In Rhizomia: Actors, Networks and Resilience in Urban Landscapes

Henrik Ernstson
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A mi compañera de vida: Andrea Eckstein.
Abstract

The overarching theme of this thesis is the generation and distribution of urban ecosystem services. Ecosystem services are the benefits humans derive from ecological processes such as food, clean water, stress relief, and improved air quality, which depend upon complex interactions between species and matter. Research in natural resource management has mostly been from a functional management perspective, and less engagement has been from a critical perspective concerning who in society benefit from these services and how issues of equity and power influence ecosystem management. Both perspectives are pursued here.

The bulk of the empirical data has been generated through a case study of an urban social movement that has protected the Stockholm National Urban Park from exploitation, a large and centrally lying green area. In Paper I, a theoretical argument is made that ecosystem management can be studied through analyzing the structure of social networks, i.e. the patterns of relations between agencies, stakeholders and user groups. In Paper II, a social network analysis of the 62 movement organizations revealed a core-periphery structure effective to ward off exploitation plans, but which also seems to have constrained ecosystem management; user groups with ecological knowledge have been marginalized on collaborative arenas due to their peripheral social network position. Based on in-depth interviews and participatory observations, Paper III traces the practice by which activists constructed holistic values and visions for the park. The articulation of values seems to have been conditioned by the access to certain artefacts (historical maps, biodiversity mappings etc.) and social arenas. In Paper IV, and based upon other case studies from Stockholm, a conducive network structure is proposed aimed at linking managers and user groups (e.g. allotment gardens, cemetery managers, and urban planners) across spatial ecological scales so as to improve management. Building on the previous papers, Paper V presents a framework to analyze the social-ecological dynamics behind the generation and distribution of ecosystem services in urban landscapes.

The thesis argues that urban green areas should be acknowledged as physical sites of social-ecological interaction that can nurture ecological knowledge, value creation processes, and human agency to improve urban ecological processes. The thesis points towards the notion of “a social production of ecosystem services” and argues for deeper engagement with the fields of urban political ecology and critical geography.
List of Papers

I. Social networks in natural resource management: what is there to learn from a structural perspective?
Örjan Bodin • Beatrice Crona • Henrik Ernstson (2006)
Ecology and Society 11(2):r2
(NB! All authors participated equally.)

II. Social movements and ecosystem services: the role of social network structure in protecting and managing urban green areas in Stockholm
Henrik Ernstson • Sverker Sörlin • Thomas Elmqvist (2008)
Ecology and Society (in press)

III. Weaving protective stories: connective practices to articulate holistic values in Stockholm National Urban Park
Henrik Ernstson • Sverker Sörlin (2009)
Environment and Planning A (in press)

IV. Ecological scales and social network structure: management and governance of urban ecosystem services in Stockholm, Sweden
Henrik Ernstson • Stephan Barthel • Erik Andersson • Sara Borgström (manuscript)
Environmental Management

V. The social production of ecosystem services: lessons from urban resilience research
Henrik Ernstson (manuscript)
Human Ecology

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<td>Actor-network theory</td>
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<td>NUP</td>
<td>National Urban Park, <em>The (Nationalstadsparken)</em></td>
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<td>SES</td>
<td>Social-ecological system</td>
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<td>SMO</td>
<td>Social movement organization</td>
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Introduction

Humans influence ecosystems at scales from local to global (Vitousek et al. 1997) and it has become imperative to understand and better account for the linkages between humans and ecosystems (Berkes and Folke 1998). Research in natural resource management has embraced this notion through stressing a human-in-nature perspective and turning the object of study into “social-ecological systems” (ibid.) seen as complex systems in which humans and their institutions (including organizations, knowledge, and values) become an equal part of analysis with ecological components as water flows and pollination patterns (Gunderson and Holling 2002, Berkes et al. 2003). Tightly linked to this lies the recognition that human activity depend on the goods and services generated from ecosystems (Daily 1997a, Costanza and Farber 2002, MA 2005, Daily and Matson 2008). The clearest difference between social systems and ecological systems lies in that humans are reflective and can consciously manipulate the direction of development, with both intended and unintended consequences for both social and social-ecological systems (cf. Giddens 1984). The focus of natural resource management research then evolves to ask question about how humans, through purposeful actions can act as agents in social-ecological interactions so as to create, sustain and improve the generation of ecosystem services. This should however not be translated as efforts to control ‘nature’ for the benefit of humans, but in efforts to navigate a complex and continuously changing social-ecological system so as to sustain good human living conditions (Levin 1999, Berkes et al. 2003). Nonetheless, as remnants from an old paradigm, these purposeful actions are often called ‘management’ or ‘protection’ of ecosystems, referred to as ‘ecosystem-based management’ or ‘adaptive management’, but should be read as an interaction from within an ecosystem rather than as actions from the outside.

Natural resource management literature has traditionally focused on the generative capacity of ecosystems to provide ecosystem services, which I will call a functional analytical perspective. However, a critical perspective that engages with issues of power, equity and the distribution of ecosystem services, i.e. who benefit from ecosystems, has been less developed (Paper V, cf. Ribot and Peluso 2003). For example, while most urban dwellers would agree that living close to green areas can have many benefits (e.g. improved air quality and easy access to space for children to play) less attention in natural resource management literature has been on analyzing the mechanisms behind the uneven patterns of green areas in cities, and the distribution of services from ecosystems more generally.

Based on this, there has been three objectives of this thesis: Firstly, to extend the research agenda of natural resource management to include both the...
Figure 1. The left hand figure displays the overarching framework of the thesis. Two perspectives are used for analyzing complex social-ecological systems; a functional management perspective and a critical equity perspective. The former is needed to analyze the generation of ecosystem services, while the other the distribution of ecosystem services and how discourses and power influence management (right figure). In the right hand figure it is indicated roughly where the three empirical and two theoretical papers are located in the universe of the framework along the two axes of generation/distribution and social/ecological analysis.

generation and distribution of ecosystem services, as outcomes of human interactions with ecosystems. As an overarching assumption I have taken that social-ecological systems both generate and distribute ecosystem services and that two perspectives are needed to analyze them: a functional perspective seeking the structures and processes underpinning the generation of ecosystem services, but also a critical equity perspective that engages with the distribution of ecosystem services, as depicted in Figure 1. The latter also includes the mechanisms by which certain ecosystem services are prioritized before others, often translated as management prioritizations or in competing land use interests. The second objective has been to contribute to the studies of social-ecological transformations, or transitions towards ecosystem-based management (Olsson et al. 2004b, Olsson et al. 2008). Given Figure 1, this means to account for how such transitions alters both the generation and distribution of ecosystem services. A third objective of this thesis, based on case studies from an urban landscape, has been to contribute to urban theory and policy.
The first two objectives have been pursued by placing different analytical perspectives in focus in different papers (Figure 1). In Paper I and Paper IV the functional management perspective is in focus through studying the patterns of relationships between resource users and stakeholders, i.e. their social networks. Paper I is a theoretical paper, and the ideas pencilled out are taken considerably further in Paper IV when the structure of social networks are combined with empirically identified ecological scales from the management of urban green area ecosystems in Stockholm. Paper II and Paper III use a case study of a local urban movement that managed to protect a large green area in Stockholm. Paper II explores this through a social network analysis, while Paper III, inspired by actor-network theory, focuses on how the movement managed to construct holistic values and visions for the green area, a key factor in the transformational process. Building on these experiences, Paper V is an effort to articulate a framework for how we can understand and analyze the functional management and critical equity perspectives of especially urban social-ecological systems.
The thesis is part of a strong current to combine ecological theory with social theory (e.g. Berkes et al. 2003 and the journal *Ecology and Society*). An original intention with this thesis was to open contemporary discourse of resilience and natural resource management to fields more engaged with the issues of power, equity and service distribution. As in all interdisciplinary work, this comes with a risk. One great risk is to wander out too far in social theory and simplify the complexity of ecosystems, and another to simplify social theory in ways that make it irrelevant. The potential gains, however, lie in building interdisciplinary frameworks that can guide analysis of human-ecosystem interactions in which other fields of research can participate. In pursuit of this goal I have not been hesitant in drawing upon ideas from a diverse set of sources. From sociology I have used social network analysis (Wasserman and Faust 1994), social movement theory (della Porta and Diani 2006), and actor-network theory (Latour 2005), and from historical research, ideas pertaining to social articulation (Sörlin 1998). These have been combined with resilience theory and landscape ecology as used in natural resource management (Holling 1973, Nyström and Folke 2001, Gunderson and Holling 2002, Berkes et al. 2003). This has resulted in a theoretical web that opens the field of natural resource management to especially critical geography and urban political ecology (Harvey 1996, Swyngedouw 1997, Keil 2003, 2005, Walker 2005, Heynen et al. 2006). One can of course question this mixing of theory as an unacceptable eclecticism, but I find support in sociologist Anthony Giddens that once wrote that “[i]f ideas are important and illuminating, what matters much more than their origin is to be able to sharpen them so as to demonstrate their usefulness” (Giddens 1984: xxii). It is of course up to the reader to judge if I have been successful.

The aim of this pre-chapter, or *kappa*, is to lay the background of the thesis, point out underlying assumptions, summarize the included papers, and draw out wider implications for theory, policy and future research that the thesis has established.

**Urban landscapes and urban ecosystem services**

Urban landscapes are extreme among social-ecological systems through the great impact human activities have on ecosystem processes (Collins et al. 2000, Grimm et al. 2000a, Grimm et al. 2008, Pickett et al. 2008). Being centres of economic and industrial activity, cities draw upon resources far away through trading routes, but they also impact on local and regional ecosystems affecting the living environment for a more and more urbanized human population (McGranahan et al. 2005). Currently half of Earth’s 6.6 billion humans live in urban areas, while by 2030 another 2 billion are expected, with the highest increase in developing countries (UN 2005). It is therefore of crucial concern to address what constitutes the living environment of these human habitats in which local and regional ecosystems, to-
In the United Nation’s Millennium Ecosystem Assessment (MA 2005: vi) ecosystem services were described as consisting of four main categories:

- **Provisioning services** (products obtained from ecosystems like food and fibre);
- **Regulating services** (benefits obtained from regulation of ecosystem processes like air- and water filtration);
- **Cultural services** (nonmaterial benefits obtained from ecosystems, like spiritual enrichment, cognitive development, recreation, and aesthetic experiences); and finally
- **Supporting services** (ecological functions such as pollination, nutrient cycling and soil formation) seen as necessary for the production of all other ecosystem services.

Three recent developments have been important for this thesis. First, the concept of ecosystem services, or “nature’s services” as it was originally coined, defined as the goods and services derived from natural processes that benefit human well-being (Daily 1997a, Daily 1997b, Costanza and Farber 2002, Daily and Matson 2008). Ecosystem services now occupy a central position in policy and research on human-ecosystem interaction, and in the UN-initiated Millennium Ecosystem Assessment in 2005 (MA 2005) four main categories were suggested: provisioning, regulating, cultural, and supporting ecosystem services (Box 1). Second, since the 1990’s and through a significant shift within the discipline of ecology (Kingsland 2005), urban nature has been ‘discovered’, both for its intriguing ecology, and as a policy arena to sustain its productive force to generate urban ecosystem services (Bolund and Hunhammar 1999, Grimm et al. 2000b, Pickett et al. 2001, Alberti 2005, Colding 2007, Pickett and Cadenasso 2008). Thirdly, the development of the theory of resilience, which started as an internal debate within ecology regarding how to interpret the stability of ecosystems (Holling 1973), to now encompass ideas of dynamic change of human-ecosystem interaction through social-ecological system analysis, including adaptive management and governance (Gunderson and Holling 2002, Folke et al. 2005).

By directing attention towards urban green and blue areas such as urban forests, parks, and watersheds, a wide range of services generated by urban ecosystems have been identified (Bolund and Hunhammar 1999, Jackson 2003, McGranahan et al. 2005, Jansson and Colding 2007). Some services
are primarily locally distributed, as when single trees, urban forests and green areas reduce noise and wind, while providing shade, clean the air from pollutants and improve general health (Bolund and Hunhammar 1999). Simultaneously, local green areas can lower the levels of human stress, and strengthen community life (Kuo et al. 1998) through providing space for informal meetings and recreational activities. Urban wetlands can mitigate local flooding events and retain nitrogen at a regional scale (Jansson and Colding 2007). On greater spatial and temporal scales, benefiting a larger but more abstract and even future population, vegetation covered land aid in draining rainwater and sustaining the ground water table (Bolund and Hunhammar 1999), while also absorbing CO₂ emissions (Jansson and Nohrstedt 2001). Urban green areas have also been shown to sustain pollination and seed dispersal processes and provide substitute habitat for endangered species (Sukopp and Weiler 1988), which underpin global biodiversity increasing the capacity to adapt to environmental and climatic changes (Folke et al. 1996). Furthermore, in a rapidly urbanizing world green areas within walking distance could prove crucial in enhancing broad-based support for sustainable development (cf. Miller 2005).

To study urban social-ecological systems

In studying the dynamics of urban social-ecological systems there are at least three characteristics that make them different from non-urban systems. Most studies of social-ecological systems have been on systems with a direct linkage at a local scale between resource users and ecological dynamics, (see e.g. Berkes et al. 2003, Folke et al. 2005). Although such systems are influenced by greater scale linkages (for example through markets etc.), people in such systems depend directly on provisioning services from local ecosystems (e.g. crop or fish) which they either eat or sell. People might even be aware of how supporting services, like pollination and soil formation in the local ecosystem benefit their production and consumption (Berkes et al. 2003), or institutions, norms or taboos have evolved that seem to sustain those services (ibid.). Consequently, there are quite easily identifiable local feedback loops between social and ecological systems, which makes it more straightforward to talk about one (co-evolving) system (Berkes and Folke 1998), and to make these feedback loops the object of study to understand the system (Berkes et al. 2003). However, in urban systems this type of direct and local scale linkage is considerably weaker. Provisioning services are mainly imported through trade (which instead involves linkages at a regional and global scale abstracted through the market (Deutsch et al. 2000)), and the local scale linkages that exist are instead shaped by the desire of cultural services, and to some extent regulating services, as these address more urgent issues of urban life. The less tangible benefits of having space for recreation, improved air quality, an English park to contemplate or a garden to
tend—which are all distributed to urban citizens in the form of spatially constrained green space, parks, urban forests and lakes—are of value in an urban landscape. Although urban farming and allotment gardening could be important for some groups (especially in lower-income countries), citizens depend generally less directly on their local ecosystems. An assumption from this is that the choice of how to use green areas become more a matter of taste and culturally constructed values, which, as investigated in sociology, are often dominated by those with higher economic, cultural and social capital (Bourdieu 1984).

The second and third general characteristics of urban systems pertain to if green and blue areas will exist at all. The spatial pattern of urban landscapes are tightly linked to cities’ centrality in contemporary modes of production of goods and services as explored in sociology and geography (Castells 1989, Harvey 1996, Sassen 2006). A variety of functions, from transport and sewage systems, to housing and offices need to find their space, along with urban parks and greenery, in order to produce urban services craved by citizens, industries and commerce, all in a competition of which land use can render highest profit on capital investment, being either private or public capital (Castells 1983, Harvey 1996, Swyngedouw 1997). As described by geographer David Harvey (1996, 2002), the space of the city is a potential space for profit. Consequently, two other interlinked characteristics of urban social-ecological systems, apart from the decoupling of direct need at the local scale, is first that the issue of how to use land becomes to a large extent a matter of human choice (often regulated through urban planning) in which the alternative uses for each patch of land are greater than in non-urban landscapes, which secondly produces an extreme heterogeneity of land use.

Based on these characteristics, an underlying assumption in this thesis is that when analyzing urban social-ecological systems one must engage more explicitly with the politics of the city, the creation of values around urban space and green areas, and how different actors strive to influence the institutions and decisions guiding land use and urban planning.

Theoretical framework

Ecosystem management in urban landscapes

My general approach to the functional management perspective of social-ecological systems (Figure 1) has been through social network structure and ecological scales. Here the urban context is challenging and it has been argued that given the extreme heterogeneity of urban landscapes, they have a higher tendency of scale mismatch, i.e. a temporal or spatial mismatch between the scale of ecological processes and the scale of social organization for management (Folke et al. 1998, Cumming et al. 2006).
Ecological scales are context sensitive and difficult to readily define in practice, but are generally viewed as hierarchically and dynamically linked (Gunderson and Holling 2002) where interactions between parts in ecosystems (plants, animals and chemical compounds) are nonlinear and local, and constrained by larger scales, but where local interactions could have emergent effects influencing other scales and the system as a whole (Pickett et al. 2008). One key to finding the relevant scales for management is to understand how different organisms perceive and interact with the landscape, especially those species forming part of functional groups that play complementary roles in facilitating ecological processes (Hostetler and Holling 2001, Farina and Belgrano 2006, Lundberg et al. 2008).

Although studies in urban ecology have embraced cities as social-ecological systems, they have mainly focused on exploring how the heterogeneity of land use patterns and dynamics affect ecosystem function (Alberti 2005, Cadenasso et al. 2006, Grimm et al. 2008, Pickett et al. 2008) with less focus on actual management. In this thesis, focus has been on actors that intentionally interact with urban ecosystems at different scales, from cemetery/park managers, allotment gardeners, and urban social movements at the local scale, to urban planners at greater scales. This approach acknowledges a wider importance of green areas. Besides being parts of green spatial patterns, they also constitute physical sites of social-ecological interaction that can nurture ecological knowledge and open for human agency in manipulating and improving ecological processes (cf. Miller 2005, cf. Berkes et al. 2003).

Green areas represent an opportunity in urban social-ecological systems to establish ecological feedbacks at the local scale, in spite that most activities depend less on these local ecosystems as explained above. This has been used in this thesis as a way to link my research to more general studies (or actually non-urban studies) of adaptive co-management and governance of ecosystems (Gunderson and Holling 2002, Berkes et al. 2003, Folke et al. 2005). This literature argues for a management paradigm based upon collaboration between various actor groups that are active at different scales and with different and often scale-specific knowledge and information about the ecosystem (Bandura 1977, Ashby 2003, Olsson et al. 2007). This is seen to facilitate social learning about ecosystem dynamics and help coordinate management actions so as to decrease scale mismatch. Successful collaboration in turn depends on several social factors such as trust, conflict resolution, and knowledge integration (e.g. Folke et al. 2005, Manring 2007). However, and crucially for this thesis, all these factors depend (in one way or another) on creating and sustaining social networks for information flows (ibid., Bodin et al. 2006a).
Social network analysis

Just as ecological patches are part of greater scale patterns (Alberti 2005), social actors are part of emergent social network structures (Wasserman and Faust 1994). Social networks consist of actors interlinked through measurable and quantifiable relationships, e.g. friendship, exchange of information, family, co-worker etc. (ibid., Marsden 1990). A presumption is that all relationships in a social network come with an effort (or a cost) for establishing and then sustaining the relationship (Granovetter 1973, Degenne and Forsé 1999). This tends to direct information flows through established patterns of interaction (Diani 2003). “Network theory builds its explanations from [these] patterns of relations” (Burt 1986: 106) and could consequently be used to investigate social processes, including social learning and collective action in relation to natural resource management. Crucially, the patterns of interaction are an outcome of localized interactions, which means that no actor can fully control the emergent structure (Diani 2003). This opens for human agency to change at least parts of the network structure through interacting with new actors (ibid.). However, this also demonstrates the inertia of social network structure (and why we refer to it as ‘structures’) (Degenne and Forsé 1999).

The field of social network analysis has formalized the analysis of networks, translating actors and their relationships into graphs of nodes and links (Degenne and Forsé 1999). Through mathematical algorithms one can analyze how patterned relationships within a system can facilitate and constrain both the individual behaviour of actors, as well as system function and collective action (Wasserman and Faust 1994). This makes it possible to bridge the ‘micro’ scale of interacting individuals, and the ‘macro’ scale of groups and institutions (Emirbayer and Goodwin 1994).

This thesis used social network analysis to analyze the functional management and the critical equity perspective of social-ecological systems (Figure 1). From a functional approach networks were viewed as a means to link actors across ecological scales to increase ecosystem monitoring and social learning about ecosystem dynamics (Paper I, Paper IV). From a critical approach, the structural network position of actors was used to analyze how some actors can enhance the impact of their agenda, while others are constrained (Diani and McAdam 2003), be that in social movements (Paper II), or in collaborative management and governance (Paper I and Paper IV).

Many authors use the notion of social capital together with social networks, but since there exist various definitions and usages of social capital (Portes 1998), I have in my analyses quite consistently referred to the more unambiguous analytical categories of actors/nodes, ties/links and network positions to explain social mechanisms.
Social movement theory

Analyzing transformational processes towards ecosystem-based management in urban landscapes needs to acknowledge urban politics and urban planning. This thesis engaged this notion by using social movement theory in analyzing a local urban movement that played a key role in protecting and changing the governance structure of a large green area in Stockholm (Paper II, Paper III).

Social movement research is a field that *par excellence* has studied transformational change (della Porta and Diani 2006). Within this field urban movements have been viewed as a social mechanism that can transform urban politics (Pruijt 2006 with reference to Castells 1972/1977). Tied together through informal social networks, civil-society organizations opposing dominating city-politics have played crucial roles before in pointing out injustices, lifting non-forgotten issues, and placing novel ones on the city-agenda (Ballard et al. 2006, della Porta and Diani 2006). Through engaging in what Manuel Castells (1983) referred to as struggles over collective consumption – which could be any urban service from access to medical care, schools, or green areas – “social movements […] have contributed to major shifts in the goals and values of societies” and through this shaped policy and public perception of reality (Melucci 1995, Boström 2004).

Three central aspects of social movements have been identified: the structure of opportunities, mobilization processes, and cultural framing processes (Ballard et al. 2006: 3). Structuralist and institutionalist discussions of political opportunity structures seek to understand the context within which mobilisation is more or less likely (Tarrow 1994, McAdam et al. 1996). Resource mobilization theory focuses on social movement organizations and the (often formal) resources such as money and labour that these aggregate to carry out strategies (McCarthy and Zald 1977, Diani 2003: 304). Mobilization processes have investigated how new members are attracted, often using social network analysis (della Porta and Diani 2006: 117). Cultural theory focuses on collective identity and framing processes (Eyerman and Jamison 1991, Melucci 1995) in which social movements are viewed as occupying “cultural roles” in society as they “interpret tensions in contemporary societies, demonstrate inequalities, and suggest alternatives to existing conditions” (Boström 2004 with references to (Eyerman and Jamison 1991, Melucci 1995). Through novel framing of reality they can be seen as knowledge producers while they “open up new conceptual spaces and in this way contribute to social change” (Boström 2004), while in parallel it helps them mobilizing new members (della Porta and Diani 2006:127).

Given the above, social movement theory served as a guide to analyze transformational processes, especially through an analysis of the movement’s social network (Paper II) and how it framed the values of the National Urban Park (Paper III).
Framing, value creation processes, and actor-networks

Framing processes were in this thesis analyzed through the practices by which movement actors created values around green areas. Historical research holds that in order for something to be seen as having a value, there needs to be actors that can explain that it has a value (Sörlin 1998). This is often carried out through the use of artefacts produced by other actors, for example artist’s paintings or scientific reports. A scientific report of red-listed species can be an asset for environmentalists, but an obstacle for developers. With inspiration from actor-network theory (ANT; Callon and Latour 1981, Callon 1986, Castree and MacMillan 2001, Latour 2005) processes that “create value” can be seen as a political programme that gains power as actors “pick up” artefacts produced by other actors and fit them with the programme to give it “weight” (cf. Forsemalm 2007). This produces what can be referred to as actor-networks, viewed as assemblages of humans and non-humans that should not be seen as a structure of relationships (as in social network analysis), but rather as a set of transformations or associations (Latour 2005). Callon (1986) refers to a “sociology of translation”, which I interpret as an urge to recognize in analysis that humans are dependent on non-humans to translate different meanings, ideas and values, and that these non-humans (e.g. a construction plan for a building) can come to change social processes “on its own”. Although such actor-networks do not possess power in any formal sense, they can (if successful) make a change, i.e. gain power, both as a “community of practice” wielding power and knowledge (Fox 2000, Wenger 1998, Foucault 1980), and through the framings, narratives and visions emanating from them which could mobilize yet more actors and artefacts into action (Callon 1986, Forsemalm 2007). In social movement theory, Snow and Benford (1988) have referred to this as “frame resonance”, but without acknowledging the ANT-“twist” that artefacts, such as maps of species dispersal corridors, can become “immutable mobiles” (Latour 1987) as they are reproduced by journalists and other actors on various social arenas, to expand the actor-network and gain (if successful) more supporters.

1 Also non-humans could consequently be regarded as actors, as they change things and “act”. This has made scholars of ANT to use the word “actant” and “actant-network” instead to avoid the humanistic connotations of actor. However, in this thesis, actors are human actors. Although some scholars of ANT (including Bruno Latour himself) would disagree with my usage of actor, it relates better with social network analysis. Critics of ANT, see for example Vandenberghe (2002), would probably be sympathetic to my usage as it reinstates a more stratified view of social reality, than what is usually acknowledged in the “flat ontology” of ANT. As developed a bit further in the Discussion section, but at length elsewhere (Ernstson et al. forthcoming), I believe there is a chance to merge structural social network analysis with “ANT-inspired” thinking, i.e. to recognizes that also non-humans participate in creating what we often refer to as the ‘social’ (Latour 2005).
Method and study area

Stockholm and the National Urban Park

The Stockholm metropolitan area (Figure 2) is situated at the boundary between the northern hemisphere boreal zone and the mid-European nemoral zone, and at the outlet of the freshwater lake Mälaren into the brackish Baltic Sea. The physical landscape is to a large extent shaped by the last glacial period 10,000 years ago and consists of fissured bedrock and clay covered valleys. The resulting small scale rough terrain and the climatic conditions convey a relatively high biodiversity (CAB 2007). An isostatic rebound from the latest glacial period has constantly increased the land available for human use (Bratt 1998). As a consequence, most of the ecosystems in Stockholm are remnants from cultural usage and shaped by humans over the millennia. Ecosystem services generated today have emerged from this long-term cultural-ecological interaction (Barthel et al. 2005). Stockholm, founded as early as mid 1200s has a long history of more or less planned urbanization with early land use plans.

Stockholm is the capital of Sweden and the county hosts a current population of 1.9 million people, with 0.8 million in the most central areas (SCB 2007). It is the country’s most densely populated region with 2500 inhabitants/km² (SCB 2002), and current green area management and planning is challenged by rapid population growth, estimated at approximately 20,000 new inhabitants per year (RTK 2001). The struggle over different land use and consequently the generation and distribution of urban ecosystem services will be a growing issue.

The National Urban Park is a 27 km² mixed woodland area close to the city centre of Stockholm (Figure 2). Barthel et al. (2005) showed that the area’s high biodiversity and its capacity to generate ecosystem services is tightly linked to the long-term use of the park by various user groups such as allotment gardens and by royal management stretching back hundreds of years. The park is also an important node in the city’s ecological network (Löfvenhaft 2002, Elmqvist et al. 2004, Mörtberg and Ihse 2006). However, the proximity to Sweden’s political, administrative and business centre have resulted in a huge exploitation pressure from municipalities, state and building companies that has accelerated since the 1950’s. Although voices for protection had been heard earlier, it was not until 1990, as a reaction to a new set of heavy exploitations plans, that the Ecopark movement emerged, originally forming part of a city-wide protest cycle opposing new motorways and other planned exploitation (Stahre 2004, Ernstson and Sörlin 2009, details in Ernstson 2007).
Figure 2. The map shows Stockholm metropolitan area lying in the south east part of Sweden (59°20’N, 18°05’E). Marked in the figure is also the Stockholm National Urban Park (Swedish: Nationalstadsparken), which is situated close to the city center. It stretches mainly into Stockholm and Solna municipalities, with a small part into Lidingö.

Case study approach

This thesis has used a case study approach (especially Paper II, Paper III and Paper IV). Instead of seeking cases in which some variables can be said to be constant and a single one varied, a case-study can have hundreds of variables (Yin 1994), and the task is to select a case study that can be considered “purposeful” for communicating and challenging already established theories (ibid.), and consequently not for generalizing to other cases. This type of research stress the dialectical relationship between theory and empirical data, and the iterative process of how interpretations emerge as the researcher moves back and forth between the field and the theories (Bryman 2002: 254).

The case of the National Urban Park is valuable for various reasons: A large-scale structural change occurred as the green area became protected,
which opens for discussing transformational processes in social-ecological systems. Furthermore, the movement has been heavily engaged in land use struggles and urban planning; and furthermore, the collective action rested upon informal social networks between a diverse set of civil-society organizations representing various interests, which opens towards discussing collaborative management more general, and in urban landscapes more specifically.

In total I worked with the case for three years (2003-2006), with various intensity. I made a concentrated pre-study to aid the design of the questionnaire for the social network study (Paper II), in formulating general research questions (cf. Bryman 2002: 252, Kvale 1997), and in writing the context and history of the Ecopark movement. The social network was generated through a questionnaire sent out to sixty official leaders of movement organisations. Through a recall list (Marsden 1990) respondents marked organisations they interacted with and their answers were combined into a social network consisting of those organizations perceived as active in the protection of the National Urban Park by at least two others. Among other attributes, the user intensity of the park was measured for each organization, along with the number of political contacts to authorities (further details in Paper II, Paper III).

Through working with the social network analysis, insights were gained into how movement members framed the park and articulated its values, which were presented in Paper III. Interview theme-sheets were prepared as described in Bryman (2001) with questions concerning the emergence of the movement, how activists had acted to protect the park, what resources they used, and the values they perceived the park had. Interviewees were selected based on a list of most-cited activists generated from the social network survey above, which had asked all respondents to name those persons they felt most engaged in protecting the park. This consequently made sure that the interviewees were considered important in protecting the park by the field itself, and thus supposedly heavily involved in the articulation process of its values. Interviews followed an un-structured fashion in which interviewees were allowed to develop their answers (Bryman 2002: 301). Most interviews were recorded and transcribed (see Paper III). I also visited highly profiled events organized by movement organizations or by authorities. These were visited since they represented important arenas for movement organizations and activists to articulate the values of the park (Paper II). With inspiration from actor-network-theory, I went back to some of the data and identified artefacts used by activists for articulating values. Although many field documents had been read before, it was with this insight that more documents were collected and analyzed in order to deepen the understanding on how artefacts were put into use to articulate values. Newspaper articles were searched in which activists had been interviewed, along with letters that had been sent to authorities. Also organizational homepages and books published
by movement organizations, activists, or by people standing close to the movement were analyzed, along with documents from authorities. Through these qualitative data, along with interview data, the interpretation of how values and which values were articulated could be iterated.

The network analysis, although being more linear since it relies heavily on a questionnaire that was sent out once, also had its iterative steps. Especially the construction of the attributes of political contacts and user intensity was developed after having gotten to “know” the data set better (cf. Bryman 2002).

Paper IV is based on a synthesis of seven individual case studies (including studies carried out by my colleagues), from the urban landscape of Stockholm and published in separate papers (see Paper IV). The individual studies focused on different aspects of ecosystem management in Stockholm and generated both social and ecological data in order to capture the dynamics of social-ecological processes. Ecological data focused on functional groups of ecosystems (especially pollinators, seed dispersers, and insectivores) and were generated through field surveys of birds and bumblebees, complemented with ecological landscape analysis based on land cover structure from satellite images. Social data were generated through engaging with different actors at different scales using different methodological tools such as text analyses, questionnaires and interviews. Actors included were regional and municipal agencies, cemetery and park managers employed by the public or private sector, and civil society groups such as allotment gardens, outdoor life associations, boating clubs and cultural-history and nature conservation groups.

In the Appendix of this thesis, complementary data not found in the individual papers are given for the case study of the Ecopark movement.

Summary of Papers

Paper I

Paper I was written to clarify how social network structure enters as a variable to effect various features such as learning, leadership, and trust, which have been identified as important in adaptive collaborative ecosystem management. While others have suggested that the ability to cope with change will increase through a dynamic balance between bridging/weak and bonding/strong links (i.e. links stretching outside the community are needed to access diverse resources and internal links are needed to absorb these benefits (Granovetter 1973, Newman and Dale 2005)), this paper focuses on the structure within the ’community’ or collaborative network. Several network measures are presented and it is shown that there might be inherent
juxtapositions among these measures. A high degree centrality (the tendency in a network for a few actors to have many links, e.g. wheel-star structures) could facilitate coordination in times of rapid change, but could also in the longer-term undermine social learning because it reduces the access of individual actors to multiple sources of information (Leavitt 1951, Weimann 1982, Abrahamson and Rosenkopf 1997). High density (that most actors are directly linked to each other) might strengthen trust to reduce transaction cost for collaboration and promote mutual norms (and compliance) in relation to resource use and extraction (Granovetter 1985, Ostrom 1990, Pretty and Ward 2001). However, high density might also result in homogenization of experiences which undermines social learning and innovation (Oh et al. 2004, Crona and Bodin 2006). Furthermore, while studies based on ethnographic methods often result in the characterization of different ‘social roles’ in collaborative management (Folke et al. 2003), network analysis seeks to explain social roles based on network position (Borgatti and Foster 2003). One of the most important position is held by brokers that have many exclusive links to groups that would otherwise not be in contact (Burt 2003, 2005). Merely by its position in-between many others, the broker gains access to group-specific information and an advantage in knowing which groups or individuals to connect (or not to connect), how to connect them and when. As is pursued further in Paper II and Paper IV, this enhances the broker’s ability to navigate a continuously changing social landscape and an increased ability to coordinate the actions of a network through finding new collaborative solutions for different and upcoming problems. The broker seems gifted with creativity, but also has a greater potential to influence the network, i.e. power.

Paper II

This paper analyzed the social network structure of the Ecopark movement that was found to consist of 62 civil-society organizations – from user groups such as boating clubs and allotment gardens, to culture and nature conservation groups – that all were engaged, to larger or smaller extent in protecting the Stockholm National Urban Park. The results revealed a core-periphery structure where six core and semi-core organizations had deliberately built political connections to authorities, whereas the periphery gathered all user groups involved in day-to-day activities in the park. On one hand it was shown how the structure facilitated social mechanisms underpinning protective capacity. Core and semi-core organizations had, facilitated by the many links between each other developed a set of methods to influence large-scale land exploitation plans. However, since they also had weaker links to user groups that were active in the landscape, also smaller-scale exploitations could be monitored and acted upon. This demonstrates the importance of network diversity for adaptive response and protective
capacity (cf. Cash et al. 2006). However, it also shows that diversity in itself is not enough, but that it is the structure of social networks (especially the upholding of cross-scale linkages) that bring out purposeful collective action. On the other hand, the study showed that the same social network structure could have constrained collaborative ecosystem management. Especially user groups with valuable local ecological knowledge had not been included in collaborative arenas, which exemplifies the inherent double-nature of social networks as they can facilitate certain collective actions, while constraining other (Diani 2003, cf. Giddens 1984).

Paper III

While Paper II is a study of an urban movement based upon resource mobilization and social network structure, Paper III analyzes framing processes as emergent actor-networks. The paper shows that activists, by interlacing artefacts and discourses from cultural history and conservation biology managed to link spatially separated green areas, while they simultaneously articulated the interrelatedness between the cultural and natural history of the area. This connective practice was effective in that it constructed holistic values of a unified park, a protective story, but also in that it stretched the identity of the movement to facilitate the mobilization of organizations active in different parts of the park. The framing, which rested on both existing and newly produced artefacts, heavily influenced the official framing of the park’s values and actually came to define and create the National Urban Park as it was inscribed in the statute book. There was consequently, in this transformational process, a tight linkage between the spatial emergence of the social network structure and the framing process (Ernstson and Sörlin in prep., Miller 2000). The paper also argues that in contrast to historically top-down led designation of natural reserves, the involvement of civil society in protecting nature (and culture) is on the rise. This nonetheless begs the question concerning who can participate in these value creating processes, and if certain green areas have an advantage over others. Four structural factors seem to mould actor-networks constructing values for urban green areas: (i) the number and type of artefacts linked to an area; (ii) the capabilities and numbers of actors involved; (iii) their access to social arenas; and (iv) the social network position of actors.

Paper IV

This article advances the theoretical insights from Paper I to present a framework that combines a structural social network perspective with that of ecological scales. Of concern is how knowledgeable actor groups that interact with green areas at different spatial scales in Stockholm can be linked through social networks so as to overcome scale mismatches between man-
agement processes and ecological dynamics. Based on the framework and empirical data, an alternative management system is suggested for Stockholm organized around three ecological scales (local green areas, city-green networks and the regional green infrastructure). New actors are proposed for the management of the unattended mid-scale, along with scale-crossing brokers. One contribution of this study lies in theorizing how a social network structure would look like that increases the sensitivity of city governance to ecosystem dynamics. A strategy based on purposeful networking to accomplish this is spelled out, along with the recommendation to acknowledge that green areas are not only ecological entities, or green space, but also important physical sites of social-ecological interaction that nurture the generation of ecological knowledge.

Paper V

Building on the previous papers, Paper V explores the presumption that social-ecological systems both generate and distribute ecosystem services. The aim was to articulate, by setting social theory in communication with especially landscape ecology, a framework for analyzing both the functional and critical perspective of urban social-ecological systems. My first notion of the framework originated out of the case study of the National Urban Park. While the analysis of the Ecopark movement could explain the high protective capacity for this particular green area, I lacked a framework to analyze the effects of this protection on a larger landscape and city-wide scale. One hypothesis was that the movement, through developing new conceptual tools by which the values of green areas could be articulated, might have helped accomplished a paradigm shift in urban planning and increased the general value of green areas in relation to other land use interests. However, a parallel hypothesis was that other neighbourhoods were losing “their” green areas as a result of the strong protective capacity of the National Urban Park; exploitation pressure will seek out green areas for which a strong enough voice for resistance does not exist, or can not be created. Further, such an effect could relate to the city’s ecological resilience (Alberti and Marzluff 2004, Andersson 2006, Colding 2006, Colding et al. 2006), while if lost green areas are crucial in city-spanning ecological networks, the overall capacity in maintaining functioning ecosystems might decrease drastically (cf. Andersson and Bodin, accepted). The generation and distribution of urban ecosystem services seem to be linked in complex ways, and with this in mind I set out to write Paper V. The ideas that emerged are followed up in the discussion section below.
Discussion

I had three overarching objectives with my thesis.

I Develop ideas and frameworks on how to analyze social-ecological systems from a functional management perspective and a social equity perspective.

II Contribute to the understanding of transformational processes towards ecosystem-based management.

III Contribute to urban theory and policy regarding the generation and distribution of urban ecosystem services.

These objectives will be discussed here to draw out some of the wider implications for research and policy that the thesis has established.

Social network structure and natural resource management

Analyzing social network structures can give both a functional and critical perspective on natural resource management. Social networks are seen as a prerequisite for collaborative management (Carpenter et al. 2001, Olsson et al. 2004a). However, my case study of the Stockholm National Urban Park demonstrates that although a social network existed, connecting stakeholders, user groups and authorities, it was not obvious if and how this entailed an advantage. Instead the analysis pointed to the inherent double-nature of social networks and the importance of analyzing social network structure (Diani 2003).

The same structure that helped protect the park and sustain ecosystem functioning, could simultaneously have constrained collaborative ecosystem management (Paper II). User groups with ecological knowledge were marginalized on collaborative arenas partly due to their peripheral structural position in the movement’s social network that constrained participation directly, but also in more subtle forms when the values of the park was articulated; user values was deemed less important than values held by more central organizations focusing on cultural-history and biodiversity conservation (Paper II).

The structure of social networks also relates to studies of adaptive capacity. In their review of research on adaptive governance, Folke et al. (2005) identified social memory – defined as the arena to capture experience of ecosystem change actualized through community debate and decision-making – as a source of resilience that “key persons” can use to guide and frame collective action in times of crisis and re-organization (cf. Barthel et al. in prep.). A more critical stance would wonder how this social memory gets constituted, who constructs it, and who uses it (Halbwachs 1952/1992). As was shown in Paper II and Paper III, core and semi-core actors in the...
Ecopark movement – sometimes in alliance with authorities – have been central in decision-making and in constructing the identity of the park, which hinges more on conservation biology and cultural history, than on active use by allotment gardens and others. This indicates that social memory is contested and should be treated as an outcome of power relations. Consequently, if it is in time of crisis that social memory gets activated to frame activity, this turns the whole issue of adaptive capacity into a political issue where certain actors could shape the unfolding collective action possibly towards benefitting them more than others (Halbwachs 1952/1992, Melucci 1996, Boström 2004). From a functional perspective, the domination of some actors – state agencies and/or civil-society organizations – can come to work as a conservative force through locking certain landscapes into a certain identity that could hinder experimentation and decrease adaptive capacity (Gunderson and Holling 2002).

Studies of adaptive co-management and governance of ecosystems (Gunderson and Holling 2002, Berkes et al. 2003, Folke et al. 2005) have hitherto been less applied in urban landscapes. There is consequently less said about how to take into account the great heterogeneity and the spatial patterns of urban green areas, which to large extent conditions urban ecosystem functioning (Alberti 2005, but see Colding 2007). From Paper IV it was learnt that this requires a more spatially explicit analysis of management and governance systems than what current theory has proposed (e.g. polycentric structures, collaborative or adaptive governance, learning networks as in: Ostrom 1998, Folke et al. 2005, Manring 2007, Pahl-Wostl et al. 2007). Paper IV showed that by combining the analytical perspective of social network structure with empirical analyses of ecological scales, scale mismatches between ecological processes and the scales of management can better be analyzed as attention is directed towards actor groups in the landscape, how they are linked to each other, and if there are actor groups on all relevant ecological scales. Such analysis also helps to uncover strategies for how to build purposeful social networks for ecosystem management. One suggestion from Paper IV, which extends ideas regarding “bridging organizations” (Hahn et al. 2006, Olsson et al. 2007) and “net brokers” (Manring 2007), was the position of a scale-crossing broker, which could be filled by actors focusing on nurturing links between actor groups across ecological scales, either through meeting with them directly, initiating collaborative management arenas or meeting forums as “connection arenas” to generate weak links between actor groups. Such actors should operate as agents to sustain a conducive network structure to better handle slow, rapid and unexpected changes.
Studying transformational processes

Building on my thesis, a model for transformational processes in social-ecological systems can be constructed that aims to merge value creation processes (based on actor-networks) and social network analysis (Ernstson and Sörlin in prep., see also footnote 1). The idea draws upon framing and resource mobilization theory from social movement research, but greater attention towards ecological and social-ecological complexity needs to be maintained.

First, by using the approach of value creation and actor-networks, a deeper analysis of transition dynamics and collective action can be reached. Especially the analytical categories of leaders, key stewards, and visions, which are often used in explaining social dynamics, can be taken further (Folke et al. 2003, Olsson et al. 2004b, Olsson et al. 2008). Both actors and artefacts are important. It is the continuous assembling of humans and non-humans into actor-networks that give shape to values and visions, which in turn could change what has been referred to as stakeholder’s “mental models” (Walker et al. 2002). As stressed in social movement theory (Boström 2004), informal networks are self-organized and collective action is not controlled by a single leader or key steward, but narratives that explain “the right course of action” emerges out of the interaction between humans and non-humans as Paper III showed. Through tracing the actors in their course of action (Latour, 2005), important social arenas can be encountered on which these values and narratives are articulated. As argued by Latour (2005), political programmes gain power as they are set in a constant state of “becoming” on various social arenas, for instance in a debate forum directing a large audience, in a newspaper, in a scientific meeting, an exhibition, or a lecture room. Guided by these remarks one could start asking: What is the nature of artefacts that seem to facilitate transitions towards ecosystem based management? Who produces these and who can use them? How do such actor-networks sustain narratives that can translate the complexity of ecosystems and foster preparedness towards unpredicted changes?

Second, and building on my findings from structural social network analyses, an emergent hypothesis is that actors with great network centrality have an increased potential to be active in assembling actor-networks (Paper III, Ernstson and Sörlin in prep.). Especially brokers that sit on network paths between many actors (Burt 2003, 2005) have a greater potential to navigate a continuously changing social landscape and coordinate the actions of a network. Reminiscent of Callon’s (1986) “obligatory passage points”, their network position could render them greater abilities to dominate processes of finding, picking-up and translating artefacts to assemble actor-networks that build certain visions and values (and not other)(see also (Fox 2000). This relates to research made around bridging organizations and net brokers (Hahn et al. 2006, Manring 2007, Olsson et al. 2007).
The above underlines one general finding from my studies: natural resource management is not just about knowledge, but also about values (Paper II, Paper III, Paper V). Both transformational processes and collaborative arenas should be analyzed not just for their ability to synthesize knowledge about ecosystems, but also as processes and arenas that construct values influencing land use and management prioritizations. Through this, two fallacies of contemporary thinking on natural resource management can be addressed: first an objectivist stance that ecosystem services exist “out there” in the landscape (independent of humans and social articulation); and secondly that the process of “finding the right trade off” between different ecosystem services is often simplified into a consensual process or as a rational choice game between actors with fixed interests that can be steered/guided by economic incentives (Folke et al. 2005, Ostrom 2005, Goldman et al. 2007). These fallacies are serious since the analyses that follow from them will miss the processual and relational dynamics captured in actor-networks and also the value formation as a social process involving social groups, knowledge, and power. Closely associated with this, models of adaptive management and governance of ecosystems can also be interrogated (Gunderson 1999, Folke et al. 2005). In these models, knowledge about specific ecosystems, as held by different actors and users, are predominantly seen as merely useful, or “functional”, for building more complete understanding of ecosystem dynamics. This tends to neglect the situatedness of knowledge as a product of social class and cultural processes (Berger and Luckmann 1966, Bourdieu 1984, Shapin 1995: pp. 303). A richer understanding could be achieved through Foucault’s conception of knowledge as indiscernible from power (expressed as ‘power/knowledge’), along with his concern of ‘concrete practice’ (what actors do) (Law 1986). Both these can adequately be explored through an actor-network perspective to better (Foucault 1980, Fox 2000, Adger et al. 2005) and open analytical pathways to better come to grips with how different stakeholders can bias management towards certain ecosystem services (instead of other) as I have tried to do (Ernstson et al. 2008, Ernstson and Sörlin 2009).

Towards new urban theory

Social-ecological system analysis stresses that systems should be characterized by their feedbacks, i.e. their reinforcing mechanisms that tie the social and ecological system together in patterns of co-evolution (Berkes and Folke 1998, Gunderson and Holling 2002). From this horizon, and as established in the Introduction, urban systems are different from non-urban systems in that their direct dependence on tangible products from local ecosystems are weaker, that the range of choices of how to use land is greater (producing heterogeneity), and that the spatial patterns of localized urban ecosys-
tems (green and blue areas) are moderated through intense political land use struggles.

As the concept of ecosystem services is moved to the urban landscape, it becomes inscribed in intense political land use struggles. Green areas, vacant lots, and brown-fields, all can be turned to different land use, from housing, offices, motorways or through replantation to urban parks, which will affect the overall generation of ecosystem services (Alberti 2005, Colding 2007), as well as their distribution at different scales (Heynen 2003, Paper V). Ecosystem services is therefore tightly linked to capital investment, either through private or public capital, or through the “investment” by civil society in engaging time, effort and skills in managing and protecting urban green and blue areas. The above comprises the foundation upon which we can talk about a “social production of ecosystem services” as argued for in Paper V, since the human choices (and all the social, cultural, technical and political processes that impinge on these) will moderate both the generation and distribution of urban ecosystem services.

In Paper V, and building on the other papers, a framework for analyzing the social production of urban ecosystem services was proposed based on two interlinked modes of analysis: spatial social-ecological networks, and value-creation processes around ecosystem services. The first mode is based upon a spatial social-ecological network in which each node in the network – a green or blue area – have different levels of management or protective capacity, i.e. the level of resistance to disappear or ecologically degrade (through exploitation), and the level of capacity to sustain landscape ecological flows (through management practices), respectively. Ecological dynamics are accounted for through an ecological network approach where green areas are seen as connected through functional ecological links representing species movement or other vital ecological flows as developed by others (Bodin et al. 2006b, Bodin and Norberg 2007, Andersson and Bodin accepted, Zetterberg et al. in prep.). The second mode of analysis examines the decisions regarding trade-offs between ecosystem services as a value creation process. Different actors, with different and unequal abilities and resources, are seen as participating in creating values around different and sometimes opposing ecosystem services (cf. Wilson and Howarth 2002). By interlinking the second mode of analysis with the first mode, effects at the local scale (for instance that a green area gets built upon) can be translated to systemic effects at the city-wide scale. The changes in the social-ecological network, through the different levels of management and protective capacities, becomes a way to understand the effect of how socio-political processes moderate biophysical processes at different scales, which parallels how cities are conceptualized by critical geography and urban political ecology (Harvey 1996, Swyngedouw 1997, Heynen et al. 2006). Civil society groups, say an allotment garden or organizations resisting exploitation, enter as agents that could change the different levels of protective and management capacity, eit-
Global scale

Biophysical social economic drivers

Metabolism

Global scale

Governance

Urban services
(ecological and material infrastructure)

Urban institutions
(knowledge, practice and power)

Local scale

Figure 3. A suggestion for an overall framework for the study of urban systems. Local institutions and governance moderate global drivers to generate and (unevenly) distribute urban services, which includes transport services, electricity, medical care, broadband, and urban ecosystem services.

her directly through their own practices, or through interfering with urban planning processes (Paper II, Paper III, Paper IV).

When the critical dimension of social-ecological systems is stressed, current usage and definitions of resilience in natural resource management can be questioned and extended (Holling 1973, Berkes et al. 2003, Carpenter and Folke 2006). Resilience is thought of, as described by Berkes et al. (2003: 13), as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain essentially the same function, structure, identity and feedbacks. This could be translated to the normative goal that resilience is the capacity to maintain the generation of ecosystem services. However, these definitions could implicate that resilience is maintained through a very unjust social system, i.e. in which the distribution of ecosystem services falls unevenly among the population. In regard, I extend the definition to offer a more critically formulated definition of resilience:

Resilience is the capacity of a social-ecological system to sustain a certain set of ecosystem services, in face of uncertainty and change, for a certain set of humans.

Applying this definition to practical research begs the researcher to analyze not just how ecosystems are managed (as in most natural resource management literature), but also which ecosystem services that are prioritized (as in recent literature on trade offs (Daily and Matson 2008)) — but, and on top of that, who benefit from these services. This opens the social-ecological system and the concept of ecosystem services for political and critical analy-
sis, without loosing the analysis of how to manage and interact with complex ecosystems in uncertainty and change. This definition is useful for analyzing the question of “resilience for whom and for what” (Armitage and Johnson 2006 and references therein).

Finally, if urban ecosystem services are viewed as socially produced, an important and far-reaching possibility opens to integrate urban ecology in the wider field of urban theory and critical geography. As depicted in Figure 3, ecosystem services could be treated as part of a broader category of urban services that also includes services like transport, fresh water, electricity, broadband, medical care and education. All urban services require space in the city so the generation and (uneven) distribution of them can be linked to analyses of the institutions guiding land use and urban decision-making, including social movements and policy processes striving to effect these (Paper II, Paper III). With such a model of the urban landscape, political and normative goals for urban governance can be formulated as visions towards sustaining a good living environment for all citizens and increase the adaptive capacity of the city to sustain these services in face of change and uncertainty. This model of the city, could furthermore help to politicize urban ecosystem services as part of a whole bundle of urban services and help link diverse struggles for social justice (Castells 1983, Harvey 1996). This would probably also challenge – and hopefully renew – current collective identities within the environmental movement more based on habitat and biodiversity conservation.

Conclusion

In this thesis I have analyzed social-ecological systems and what underpins the generation of ecosystem services, seen as the benefits humans derive from ecological processes, but also who in society that can benefit from them, i.e. the distribution of ecosystem services. My particular focus has been on urban landscapes with the empirical base from a case study of a local urban movement that protected a large green space in Stockholm. My writings aimed at opening the discourse of resilience and natural resource management towards social sciences, on one hand towards sociology to uncover important social mechanisms behind collective action for transformation and ecosystem management, and on the other, towards critical geography and urban political ecology to engage with issues of social equity and power.

Important challenges for future research have emerged from my work. One is to more explicitly engage with critical-equity perspectives and issues of power. One the one hand it is important to find models and frameworks that makes it possible to analyze and increase understanding of the dynamics of both the distribution and generation of ecosystem services (Paper V).
Here, the structure of social networks enters as an interesting approach (Paper I, II and IV): What types of structures exist in empirical settings? What is a good structure to facilitate ecosystem-based management? How do network structures change over time? One the other hand, and as similarly argued by Adger et al. (2005), it is important to analyze more critically the concept of adaptive capacity, social memory and knowledge in relation to ecosystem management (Paper II). If issues of power and social equity is left outside analysis, then, in times of crises (which seems to increase in a world of climatic and environmental change), patterns of injustice could come to be sustained or even strengthened as those with economic, social and cultural resources would impose their framing of what is the “best” course of action to re-organize and secure future resilience (Paper III, V). How do we make the discourses of resilience and ecosystem services more sensitive (and therefore also us researchers more observant) to the voice of the now disempowered and disadvantaged? Could these discourses even be made to work in their favour? Or should other discourses be employed instead?

Another set of future challenges emerge in relation to studies of transformational change in social-ecological systems, or transitions towards ecosystem-based management (Olsson et al. 2004b, Olsson et al. 2006, Olsson et al. 2008). Especially the analytical categories of leaders, key stewards, and visions can be understood better by also searching for the artefacts and social arenas that underpin this type of collective action (Paper III). Actor-network theory here presents a compelling framework which could be linked to social network analysis to also pose questions regarding who can participate in these processes and whose values are represented (Ernstson and Sörlin in prep.). This could enrich our understanding of these important transition processes.

When it comes to policy and urban planning, the most general implications that one could draw from this thesis is that in a world of rapid urbanization, urban green areas should be appreciated not only as ecological entities part of larger green structures that generate and distribute ecosystem services (Alberti 2005), but also as physical sites of social-ecological interaction (Paper IV and references therein). The latter acknowledges that green areas are sites that mutually nurture urban ecological knowledge (Paper IV) and collective action to articulate values of urban green areas (Paper II, Paper III). Following from this, and in order to secure the generation of ecosystem services, one is dependent not only on ecosystem knowledge held by different actors in the landscape, but also – and in order to cope with slow, rapid and uncertain change – on the structure of the social networks that link different actor groups across the landscape (Paper I, Paper IV). For policy this would mean to (i) devote attention to find suitable ecological scales for management, which in Stockholm were proposed to be local green areas, city-green networks, and the regional green infrastructure (ibid.); (ii) invest in identifying existing management capacities in the urban landscape (e.g. allotment
gardens and cemetery managers); and (iii) develop networking strategies to facilitate the emergence of scale-crossing brokers that can link between actor groups and facilitate social learning around urban ecological processes on which ecosystem management can be based. Such a management network would, in spite that cities are generally less directly dependent on their local ecosystems (see above), increase the sensitivity and responsiveness towards urban ecosystem dynamics and their inherent complexity (Paper IV).

In face of other land use interests, it will become increasingly important to argue for investments in urban ecosystems and protect urban green areas. This thesis has uncovered a connective practice of value creation of green areas built upon active citizens and useful artefacts such as historical maps and biodiversity dispersal corridors. New type of artefacts are probably needed, developed by state agencies and/or by social movements, to explain urban ecosystem services and where in the urban landscape they are generated and distributed.

The critical resilience definition above, combined with the framework for analyzing generation and distribution of ecosystem services at different scales, is designed to invite for systemic critique of current social order, while maintaining ecological sensitivity (Paper V). Hopefully it can also aid in working out material political practices towards democratizing urban change and increase social justice.
Afterword [In Rhizonia]

For a long time I have been living with the word “rhizomia” derived from “rhizome”, which is the horizontally growing underground stem of a ginger, potato and other plants that sends out shoots and roots from its nodes. The connection points are where things happen; if you cut it in half, shoots and roots can still grow from remaining connection points; a quite resilient life-form. As a metaphor rhizome has been used in contemporary philosophy, especially by Gilles Deleuze and Félix Guatarri (1987). But, and in closer connection to my text, the word as also been used by Bruno Latour. In recalling the development and use of actor-network theory (ANT), Latour (1999) refers to Mike Lynch that once said that “ANT should really be called ‘actant-rhizome ontology’” since it better describes what ANT does (and tries to do) both with me as a researcher and what I am researching. Latour explains:

It was never a theory of what the social is made of [, or] one more school trying to explain the behaviour of social actors […] it always was, and this from its inception (Callon and Latour 1981), a very crude method to learn from the actors without imposing on them an a priori definition of their world-building capacities.

I have not been faithful to ANT, but have “applied” traditional scientific concepts like “context” and “scales” over the worlds of the actors (both humans and non-humans) to explain – as best as I can to other researchers – the behaviour of social actors and social-ecological systems. But, I have been inspired by ANT and especially its motto to “follow the actor” and search for all the actors – the human and non-human actants – that are assembled to translate complex social-ecological processes into ideas, values and visions that can open up the minds of others to join in the translation process and change the world and its development. ANT expanded my awareness as a researcher, and as a citizen, to also strive to take in social actors (the activist, the scientist or somebody else), and their artefacts (maps, reports etc.) [which in turn are products from the interaction between social actors, plants, animals, measuring technology, or the brush of an artist] together with the social arenas on which these translations, ideas, values and visions can be expressed, articulated, ‘performed’ and kept alive. When I started to recognize this whole dynamic heterogeneous network (or rhizome) of humans and non-humans, my awareness of the world, and how it works had been changed. Bit for bit, I was, I might say, entering rhizomia.
Sammanfattning på svenska

Det övergripande temat för denna doktorsavhandling är generering och distribuering av ekosystemtjänster, vilket har analyseras genom social nätverksanalys och social rörelseteori. Ekologiska processer skapar nytta för människor genom mat, rent vatten och förbättrad luftkvalitet. Dessa så kalla de ekosystemtjänster beror på komplexa interaktioner mellan arter och materia. Studier inom naturressursförvaltning har företrädesvis använt sig av ett funktionellt förvaltningsperspektiv för att undersöka hur människan bör interagera med ekosystem så att ekosystemtjänster kan upprätthållas trots förändringar och stora osäkerheter. Färre studier har utförts från ett kritiskt perspektiv där frågorna istället blir vem i samhället som drar nytta av dessa ekosystemtjänster, och hur makt- och rättviseaspekter påverkar en effektiv ekosystemförvaltning. Denna avhandling har arbetat utifrån föreställningen att båda perspektiv är nödvändiga för att förbjuda vår förståelse av länkade social-ekologiska system, speciellt för urbana landskap.

tiv med empiriskt belagda ekologiska skalar (t.ex. det område över vilken en humla rör sig), föreslås en nätverksstrategi för hur förvaltningen av Stockholms ekosystem kan förbättras. Bland annat diskuteras en så kallad scale-crossing broker, en skalöverskridande medlare som ska föra samman aktörsgrupper från olika skalar (t.ex. kolonilottsföreningar, park- och kyrkogårdsskötare på en lokal skala, med stadsplanerare på en högre). Den skalöverskridande medlaren kan liknas vid en nätverksagent som strävar efter att upprätthålla ett socialt nätverk som underlättar för socialt lärande och ökar förvaltningens anpassningsförmåga till överraskningar och ständiga förändringar i ekosystem och det urbana landskapet. Baserat på erfarenheterna från de andra artiklarna, presenterar artikel fem (Paper V) ett ramverk för hur man rumsligt kan analysera genereringen och distribueringen av ekosystemtjänster i urbana landskap.

Denna avhandling argumenterar för en kompletterande syn på grönområden. De är inte bara komponenter i ett större ekologiskt nätverk som kan generera ekosystemtjänster, inte heller enbart ett socialt eller offentligt rum i staden. Utöver detta måste de också ses som fysiska platser för social-ekologisk interaktion som kan skapa och upprätthålla lokal ekologisk kunskap och arenor för värdeskapande processer kring urban natur. Dessutom utgör de platser för att manipulera och förbättra ekologiska processer i det urbana landskapet. Avhandlingen menar också att eftersom människan och samhället i så stor utsträckning villkorar både genereringen och distributionen av urbana ekosystemtjänster (genom urban planering, daglig skötsel etc.) så pekar avhandlingen mot en begreppsmässig förståelse av en "social produktion av ekosystemtjänster". Detta formuleras också som ett argument mot att fördjupa utbytet med urbanpolitisk ekologi och kritisk geografi, vilket påbörjats i denna avhandling.
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