes the results and analysis part of this thesis. The linkage between “scenarios in comprehensive planning” and “strategic action plans” is due to the fact that strategic action plans and the comprehensive plan need to harmonize with each other.

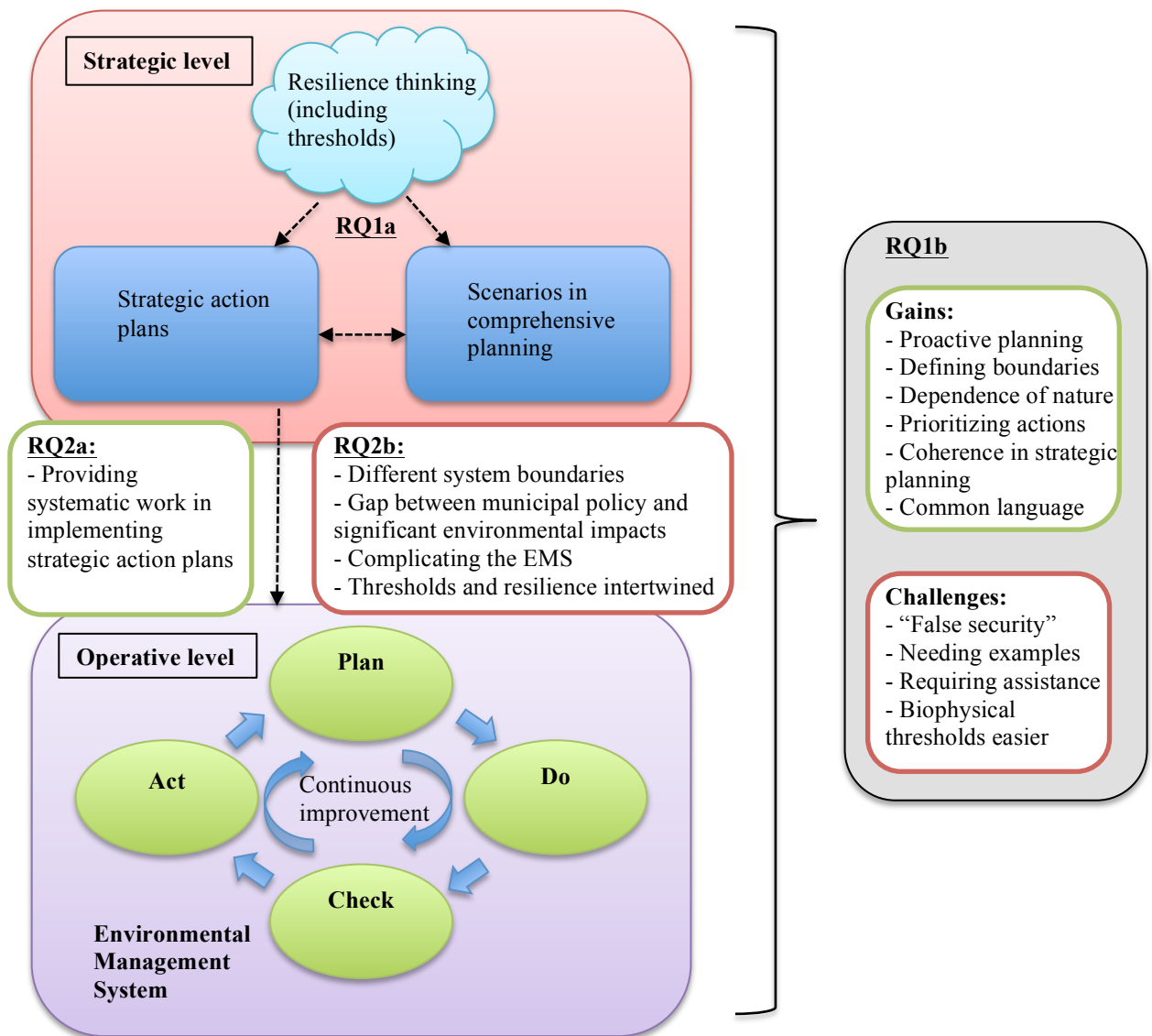


Figure 7. Summary of results and analysis.

RQ1a: Thresholds can potentially be operationalized either in the process of constructing scenarios in the comprehensive plan, or through strategic action plans. Common for both ways is that resilience thinking and thresholds mainly serve as background material in an earlier analysis at a highly strategic level.

RQ1b: The operationalization of thresholds comes with a set of gains as well as challenges.

RQ2a: The EMS can provide systematic work in handling strategic action plans, and there are thus synergistic effects between the operationalization of thresholds and an EMS.

RQ2b: There are also difficulties in having a synergistic relationship between an existing EMS and thresholds.

6 Discussion

6.1 Thresholds and resilience as a radical agenda

All themes regarding how thresholds could add value to strategic planning in Eskilstuna (RQ1b) were in one way referring to the same overarching idea; from the planner's perspectives, the concept of thresholds provided an argument for why certain development trajectories need to be changed. This overarching theme is also present in Sellberg et al. (2015). In order for municipal planners to achieve a change of development, e.g. reduction of emissions or the matter of building permits (as the Spatial Planner mentioned), they are in need of arguments. For example, different departments and actors in the municipality have diverse interests and focus areas, and decisions in one area do not happen in isolation from the others. The question of *why* a development trajectory needs to be changed can therefore be a complicated one from the planner's perspectives.

This has a connection to Hornborg (2013), who despite his critique suggests that social-ecological resilience theory could be used as a way of challenging mainstream activities, such as assumptions in the economic system. Introducing the concept of thresholds in Eskilstuna seems to have provided new, more radical arguments for change in strategic planning. Therefore, the more radical side of resilience theory that Hornborg (2013) suggests is generally missing seems to be present among the planners in Eskilstuna.

Regarding the critique from Engle (2011), i.e. that resilience in practice often is used from an engineering perspective with focus on bouncing back quickly, the case of Eskilstuna showed no tendency of this. Instead, by introducing the concept of thresholds, the planners were provided with an argument as to why critical boundaries should not be crossed. The interviewees showed no interest in building resilience for bouncing back quickly. Instead, they assumed that the way back from crossing a threshold would be difficult (if not impossible) and therefore should be avoided.

6.2 Environmental Management Systems and adaptive management

The interview results displayed a potential synergistic effect between the municipal Environmental Management System (EMS) and the operationalization of thresholds, which was that the EMS could facilitate the implementation of strategic action plans.

Therefore, the EMS seems to be a useful management tool in relation to the operationalization of thresholds. However, Holling (2001) suggests that resilience in social-ecological systems should be managed with adaptive management approaches. Is an EMS in a Swedish local authority, e.g. Eskilstuna, an example of such an approach? The interviews and the literature review show that there are some similarities between adaptive management, such as Strategic Adaptive Management (SAM), and the underlying principles for an EMS.

First, the EMS includes *monitoring* of different indicators connected to significant environmental aspects. This is similar to SAM, where Thresholds of Potential Concern (TPCs) are monitored and constantly evaluated (e.g. Biggs & Rogers, 2003; Freitag et al., 2014). An EMS could thus serve as a tool for following up variables connected to potential threshold effects. Second, the EMS is ideally an iterative *process* with yearly revisions and evaluations. This feature is also present in SAM, in which management activities are continuously updated and evaluated (e.g. Roux & Foxcroft, 2011; Biggs & Rogers, 2003). The way in which both EMSs and SAM in theory operates as a process is hence a similarity. Emilsson & Hjelm (2005) note that local authorities from time to time tend to struggle with seeing the EMS as a process. The demand for yearly revisions in a standardized EMS, e.g. “Miljödiplomering”, could be seen as a way of ensuring that the environmental work is constantly revised and evaluated. The third similarity between EMSs and adaptive management approaches is the explicit focus on learning. According to e.g. West & Schultz (2015) and Allan & Curtis (2005), adaptive management should promote continuous learning. The Sustainability Developer (SD) explained during the interview that the EMS also consisted of education for employees, which is further confirmed by Svensk Miljöbas (2014).

However, a more theoretical comparison based on the literature review shows that management in a threshold/resilience context (adaptive management) differs from how an EMS operates. One limitation to a synergistic relationship between managing thresholds and an EMS is that an EMS will not be able to fulfill the criteria for an *active* adaptive management system such as SAM. While the EMS embraces “process-thinking”, learning, and continuous evaluation, there is no notion of hypothesis testing through experiments (as explained by Allan & Curtis (2005)). Due to the demand for continuous improvement in the EMS (e.g. Emilsson & Hjelm, 2005), a “safe to fail

approach” as described by Allen & Gunderson (2011) is not practically possible. Even though SAM also prescribes continuous improvement (c.f. Kingsford & Biggs, 2012), it is more in relation to the management practice itself rather than with respect to environmental performance.

Another difference between EMSs and SAM is their scope. As noted by e.g. Allen & Gunderson (2011), active adaptive management is suitable for a subset of natural resource management contexts. A mature EMS instead has its scope towards direct and indirect impacts from activities in the organization (Emilsson & Hjelm, 2009). These two management approaches are thus constructed for different purposes; one for natural resource management (SAM) and the other for indirect and direct environmental impacts of organizations (EMS). Figure 8 below illustrates the overlap between SAM (an active adaptive management practice) and an EMS, and the main differences between them.

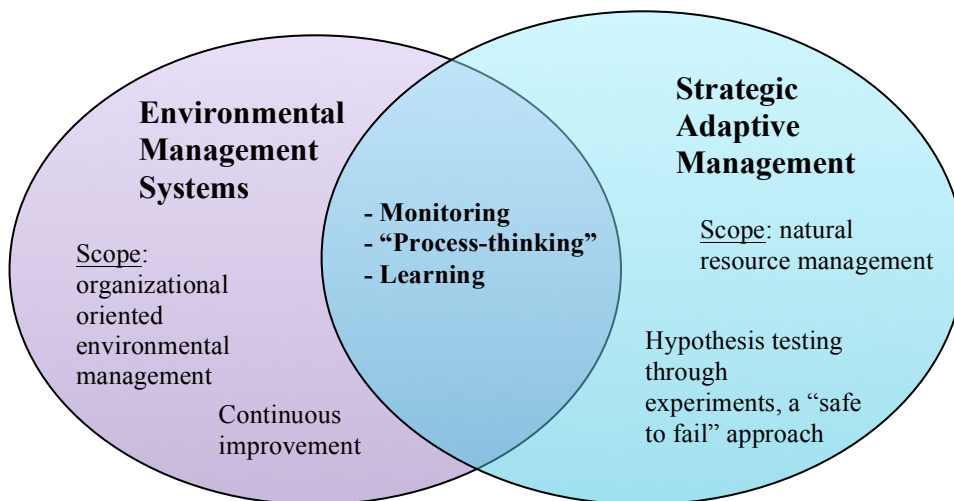


Figure 8. Similarities and differences between active adaptive management (here exemplified by SAM) and an EMS.

There are thus both differences and similarities between EMSs and SAM. The overlap between active adaptive management approaches such as SAM and an EMS can, as presented earlier, enable some synergistic effects concerning managing for thresholds in a resilience context and an EMS in a local authority. A more normative question is whether or not active adaptive management such as SAM is at all appropriate in a

municipality context such as Eskilstuna. Even though the scope of SAM differs from an EMS often used in a local authority, natural resource management (the scope of SAM) is nevertheless an important aspect of a municipality's work. Therefore, a subset of tasks performed by the municipality might be very well suited for active adaptive management approaches such as SAM. For other issues, e.g. direct and indirect environmental impacts from the organization, an EMS might be more fitting due to its organizational focus. The question of whether or not active adaptive management is appropriate for local authorities such as Eskilstuna therefore has no clear, straightforward answer. However, due to the absence of implemented and published examples of active adaptive management approaches (Allan & Curtis, 2005), adopting e.g. SAM in a local authority could demand for developing new working procedures and new ways of thinking.

6.3 Quantifying threshold effects in a complex world

Even though the threshold concept was associated with a set of gains for strategic planning in Eskilstuna, the interviewees expressed a tension between quantifying and not quantifying the critical boundaries. Quantification was seen as difficult due to complexity, but at the same time perceived as a way of making thresholds more operative and useful for strategic planning. So on the one hand, quantification provides an operative advantage, and on the other quantification might be difficult and could provide a "false security".

Due to the concern of a "false security", the interviewees in Eskilstuna thought that it would be better to not focus too much on quantification, and instead see thresholds as a way of problematizing potential risks. This is similar to the idea of Thresholds of Potential Concern (TPCs) in Strategic Adaptive Management (SAM), described by Freitag et al. (2014), Biggs & Rogers (2003), and Roux & Foxcroft (2011). Earlier in the discussion, I presented difficulties with combining EMS and SAM in a municipal context. However, the idea of TPCs seems to be a fruitful way of talking about thresholds in contexts where it is not possible to determine an exact tipping point. The idea of potential thresholds could serve as a way of illustrating *what could be* critical boundaries in the system. The yearly revisions in the EMS could facilitate the handling of potential thresholds through monitoring variables connected to what could be threshold effects.

It should be noted that there is a difference between quantifying the tipping point itself (i.e. the threshold), and quantifying the effects due to the crossing of a threshold. As Walker & Salt (2012) and Resilience Alliance (2010) claim, the threshold level itself can be difficult to quantify and to work with in practice. Regarding the effects in terms of loss of ecosystem services, for instance, there are multiple examples in both the Regime Shifts Database (Stockholm Resilience Centre, n.d.) and in the Resilience Alliance's Thresholds Database (Resilience Alliance, n.d.), yet mainly in the biophysical domain. Nevertheless, it is important to make a distinction between quantifying threshold effects (connected to the theme of "providing more proactive planning") and quantifying the threshold level itself.

6.4 Transforming the sustainability discourse

Two areas in which thresholds could add value to strategic planning were to emphasize human dependence of nature and defining boundaries for a desired system state. To see nature as crucial for human well-being, and that there are critical boundaries (thresholds) that define conditions for a desired system state, has implications for how the concept of sustainability is perceived. In Eskilstuna's policy document for sustainable development, sustainability is portrayed as an overlap between three dimensions (social, ecological and economic) (Eskilstuna kommun, 2002). But when the interviewees talk about sustainability, they tend to emphasize the ecological dimension as a prerequisite for the other two. This can be seen in one of the quotes presented in the result chapter:

I guess you can say that when you start to talk about sustainability and some kind of long-term balance thinking that we do things that are more in line with the cycles of nature in different ways, then a question mark rises, how does this look like and how do you do this, what it this? And then all of this with thresholds and that discussion becomes present. (SEP2, author's translation)

An emphasis on dependence of nature for present and future human well-being implies that the ecological dimension is seen as a prerequisite for social and economic aspects of sustainability. This resonates rather well with the first assumption in the resilience thinking framework, i.e. that social systems and ecosystems are fundamentally linked. Regarding linked social-ecological systems, Folke et al. (2010), claim that "the concept

emphasizes the humans-in-nature perspective” (p.3), and that the social and natural systems are interdependent. The concept of thresholds seems to have highlighted human dependence of nature through e.g. ecosystem services, and that there are limits to how much disturbances the natural systems can handle while still remaining in the desired state. Instead of seeing sustainable development as an overlap between the ecological, social, and economic dimension, (c.f. Eskilstuna kommun, 2002) the first one is seen as a prerequisite for the latter two. This is illustrated in figure 9 below.

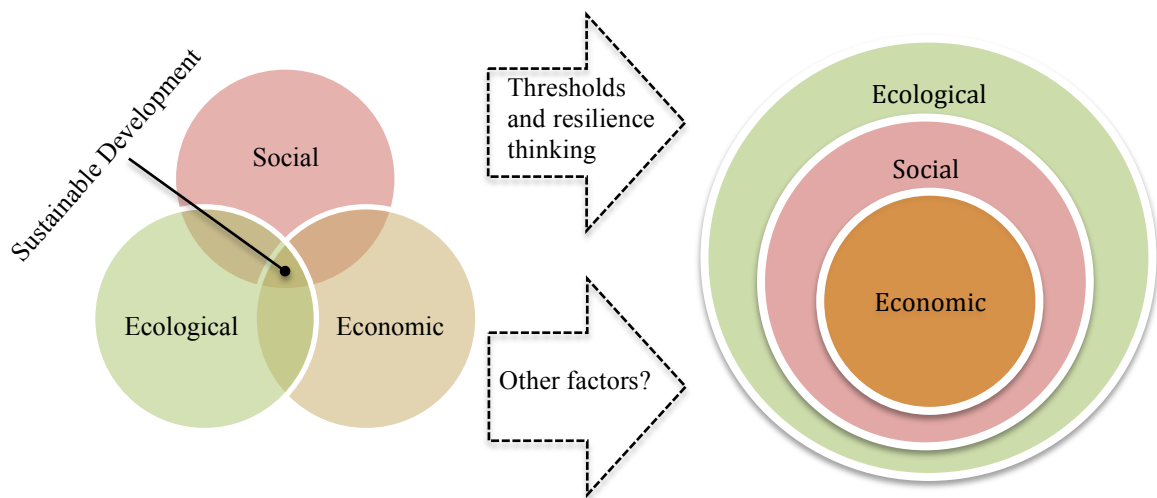


Figure 9. Transformation of the sustainability discourse. Thresholds and resilience thinking strengthened the interviewees’ idea of the ecological dimension of sustainability as a prerequisite for the other two. The role of other factors in transforming the sustainability discourse was not further investigated in the thesis.

It is important to point out that there could also be other factors contributing to the transformation of the sustainability discourse. The change from one way of viewing the sustainability concept to the other could also stem from the fact that the interviewees already possessed a worldview that harmonized well with the section to the right in figure 9. In that case, resilience and thresholds might have strengthened and supported such a worldview, but not necessary caused it from the beginning. This issue was not further investigated in this thesis.

Another important issue to raise here is connected to the remarks from Cretney (2014), i.e. the issue of what is being maintained and for whom. Resilience theory, including thresholds, emphasizes both in theory and in practice (through the results and analysis

of my interviews) that the ecological dimension of sustainability is seen a prerequisite for the other two. However, to say that ecosystem function is essential for human well-being is not the same as proclaiming natural functions as being more important than social and economic aspects of the sustainability concept. Neither is it the same as saying that some actors in society should define what should be maintained. It merely emphasizes that striving towards a more sustainable development in social and economic dimensions requires a flow of ecosystem services from nature.

6.5 Conceptual differences between domains

Even though resilience theory advocates that thresholds manifest themselves in the social, economic, and biophysical domain (e.g. Walker & Salt, 2012), there are rather important conceptual differences between them. The process of working with thresholds in the resilience assessment in Eskilstuna was influenced by a method described by Blythe (2014), where social thresholds focus on what is desirable in a system. The idea that social thresholds focus on desirability is also emphasized by Christensen & Krogman (2012), Martin et al. (2009), and Walker & Salt (2012).

According to Davoudi (2012), desirability in the social world is linked to normative judgments. A conceptual difference between biophysical and economic thresholds on the one hand, and social thresholds on the other, seems to be that the social ones are normative in the sense that they are tied to value laden judgments. While biophysical and economic thresholds also have a connection to normative aspects in the sense that what is seen as a “desirable” state is connected to values, the tipping point itself is not determined subjectively. For example, when a lake crosses a threshold and “flips” into a eutrophic regime (c.f. Gunderson & Holling, 2002), the threshold level itself is not determined by values, even though the desirability of the system regime might be. This conceptual difference between domains needs to be taken into account when dealing with thresholds in social-ecological systems. Otherwise, operationalizing resilience thinking and the concept of thresholds could, in line with Cote & Nightingale (2012), lead to a problematic assumption that natural and social systems operate in essentially similar ways.

As Walker & Salt (2012) note, social thresholds are often more context dependent than the biophysical and economic ones. This was also a result in my research, and the workshop participants found biophysical thresholds as easier to comprehend than the

other two. The need for practical examples when operationalizing thresholds, in combination with social thresholds being very contextually bound, could make their usability more difficult. But by viewing social thresholds explicitly as what is desirable in a system (c.f. Blythe, 2014; Christensen & Krogman, 2012), this problem can to a large extent be avoided. By doing so, a social threshold is no longer conceptualized as a slow variable with a tipping point, but rather as preferences within the system regarding what states are desirable. This stands in contrast to Walker et al. (2009), in which e.g. valuing the environment is seen as a slow variable with a potential tipping point.

Despite the linkage between social and natural systems (e.g. Folke et al., 2010), there are clear advantages with seeing social thresholds as distinct from the others, in terms of a more normative dimension. Nevertheless, it comes with the expense of not being able to provide applicable examples of social thresholds, which e.g. the Economic Development Manager expressed as important. The conceptual differences between thresholds in different domains are not something that is particularly addressed in the Resilience Assessment Workbook for practitioners (c.f. Resilience Alliance, 2010). Describing social thresholds as what is desirable in a system hence has a large potential to further develop the part of the workbook that explicitly deals with thresholds.

6.6 Strategic introduction of thresholds

A common denominator for operationalizing the concept of thresholds was early implementation at a strategic level. Introducing thresholds directly in the EMS, e.g. as a way of defining significant environmental impacts in an administration office, was seen as difficult and overly complicated. Variables associated with potential threshold effects often operate over rather long time scales (e.g. Folke, 2006; Folke et al., 2010). Such long time periods seems to harmonize well with the time scale for the municipality's strategic action plans and the comprehensive plan; the Water plan ranges until 2021 (Eskilstuna kommun, 2015), the Climate plan until 2050 (Eskilstuna kommun, 2012), and the comprehensive plan until 2030 (Eskilstuna kommun, n.d.d). There seems to be a good match in timescales between variables associated with thresholds on the one hand, and the municipality's strategic action plans on the other.

6.7 Thresholds as integrated within resilience thinking

On a more general level, a difficulty in operationalizing the threshold concept could be that thresholds were seen as intertwined with the resilience thinking framework. Since

Eskilstuna has worked with a resilience assessment process, which according to Haider et al. (2012) is a way of operationalizing the concepts within resilience thinking, this was not an issue in the studied case. For municipalities that have not been familiarized with resilience thinking and resilience assessment, however, the usability of the threshold concept might be different than found in Eskilstuna.

The concept of thresholds is strongly coupled to the second assumption in the resilience thinking framework, i.e. that social-ecological systems are complex adaptive (c.f. Folke, 2006). An attribute of complex adaptive, and thus social-ecological, systems is that they can exist in multiple stability states (e.g. Berkes et al., 2003), and hence the connection to thresholds. The concept of thresholds therefore relies on accepting the second assumption in the resilience thinking framework. For municipalities that have not worked with resilience thinking, or with theory of complex adaptive systems, using thresholds in strategic planning and comprehensive planning might not be entirely easy.

6.8 Specified vs. general resilience

The planners in Eskilstuna saw the concept of thresholds as a potential way of prioritizing actions in strategic planning. This implies a focus on managing thresholds, which is also suggested by Folke et al. (2009) and Folke et al. (2004). Managing for particular thresholds is similar to the idea of enhancing specified resilience (c.f. Carpenter et al., 2001). But according to e.g. Folke et al. (2010) and Walker & Salt (2012), building resilience in social-ecological systems should not exclusively focus on specific shocks (specified resilience), but must also consider unforeseen disturbances (general resilience).

Introducing thresholds in strategic planning seems to have emphasized specified resilience in the focal scale (Eskilstuna municipality as a geographical area) over general resilience. This possible trade-off is also noted by Walker & Salt (2012). Therefore, despite the potential gains for strategic planning of introducing thresholds, strategic planning should not focus solely on what could be potential thresholds in the system. Unforeseen consequences and overall uncertainties still need to be on the agenda for municipal strategic planning beyond managing thresholds. As suggested by Wilkinson & Wagenaar (2012), resilience in the focal scale should not be enhanced at the expense of diminishing resilience at other scales.

6.9 Method discussion

The case of Eskilstuna

My results are based on a single case that is Eskilstuna municipality. Ideally, the study would consider multiple cases and through that compare similarities and differences between them. However, there is currently only one on-going resilience assessment process in Sweden (Sellberg et al. (2015) in the local government of Eskilstuna), and therefore a comparative study was not practically possible. The project together with Stockholm Resilience Centre in which I took part also focused on Eskilstuna municipality.

Even though I ground a large share of my results and discussion topics on a singular case, such in rich and context dependent knowledge should not be dismissed right away. According to Kvale & Brinkmann (2009), "human activity is situated in local contexts of practice" (p.264). This means that an attempt to produce universal and fully generalizable knowledge in a social setting is simply not possible. Therefore, context dependent, rich data can also be very valuable.

An important question to address concerns generalizability of the study. Can the results from this thesis be said to apply in other cases as well? In order to answer this question, one needs to consider what it means for a research project to be generalizable. My interview results were not quantified and the interviewees were not selected by random. Therefore, according to Kvale & Brinkmann (2009), the data cannot serve as a basis for statistical generalization. However, there are other forms of generalization as well. Analytical generalization consists of "a reasoned judgment about the extent to which the findings of one study can be used as a guide to what might occur in another situation" (Kvale & Brinkmann, 2009, p.262). According to Kvale & Brinkmann (2009), such reasoned judgments can come from both the researcher and the reader. I have tried to provide the reader with transparent and enough information to facilitate a possible analytical generalization. From the researchers perspective, I believe that generalization of this study very much relies on finding a similar enough context. As noted in the discussion, the framework of resilience thinking is an important part of understanding and using the concept of thresholds. Therefore, an appropriate context for generalization would most likely be where the municipal planners have worked with resilience thinking in the form of e.g. a resilience assessment.

Choice of methods

My research is, except for a few quantitative elements in the survey, entirely based on qualitative methods. According to Kvale & Brinkmann (2009), “the quality of the data produced in a qualitative interview depends on the quality of the interviewer’s skills a subject matter knowledge” (p.82). Due to my own limited experience in conducting and analyzing qualitative interviews, one could argue that this is a weakness of the study. However, due to the design of my research, I have been able to verify my interview results with the data from the survey. Furthermore, I have confirmed all quotes used in this thesis with the interviewees, and have throughout the whole process been able to ask follow-up questions to all actors.

Validity, objectivity, and subjectivity

Validating qualitative research is a complex process, and the validity of qualitative data might not be as direct as validating quantitative data. However, that does not mean that the qualitative research method in itself is problematic. According to Kvale & Brinkmann (2009), “the complexities of validating qualitative research need not to be due to an inherent weakness in qualitative methods, but may on the contrary rest on their extraordinary power to picture and to question the complexity of the social reality investigated” (p.253). The process of verifying the data is complicated because it is connected to inherently complex phenomena. As mentioned earlier, all quotes have been verified with each interviewee before finalizing this thesis, which is an aspect of validating the results.

The concern of objectivity in qualitative research is also an important matter to address. According to Kvale & Brinkmann (2009), a principal question concerns whether there is *one correct* interpretation of the data, or if there in contrast to that exists *plural legitimate versions* of the interpretation. By accepting the assumption that there are multiple versions of a correct interpretation, discussing whether or not the objective truth has been found becomes pointless. Instead, following Kvale & Brinkmann (2009), I have tried to provide sufficient data (i.e. quotes) and arguments for my results in a transparent way to enable for the reader to test my interpretations.

One last comment concerns the issue of subjectivity in interview research. Kvale & Brinkmann (2009) distinguish between *biased* and *perspectival subjectivity*. Biased subjectivity means that the researcher only interprets and reports evidence that supports

his or her conclusions, i.e. unreliable research. Perspectival subjectivity on the other hand is different. This appears in situations when posing different questions to a text, and having different perspectives, entails diverse results and interpretations. As stated earlier, I have tried to present my perspectives, questions, and data in a transparent way so that the analysis becomes comprehensible, and so that other interpretations becomes possible as well. This implies a perspectival subjectivity of my research.

7 Conclusions

I found during my research that the concept of thresholds within the resilience thinking framework potentially could be operationalized through either strategic action plans in the municipality, or as part of working with scenarios in the creation of a new comprehensive plan. Common for both ways of working with thresholds in practice was the importance of introducing them early in the process of strategic planning. The concept of thresholds, and resilience thinking as such, thus becomes a part of the earlier analysis in strategic planning.

My research showed that operationalizing thresholds in strategic planning at a local government potentially could provide a set of added values to the planning processes. The overarching gain for local strategic planning was that the concept of thresholds provided the planners with an argument for why a certain development trajectory in the municipality needed to be changed. However, introducing thresholds also comes with a few challenges for strategic planning. The main challenge was a concern that quantifying thresholds in an inherent complex world could entail a “false” feeling of security in strategic planning. Due to complex features of social-ecological systems, quantification of thresholds is difficult and therefore associated with large uncertainties. This challenge could be addressed e.g. by focusing on potential threshold effects rather than fixed quantified boundaries.

The municipality’s Environmental Management System (EMS) provided a way of dealing with operationalized thresholds in the sense that the EMS could systematize the implementation of strategic action plans in the municipality. Due to the issue of different system boundaries in both time and space for thresholds (within resilience thinking) and an EMS, thresholds need to be operationalized through strategic action plans or via scenarios in comprehensive planning before implemented in the EMS.

In conclusion, the planners in Eskilstuna perceived the concept of thresholds within resilience thinking as a powerful way of creating a more radical argument for change that could challenge conventional planning practices.

7.1 Future research

The study in Eskilstuna highlighted a set of areas that could be of interest for further research in the field of social-ecological resilience theory and EMSs in practice:

- The planners in Eskilstuna expressed a desire to be assisted in the work with resilience and thresholds, e.g. by Stockholm Resilience Centre. The current version of the Resilience Assessment Workbook for practitioners (Resilience Alliance, 2010) therefore seems to be in need of further development. A version of the workbook for local authorities was an explicit request in the participatory process. How should such a version look like in order for the concept of thresholds to be more easily operationalized in local authorities?
- The working method for identifying thresholds in Eskilstuna, inspired by Blythe (2014) and the idea of Thresholds of Potential Concern, was well received by the planners. However, the timeframe for this project was not enough to further refine the list of potential thresholds. It would be interesting, and also a contribution to the research body on resilience and thresholds, to see if and how thresholds could be identified in the context of a local authority.
- The new Water plan for Eskilstuna municipality contains the resilience concept (Eskilstuna kommun, 2015). To follow up on how this is implemented throughout the organization would be interesting, since it would further improve the understanding of synergistic effects between a municipality's EMS and resilience thinking.
- One way of operationalizing thresholds was by adding the concept to the work with scenarios in comprehensive planning. The current comprehensive plan is to be revised, and it would be interesting to follow up on whether thresholds actually can be operationalized as a way of working with scenarios.
- The Resilience Assessment Workbook for practitioners (Resilience Alliance, 2010) does not make the conceptual differences between thresholds in different domains explicit. Further investigating how such differences can be incorporated in the workbook, by for example gathering inspiration from the results in this thesis and the method described by Blythe (2014), could thus be of value for the resilience assessment method.

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Appendix I – Values connected to Eskilstuna’s food system

These values, associated with the food system, were found during the participatory workshops in the resilience assessment in Eskilstuna. Based on these values, a common goal was set to strengthen local food production and consumption in Eskilstuna.

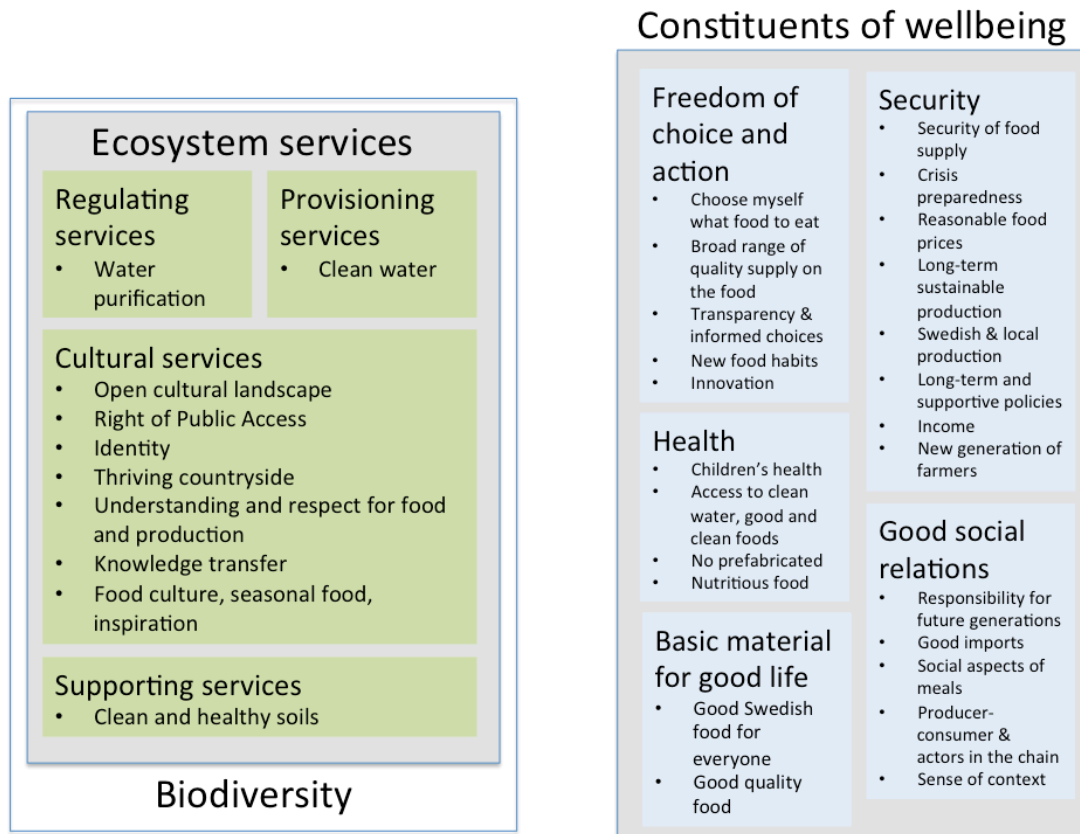


Figure 10. Values related to the food system in Eskilstuna, categorized according to the Millennium Ecosystem Assessment framework (Millennium Ecosystem Assessment, 2005).

Appendix II – Potential thresholds in Eskilstuna

This is a list of potential thresholds related to the food system in Eskilstuna. Note that this is a work in progress due to that the resilience assessment is still on-going when finalizing this thesis. With each bold line containing alternate states follows a set of variables with potential threshold effects. Some variables are represented under multiple lines of alternate states.

B = biophysical E = economic S = social

Categorization (i.e. B, E, S) was made with respect to the source of the threshold in cases where a literature source existed. In cases where a source did not exist (i.e. the thresholds was found during workshop discussions), the categorization was made by the author.

Oligotrophic or eutrophic water bodies

- Nutrient levels in water bodies. Sources: (e.g. Walker et al., 2009; Kinzig et al., 2006; Resilience Alliance, n.d.). **B**

Land available or unavailable for farming

- Level of soil organic matter. High C soils is associated with good retention of water and nutrients, while low C soils are associated with poor nutrient retention. Source: Workshop in Eskilstuna and documentation from PhD course. **B**
- Water level in Mälaren/Hjälmaren. Source: Workshop participants. **B**
- Land use changes, e.g. housing (asphalt), planted spruce forests, or agriculture (asphalting a field, or planting spruce on it, might be hard to return from). Sources: Workshop in Eskilstuna. **B-E**
- Values (prioritizing agricultural issues on the political agenda or not). Sources: (e.g. Walker & Salt, 2012; Walker et al., 2009; Christensen & Krogman, 2012). **S**
- Flooding. Source: Workshop in Eskilstuna. **B**
- Inflow of water (not too little not too much). Source: Workshop in Eskilstuna. **B**
- Availability of seeds (not a problem today but could be in the future). Source: Workshop in Eskilstuna. **B-E**

Farm/agriculture viable or not

- Income (price times harvest) during a certain amount of time is lower than expenditures. Source: Workshop in Eskilstuna. **E**
- Income/debt ratio. Sources: (Walker & Salt, 2012; Walker et al., 2009; Kinzig et al., 2006). **E** Affected by:
 - o Willingness, and possibility, of local consumers to pay for locally produced food. Sources: Internal workshop, workshop in Eskilstuna. **S-E**
 - o Global food prices. Source: Workshop in Eskilstuna. **E**
 - o Price of input material. Source: (Kinzig et al., 2006). **E**
 - o Collapse in trust for imported food. Source: Internal workshop. **S**
 - o New regulations (taxes, EU-subsidies, laws, restrictions) concerning e.g. fertilizers. Source: Internal workshop. **E**
 - o Compaction of the soil, bigger machines might no longer be able to produce larger harvests. Source: Workshop in Eskilstuna. **B**
 - o Level of soil organic matter. High C soils is associated with good retention of water and nutrients, while low C soils are associated with poor nutrient retention. Source: Workshop participants in Eskilstuna and documentation from PhD course. **B**
- Investment cost in infrastructure exceeds (or does not exceed) future benefits. Sources: (Walker et al., 2009; Kinzig et al., 2006). **E**
- Critical mass of local processing companies and/or local markets (nearby geographical distribution channel for local farmers). Source: Source: (Carpenter & Lynch, 2003). **E**

New established farms or no new established farms (barriers for a renewal of the agriculture sector).

- Land prices. Source: Workshop in Eskilstuna. **E**
- Food prices. Source: Workshop in Eskilstuna. **E**
- Critical mass of people who want to work as farmers. Source: Internal workshop. **S**
- Investment cost in infrastructure exceeds (or does not exceed) future benefits. Sources: (Walker et al., 2009; Kinzig et al., 2006). **E**

Local processing companies and stores viable or not viable (barrier for locally produced food).

- Food habits (e.g. people are used to buying cheap food and eating large amounts of meat, and the demand for food does not agree with seasonal variations in locally produced food). Source: Internal workshop and workshop in Eskilstuna. **S**
- Transportation costs (high costs will promote locally produced food). Source: Internal workshop and workshop in Eskilstuna. **E**
- Collapse in trust for imported food. Source: Internal workshop. **S**
- Time for cooking (affects the demand for locally produced food). Source: Internal workshop. **S**
- Market conditions for local stores that sell locally produced food (consumers in the municipality have low income). Source: Workshop in Eskilstuna. **E**
- Critical mass of knowledge (education) about food processing. Source: Internal workshop. **S**
- Politics in the municipality and procurement of locally produced food. Source: Workshop in Eskilstuna. **E**
- Critical mass of local processing companies and/or local markets. Source: (Carpenter & Lynch, 2003). **S**

Range of pollination area large or small

- Loss of forest patches < 5 ha (habitat for pollinators). Source: (Kinzig et al., 2006). **B**

Fish stock large or small

- Ice period of three months. Source. Earlier workshop in the resilience assessment process. **B**
- Amount of catch. Source: Internal workshop. **B**

Living/vibrant local community or not.

- Availability of schools, healthcare (disregarded of services provided by the county council). Source: Workshop in Eskilstuna. **S**

- Availability of local stores. Source: Wworkshop in Eskilstuna and internal workshop. **S**
- Identity (people that live and work in Eskilstuna, many people commute today). Source: Internal workshop. **S**
- Availability of social service (e.g. infrastructure, facilities, car-pools). Source: Workshop in Eskilstuna. **S**
- Engaged citizens. Source: Workshop in Eskilstuna. **S**

Crisis preparedness or no preparedness.

- Capacity (social, economic, land availability) to scale up production in order to cover local needs. Source: Internal workshop. **S-E-B**
- Storage possibilities. Source: Internal workshop, workshop in Eskilstuna. **S-E**

Appendix III – Interview guide

Question four and five only applies to the interviews in which the EMS was discussed.

- 1. Could you tell me about the time when you first heard about thresholds?**
 - a. Pre-knowledge?
 - b. Connection between thresholds and resilience?
 - c. Why work with thresholds? Most interesting thing with thresholds?
- 2. The process of identifying thresholds in Eskilstuna (the workshop)?**
 - a. What was easy/difficult?
 - b. Did you find some threshold(s) especially interesting? Which one? Why?
 - c. Differences between thresholds in different domains?
- 3. In what ways do you think (if you think) that thresholds can be useful in planning?**
 - a. How? Examples? Do they contribute with something new?
 - b. Knowledge gaps?
 - c. Quantifying or not quantifying thresholds?
 - d. Operationalize thresholds how? When?
 - e. Are thresholds used in planning today? Examples?
 - f. Good and bad with current planning?
- 4. Could tell me about Eskilstuna's EMS?**
 - a. The role of the EMS in the municipality's environmental work?
 - b. The relation between environmental goals and strategic action plans?
 - c. Monitoring routines? Organizational learning? PDCA-cycle?
 - d. Why standardized EMS? Why "Miljödiplomering"?
 - e. What has worked well in the EMS? Difficulties with the EMS?
 - f. Relation between the municipal environmental policy document and environmental work in the administrations?
- 5. Connection between the work with thresholds and the EMS?**
 - a. How can they be combined? Can they be combined? How?
 - b. Resilience assessment and thresholds useful for the EMS? How?
 - c. Has resilience and thresholds provided new insights?
 - d. How can the EMS contribute to the resilience assessment? Contribution to the work with thresholds?
- 6. Personal background, e.g. education (if I would want to ask about this).**

Appendix IV – List of documents

The following documents were reviewed in order to (i) get an overview of the resilience assessment process, and (ii) understand the structure of the EMS.

1. Eskilstuna municipality's politics for sustainable development (Eskilstuna kommun, 2002).
2. Climate plan for Eskilstuna municipality (Eskilstuna kommun, 2012).
3. Environmental policy for Eskilstuna municipality, old version (Eskilstuna kommun, n.d.c).
4. Water plan for Eskilstuna municipality (Eskilstuna kommun, 2015).
5. Comprehensive plan for Eskilstuna municipality (Eskilstuna kommun, n.d.d).
6. Documentation from a PhD course at Stockholm Resilience Centre (unpublished material).

Appendix V – Survey from the workshop at Eskilstuna

1) Circle the number that best corresponds to how well you knew about the concept of “thresholds” before the workshop. (1=did not know about the concept, 5=very good knowledge about the concept).

1 2 3 4 5

2 a) Has the workshop provided any new insights regarding thresholds? (1=not at all, 5=yes absolutely).

1 2 3 4 5

2 b) If yes, in what ways?

3 a) What do you think of how we worked with thresholds during today’s workshop? (1=very bad, 5=very good).

1 2 3 4 5

3 b) What was easy and what was difficult during the workshop?

4 a) Do you think that thresholds seems to be useful for your daily work? (1=not at all, 5=yes absolutely).

1 2 3 4 5

4 b) If yes, in what ways?

5) What do you think is new with the concept of thresholds compared to current municipal planning?

6) Other comments?

Appendix VI – Additional quotes

This appendix contains additional quotes from the interviews that support the themes presented in the results and analysis chapter. The following acronyms are used:

SEP1 – *Strategic Environmental Planner 1* SEP2 – *Strategic Environmental Planner 2*
 EDM – *Economic Development Manager* SD – *Sustainability Developer*
 SP – *Spatial Planner* D – *Developer*

Research question	Theme	Additional quotes supporting the theme
Operationalization of thresholds (RQ1a)	Operationalization through comprehensive planning	<i>I think that you can use it (thresholds) a lot, and different scenarios (in the comprehensive plan) could take thresholds into account. (SP, author's translation)</i>
		<i>It would have been very interesting to look at it (thresholds) more concrete when the comprehensive plan is updated. But by picking themes like rising sea-levels, flooding and erosion. And work more based on the themes that we highlight in the comprehensive plan. (SP, author's translation)</i>
	Operationalization through strategic action plans	<i>It (thresholds) has to be there already in the early stages, because otherwise it will not spread downwards either. (EDM, author's translation)</i>
		<i>It will be more of a strategic measure, which then is translated into practical action. (SEP2, author's translation)</i>
		<i>On the basis that we have analyzed a field such as the food system we arrive at a number of conclusions where we see important vulnerabilities, thresholds, and so on. And based on that we create a food strategy which tells us more operatively what we need to do. What direction should we take, which measures are required, what vision needs to be set. (SEP1, author's translation)</i>
	Creating more proactive planning	<i>You know that it will take an incredibly large effort to go back. (EDM, author's translation)</i>
		<i>That you can get a glimpse of the future, what that might lead to, and if</i>

Gains for strategic planning (RQ1b)

	<i>it happens you might not be able to use land and water as planned. (SP, author's translation)</i>
Defining boundaries for the desired system state	<i>It would be great to somehow define what boundaries we can't cross. (D, author's translation)</i>
Emphasizing our dependence of nature	<i>What is the dependence between how the system works and the function of pure water for example? What kind of processes must exist, and what happens if you go to far in a stressor that affects the processes that support this? (SEP2, author's translation)</i>
	<i>If you continue like you always have done then you won't continue to exist. /.../ If we continue with farming like this, there won't be anything left, it won't be possible to continue like this. (EDM, author's translation)</i>
Prioritizing actions	<i>And then thresholds are very important...now we are close to a threshold then we need to do something, an action of some kind. (EDM, author's translation)</i>
	<i>It (communicating thresholds with decision-makers) depends on which question you talk about and how close you are to the threshold. (SP, author's translation)</i>
Creating more coherent strategic planning	<i>I think it (thresholds) could be a good "dialogue tool" with decision-makers for example, because it is easy that small decisions are taken without seeing the "large arrow". The large arrow (for sustainable development), points out a future path but all these small decisions on the way might point out an unsustainable development. You might not think that all of these small decisions matter, but it could make the "large arrow" to point at the wrong direction and a thresholds might be crossed on the way. (SP, author's translation)</i>
Providing a common language	<i>Then you can use the same conceptual language and I think that's really useful because then you talk about the same things. (EDM, author's translation)</i>

		<i>Issues were addressed/collected “in the same bag” and a concept around it created. (SP, author’s translation)</i>
Challenges for strategic planning (RQ1b)	Providing a "false security"	<i>There are so many aspects that play a role in this, and no city is exactly the same as another one if you think about for example social risks. (EDM, author’s translation)</i>
		<i>It can be a bit risky (quantification), because in some contexts it can be difficult...because you might feel that we have gone a long way but we’re still pretty far away when it comes to this variable, so maybe nothing happens. But the variable can in turn interact other variables, so I mean...it can be really hard to go into that (quantification). (SEP2, author’s translation)</i>
	Needing concrete examples and pilot studies	<i>I think that finding a visualization is important, so that you easy can take it on board. Because if it gets too theoretically heavy, I think that many people might find it hard to use in the strategic work. (EDM, author’s translation)</i>
		<i>I think you need to have a quite basic understanding for thresholds. What it is, and a few concrete examples on situation where you have seen these effects. (SD, author’s translation)</i>
	Requiring assistance	<i>I think that information is important, and when working with scenarios, you need a source of knowledge for example if Stockholm Resilience Centre could participate during a comprehensive plan-workshop. (SP, author’s translation)</i>
	Seeing biophysical thresholds as easier	<i>I think that I have seen resilience as mostly connected to green and blue issues before, but at an earlier workshop in the resilience assessment we also discussed economy and unemployment as thresholds for Eskilstuna. So partly I knew about the concept but with focus on ecology. (SP, author’s translation)</i>

		<i>I mean in some way the thresholds, as it has been described so far, then what has collapsed and been destroyed is something that you can translate into an ecosystem service, it's those kind of things. (SEP2, author's translation)</i>
Benefits from having an EMS when operationalizing thresholds (RQ2a)	Providing systematic environmental work	<i>It will be yearly revisions, which is a requirement in this work. There you look at the environmental goals thoroughly, see how you have worked with them and the action plans. (SD, author's translation)</i>
Difficulties of operationalizing thresholds in an existing EMS (RQ2b)	Suggesting different system boundaries	<i>The EMS is (compared to the work with resilience) more straightforward, focusing on the organization. (SEP2, author's translation)</i>
	Expressing a gap between municipal policy and environmental impact	<i>Because if you work with for example health and care of the elderly, you are not that interested in a water plan. (SEP1, author's translation)</i>
	Complicating the usability of the EMS by introducing thresholds	<i>I think it might be a bit farfetched maybe, a bit difficult (regarding using thresholds as environmental goals). (SD, author's translation)</i>
	Viewing thresholds and resilience thinking as intertwined	<i>I mean thresholds, I think that's a result of this...that is kind of a part of the resilience concept and discussions around that, that it exists. (SEP2, author's translation)</i>