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Coping and adaptation in socio-ecological problem structures

Towards an integrated framework for analyzing trans-boundary environmental problems in marine settings

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Abstract

The literature on governance of socio-ecological systems has been growing fast during the last one or two decades. However, sound theoretical underpinnings to these systems have not been sufficiently articulated and tied to existing theory, it is argued in this working paper. To address this shortcoming, this paper aims to elaborate on how the theoretical constructs *problem structure*, *collective choice theory* and *adaptive governance* can be brought together to form a coherent analytical framework for analyzing trans-boundary environmental problems in marine settings. The argument that collective action problematiques may inhibit successful adaptation to environmental change among sovereign states is fundamental to this model. Given that governments tend to prefer national coping strategies where expected national rather than joint benefits are maximized, mutually beneficial cooperation often does not evolve and regional adaptation turn out piecemeal. It is concluded that in order to improve trans-national environmental governance, a better understanding of underlying drivers and countries' incentives to take action is a necessary prerequisite.

Contents

Introduction

The challenge of how to conceptualize relations between theories on biophysical systems and social institutions continues. Despite numerous attempts, there is limited agreement among scholars on how to adequately address this issue (Cannon and Müller-Mahn 2010; Davidson 2010; Folke 2006; Arvai et al. 2006; Adger 2000). So far, there has been a tendency to frame the problem description either from biophysical (e.g. the Ecosystem Approach to Management (EAM), Planetary boundaries) or social science perspectives (e.g. Regime analysis, Earth system governance). One, if not necessarily the only, reason for this duality has been because these approaches emanate from quite separate research communities (Söderström et al. 2009; Jasanoff 2000). It could be argued that this separation often has led to conceptualizations that lean towards either one of these perspectives, without being able to simultaneously do justice to both (Folke et al. 2005). In the former case, most effort and expertise has been put into assessing the environmental problem in biophysical terms and less into how to address this problem from a societal point of view, while the latter has excelled in analyzing existing and potential institutions and institutional mechanism, while often only superficially addressing underlying biophysical aspects.[1] Natural science-oriented analyses have typically been able to describe and define the problem (e.g. anoxic conditions causing dead sea bottoms), the causes behind the problems (nutrient inflows) and possible solutions (reduce nutrient loads). However, knowing the problem and possible solutions does not always lead to adequate change (Rockström et al. 2009). Social science analyses, on the other hand, have led to numerous studies on how to improve governance or regime effectiveness by changing institutional structures (e.g. hard vs. soft regulation, improved monitoring, enforcement and conflict resolution mechanisms) (Stokke 2012; Young 2011; Andresen et al. 2000). Less attention has been paid to the classical tension between actor rationality and sub-optimality in collective outcomes

[1] The Epistemic communities approach is partly an exception, but has not resulted in much further refinements after Peter Haas' (1989; 1990) important work on how to apply this concept to the governing of the Mediterranean in the early 1990s. The Elinor Ostrom Common Property Resources (CPR) approach integrates natural resource features into consideration, but so far the CPR approach has mainly been used to analyze small scale resource use in developing countries (Ostrom 1990; Ostrom et al. 2002)

(the so-called Collective action problem; Tragedy of the commons, Prisoners' dilemma and Social traps).

Looking closer at the broad and heterogeneous writings on adaptive management that has flourished during the last two decades or so, it is clear that the need for adaptation – incremental adjustment, learning by doing and making use of various forms of context-dependent knowledge – stands in the forefront in much of the literature on management of natural resources. Assuming for the moment, as a simplification, that countries could be viewed as unitary actors, that is, as individual actors rather than collectives, adaptation is conceptually unproblematic in national resource management. When political bodies and administrations within this country cannot know how events will unfold, there are few alternatives but to adapt to changing circumstances as efficiently as possible. This is often a key message when science tries to speak truth to power.

However, an aspect of adaptation that often is not problematized is how this may change when countries face large-scale environmental challenges involving considerable degrees of uncertainty, and collective decision-making is therefore asked for. Such trans-national environmental disturbances often cut the direct link between ecosystem change and forthcoming adaptation. The major reason for this form of possible de-coupling is that uncertainties related to ecosystem change and how to adapt is only one side of the coin. The other, as important, side, concerns *who pays and who benefits*. It is argued in this paper that the complicated issue of collective action – under what circumstances a group of sovereign states can benefit from cooperation while avoiding free-rider temptations – has so far not been given sufficient attention. Without careful analysis of the actual incentives facing individual countries, it is unlikely that effective and efficient adaptation at the regional level will take place. The main objective of this paper is to elaborate an analytical framework where individual countries are assumed to maximize expected net gains while facing potential collective action dilemmas, whereas adaptation is seen as the outcome of the interaction among nations.

This framework is intentionally broad in scope to allow for different uses. In line with, for example, Regime analysis and to improve conceptual tractability, governments are seen as the primary actors. This means that various types of stakeholders such as sector organizations, NGOs and social movements analytically are seen as context to government decision-making rather than actors, that is, as conditions that governments may need to consider in making specific decisions. It should be noted that modelling

governments or states as unitary actors, although common in, for example, Regime analyses, Neorealism and Neoliberalism studies (Stokke 2012; Waltz 1979; Keohane 1984), is inherently problematic, since what we can observe as a governmental strategy is rather the outcome of competing factions and interests within states, than an intentional choice by any single actor. However, tracing foreign policy strategies all the way down to local or even individual levels is often not feasible or even worthwhile. If there are indications that sub-national actors have been pivotal in forming the government strategy analysed, this context needs to be taken into account. In other cases, it may be more fruitful to simplify and only focus on the interplay among governments.

The most important conceptual building block in the approach elaborated here is the distinction between country-level drivers (incentives) and regional outcomes. Whenever governments perceive national interests to diverge from what would be optimal from a collective, regional point of view, the former will tend to take precedence. The analysis is thus actor incentive-driven (Jones 2014). It is suggested that a fruitful distinction in the analysis of trans-national environmental disturbances could be made between *coping* and *adaptation*, where states try to cope with situations they face.[2] Adaptation to trans-boundary environmental disturbances, on the other hand, need to emerge at the regional level to be effective. Whenever national interests diverge from regional outcomes, tensions are likely to develop between governments on how to formulate joint strategies to protect the environment.

However, actor strategies are not detached from systemic outcomes. A feedback loop is assumed to exist, where impacts of particular outcomes can be assumed to feed into how future strategies of the actors are revised. Thus, an indirect mechanism for adaptation is assumed to exist.

Bringing collective action and adaptation together – Preparation

Genuine differences between ecological and social systems

In contrast with most of the literature on resilience and socio-ecological systems, an important point of departure in bringing collective action and

[2] It could be argued that coping and adaptation could take place also within states, but since this framework is referring to trans-national pollution, cooperation among states is typically necessary, which in turn makes the distinction between national interests and regional outcomes pivotal.

adaptation together is the observation that there are genuine differences between ecological and social systems, despite being intertwined in a multitude of ways.[3] The analogies between ecological and social systems in terms of e.g. ecological/social redundancy and species/social adaptation may seem appealing at a first glance, but if underlying drivers and mechanisms in these systems are fundamentally different, such analogies are not valid (Hornborg 2009). To elaborate, biophysical systems evolve over time due to internal mechanisms such as evolutionary selection and external pressures. Because of the complexities of these processes, human responses to system changes largely rely on adaptation, since robust and accurate predictions of outcomes are hard, if not impossible, to achieve. This does not make planning ahead less relevant – especially as there are signs that abrupt change may take place more frequently because of human interventions (Kelly et al. 2015), making adaptation less effective – but rather that management robustness is prioritized by, for example, elaborating scenarios, back-casting, transition management or other ways to broaden the scope of how to handle different possible outcomes. Moreover, because of the trans-boundary nature of the environmental problems placed in focus here, governments affecting the biophysical systems have to cooperate, or at least coordinate strategies in order make adaptation as adequate as possible.

In contrast with biophysical systems, social systems are inhabited by actors that intentionally attempt to change outcomes in preferred directions. In certain social systems such as (perfect) free markets, intentionality may be made more or less curbed, since these systems evolve according to structural selection pressures or the so-called "invisible hand".[4]

[3] The concept of adaptation has been more frequently used than that of coping in the literature on environmental governance and management. However, there is a slight, but important difference between these two concepts. While adaptation typically implies a long-lasting and dynamic change caused by external factors, coping means that change is driven by incentives that often are short-term and aimed at addressing immediate issues. The larger the difference in over-all cost is between coping and adaptation strategies, the more likely the former is. From an over-arching perspective, it could also be argued that the concept of adaptation often implies an objectivist assumption that it is driven either by systemic selection mechanisms - evolution, perfect markets - or by altruistic concerns for collective goods, that is, no free-riding. Coping strategies, on the other hand is subjectivist in the sense that actors are driven by the preference orderings that are subjective in nature and based on beliefs about the *state of the world*.

[4] Of course, the elimination of the relevance of intentionality in market systems is, to be strict, only valid in theoretical constructions of perfect market and given assumptions of rationality and maximization of expected profits. However, in this context it is sufficient to say that most observers agree that an impersonal selection mechanism exists in most

However, in the governance context of trans-boundary marine environmental problems, no comparable internal selection mechanism could be assumed to exist. There are therefore no convincing arguments suggesting that "inefficient" or "irrational" government strategies will be weeded out because of systemic selection mechanisms, as in ecological systems or perfect markets.

Instead, there is intentionality and presumed rationality (Davidson 2010). This intentionality and rationality resides within individual actors, which means that governments can be assumed to promote *their* particular interests rather than what would be preferable from a collective perspective. Only rarely do individual and collective interests converge, making the collective action problem evaporate (in so-called *harmonious situations;* see Keohane 1984). The assumption that intentionality and rationality resides within the individual actor is thus crucial in the understanding of governance systems.

Agency and different aspects of coping

To facilitate specification of agency, assumptions on what drives stakeholders, their preferences and motivations, need to be made explicit. In the approach adopted here, standard rational choice assumptions on rationality (transitive preferences) and maximization of expected utility are made. In simple words, governments are assumed to primarily promote their own interests and agendas and they do this in a reasonably rational way, given the incomplete and imperfect information they have about other governments' interests and priorities. It should be noted that actors' interests are defined subjectively and may be based on economic and geopolitical interests as well as on tradition, culture, history or any other factors. However, in order to make the analysis tractable, case-specific assumptions on what the major drivers are (via so-called *revealed preferences,* based on known assumptions of benefits and costs that actors face or a combination of both methods) need to be made explicit. It could be reasonable to expect – based on previous research and if possible primary sources of different kinds – that, for example, Russia's views on costly increases in maritime safety on oil transportation may be influenced by the fact that it is one of the largest marine transporters of oil (Knudsen and Hassler 2011). In order to safe-guard reasonable levels of reliability, it is necessary to use inde-

markets that is not driven by human intentionality but is rather a consequence of individual self-interests.

pendent sources when motivating assumptions on actor's preferences. If these assumptions are not convincingly substantiated no conclusions can be valid, since when having defined the strategic situation, including the possibility of imperfect and incomplete information (the game formulation in game theory), nothing but actors' preferences affect predicted outcomes.

The assumption of maximization of *expected* utility incorporates important aspects of uncertainty and lack of information. Uncertainty relates primarily to incomplete knowledge of how biophysical systems are constituted and how they may change over time. Since probabilities only rarely can be estimated (e.g. how likely a major oil spill is or that an invasive alien species is to successfully establish itself in a new habitat), uncertainty rather than risk is what governments have to cope with (Renn 2008). Knowledge of major environmental problems in general and how these may influence national interests in particular is an important aspect in the formulation of countries' coping strategies. When new knowledge is gained on, for example, climate change or over-fishing, it can be assumed that countries assess how this change in knowledge influence previously adopted policies and strategies in this area. Depending on the result of this assessment, bearing in mind that considerable uncertainties most likely are part of the assessments, policy changes may, or may not, be warranted.[5]

However, governments do not formulate policies and strategies on transnational pollution based exclusively on how the problem area has been framed and formed domestically. Beliefs on how other countries perceive the situation are important as well, as are considerations of how one's own policy changes might influence priorities made by others. Here, the issue is not so much a question of knowledge about pollution hazards, but rather about how well-informed the actors are about each other's standpoints in relation to what they believe to be the main drivers of the other governments. These kinds of interactive beliefs can become very complex since they are built on how one actor's decisions influences others' beliefs, which in turn affects the first actor's decisions and so on. Game theory has been designed specifically to handle such interactive decision-making situations. Furthermore, uncertainties related to the biophysical system can be integrated into the model by comparing outcomes depending on different assumption on what the actors are assumed to believe about the state of the world (i.e. factors not attributed to the players involved in the game).

[5] For an interesting example on how uncertainty may affect resource use, see López-Corona et al. (2013).

Therefore, game theory can be a powerful tool for understanding how countries' coping strategies are interdependently connected.

In order to differentiate between different aspects of coping behaviour, a distinction is made between on the one hand *uncertainty* and *lack of information* and on the other *cognitive* and *strategic* coping. Uncertainty refers to limited knowledge on biophysical structures and mechanisms actors have, which means that they often cannot know – at least not in detail – beforehand how they will be affected by changes in the operations of these systems. However, in most situations, uncertainties are reducible which opens up rationales for investments in improved understanding. With the active support and strengthening of science and other forms of knowledge, the understanding of biophysical and social systems and processes could be improved to facilitate stakeholders' coping behaviour and reduce negative socio-ecological hazards before actual events evolve. The underlying type of uncertainty that makes this form of coping possible has been called *epistemological uncertainty* in the literature and should be clearly distinguished from the irreducible uncertainty referred to above (Cooney and Lang 2007). Knowledge on how biophysical systems function is often collective in sense of being shared by many actors. However, what is important from a cognitive coping perspective is to what extent increased knowledge calls for changes in national coping strategies. Improved knowledge – scientific as well as other forms – can reduce uncertainty, but seldom eliminate it. Moreover, as our understanding of ecosystem change expands, new fields of uncertainty often evolve. Therefore, government's cognitive coping has to be based on perceived uncertainties and how these may influence national interests together with a cost-benefit assessment of investment in knowledge production. In other words, cognitive coping forms an important aspect of policy-making.

In contrast, lack of information refers to what actors think they know about other actors' interests and preferences. Privileged information about other actors' preferences often play decisive roles and particular pieces of information may be concealed if actors find it to be in their best interest not to share this knowledge with others. Strategic coping is based on these types of beliefs about other actors' interests and priorities. While reduced uncertainty does not change the workings of biophysical systems, changed beliefs on what actors think they know about each other may alter behaviour. Because of the interactivity in social systems, strategies cannot be adopted without closely considering what types of reactions the strategy may evoke among others and how others react to changes in biophysical

systems.[6] The distinction between uncertainty and lack of information is directly related to cognitive and strategic coping, where I define cognitive coping as an aspect of how to handle unexpected ecosystem change and strategic coping as an aspect on how to handle imperfect knowledge of other actors' interests and priorities.

Cognitive and strategic coping aspects in combination are assumed to underpin government policies adopted in relation of trans-boundary environmental disturbances. It should be noted that since how governments choose to cope depends on presumed impact from the disturbances on national interests and how other actors' interests are thought to be affected, coping is sufficiently broadly defined to include all factors that are perceived to be of relevance in each particular case. What particular factors that should be included and how they should be weighted depends on the specific case being analysed. However, cognitive and strategic coping aspects are analytical components and therefore not directly observable. Cognitive and strategic components can only be inferred from how changes can be presumed to affect governments' priorities. What can be directly observed is only the combined aspects of cognitive and strategic coping, which I call *government coping*.

Table 1. *The concepts of cognitive, strategic and government coping.*

Type of coping	**Main characteristics**
Cognitive coping	Actors assumed to form subjective preference orderings based on their expectations on how changes in biophysical systems will affect their interests.
Strategic coping	Actors assumed to form interdependent decision strategies based on beliefs of other actors' preferences and knowledge.
Government coping	Cognitive and strategic coping together based on perceived national interests form government coping behavior.

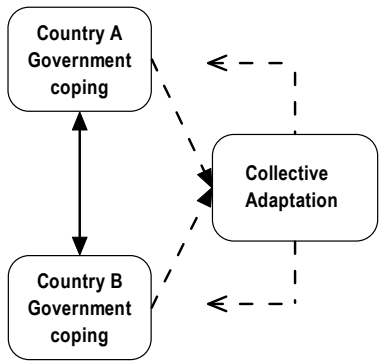
[6] This distinction is crucial in classical game theory, where uncertainty is related to the so-called *state-of-the-world* while lack on information refers to what the actors are assumed to know about opponents' preference orderings.

Modeling coping strategies and collective adaptation outcomes

In contrast with most systemic adaptation approaches, links are in the model elaborated here made explicit, and it is suggested that direct links only exist between actors (horizontal interaction), whereas links between levels (vertical interaction) are indirect in nature. The latter, vertical interaction, comprises the combined effects the actors coping behavior have on collective outcomes. Depending on how these outcomes turn out in the eyes of the involved countries, feedback mechanisms may in turn induce revised government coping. The key task then becomes to provide tools for analyzing to what extents and how countries' coping strategies contribute to adaptation at the systemic level. In Figure 1 below, it is showed, to the left, that individual countries are choosing individual government coping strategies. However, they do this in interaction with other governments.[7] These interactions among governments are assumed to largely be intentional. In other words, these actors are assumed to take expected impact on others, as well as possible reactions, into consideration when formulating government coping behavior. This is shown by the two-way arrow between the country boxes to the left in Figure 1. The dotted line between the respective country boxes and the collective adaptation box shows that the coping strategies adopted, indirectly influence the level of collective adaptation. This influence is largely and conceptually unintentional, since the governments are assumed to adopt coping strategies in relation to their interests and priorities rather than based on impact on collective adaptation. The combined effects from relevant actors' coping strategies constitutes the foundation for collective adaptation. Finally, the outcome in terms of collective adaptation in turn feeds into countries' government coping strategies, as shown by the dotted feedback arrows to the right.

[7] For simplicity, only two actors – governments – are shown, although many more actors typically are involved in actual situations. However, adding more actors does not change the underlying logic in the reasoning.

Figure 1. *Government coping and collective adaptation – A simple model.*



Most interpretations of ecosystems as well as, for example, neoclassical market system comes closer to the evolving rather than the steady-state model. Neither contemporary Baltic Sea ecosystems, nor international markets, are the same as they used to be and it is highly uncertain if there are possible ways of returning to historic conditions. Intuitively, it might be argued that a form of corrective mechanisms exist between humans and nature, where human behavior is corrected by negative feedback after observing what is perceived to be disturbed ecosystems. In analogy, it could be argued that social systems – societies – could be expected to revise behaviors that negatively influence ecosystem services that we benefit from or are dependent upon. For example, it has been shown that local communities depending on a particular natural resource through long-term adaptation in many cases have been able to avoid resource use collapse (Ostrom et al. 2002). However, in most trans-national governmental contexts no system mechanisms exist that make adaptation straight-forward and direct. Rather, there are ecological systems driven by internal mechanisms, but affected by individual actors conceptually external to these systems. From this perspective, conceptualizing this situation as interaction between social and ecological system or as merged socio-ecological systems is misleading, since the important question is how individual countries choose to cope with systemic disturbances and how these coping strategies together determine outcomes at the systemic level.

As conceptualized here, questions of adaptation to feedback from disturbed ecosystems at trans-national levels can only be understood from looking at collective adaptation and individual drivers simultaneously. The

most important aspect of coping behavior concerns issue-specific distribution of incentives. Therefore, to understand adaptation, the incentives facing involved actors have to be mapped, and to be able to strategically change outcomes mechanisms, that change key incentives in the desired directions have to be identified or created.

For our purposes it is sufficient to note that the reductionist route to explanation where aggregate outcomes (macro level) can be explained by the behaviour of the individual parts (micro level) in important ways are shared between traditional natural science and social science approaches based on the assumptions of individual rationality and utility maximization. Despite that intentionality is considered a distinguishing feature of human behaviour, rational choice and neoclassical economic analysis on the one hand and, for example, ecological modelling on the other, have been fruitfully cross-fertilized (Axelrod 1984). Not the least collective action analysis based on these premises is important when analysing actors' incentives to cope with changing circumstances.

Before looking closer at what this incentives-driven approach to agency and adaptation outcomes at the collective, transnational level conceptually may imply, the main aspects of each perspective needs to be more closely described. In the plethora of approaches in international relations building on various forms of rationality and utility maximizing behaviour of states, I have chosen to use the concept of *problem structure* as a vehicle to understand agency in this realm. The major reason for choosing this concept rather than more well-known theories such as *regime analysis, (neo)-institutionalism and (neo)-realism* is, that the problem structure approach has been developed specifically to address how system features may influence agency in international settings.

To illustrate systemic approaches to trans-national environmental management I mainly draw on *Planetary boundaries*, *Resilience, Ecosystem Approach to Management* and *Polycentricity* literatures. The first three of these approaches emanate from natural science (mainly ecology) research environments, where systemic features have been put in the foreground. The polycentricity literature is quite different from the others as it builds on social science governance research. It has been included here since its main feature – that decision-making takes place in many different and largely autonomous centres – has been seen as an important aspect in systemic socio-ecological resilience studies.

Problem structure as a building block for understanding coping

The concept of problem structure was established to capture aspects specific to a particular regime (environmental issue-area) – biophysical or social – that could be important endogenous drivers for institutional outcomes (Mitchell 2006). In a review of the few attempts that have been made to clarify how this concept could be defined and made useful, Ronald Mitchell (2006) ends up with four aspects that seem to be important in relation to agency and the forming of coping strategies: *incentives, capacities, information* and *norms*.[8] Mitchell exemplifies the incentives' category with *downstreams-upstreams* problems and coordination and collaboration situations. In downstreams-upstreams problems the dilemma is that upstream actors typically have weak incentives to take downstream outcomes (e.g. pollution of the water, not considering downstream water quality) into account when formulating coping strategies, given that effective governance structures have not been established. The dilemma is not only due to possible conflicts, but rather because sub-optimal outcomes at the collective level can be expected, unless downstream actors are able to compensate or in other ways influence upstream actors to also include their interests in their coping decisions. If upstream actors are not effectively obliged to consider downstream outcomes, the latter may have incentives to offer side-payments to the upstream actor, thus altering his incentive structure (Coase 1960). Similar dilemmas may emerge in situations where mutually beneficial cooperation or coordination is not forthcoming because of incongruences between actor rationality and collective optimality. Mitchell's examples are generic in the sense that they refer to categories of situations where the involved actors have preferences that make cooperative outcomes difficult to reach. Based on implicit assumptions of rationality and utility maximization, theoretical predictions can be deduced and have been valuable in the analysis of many practical situations. According to Mitchell the incentives facing the actors in downstreams-upstreams and coordination and cooperation situations respectively determine what type of

[8] Jacobson and Brown Weiss (2000) offer a comprehensive overview of factors that could be of importance when assessing compliance in International Relations. However, their main ambition was to identify an exhaustive list of factors of relevance for compliance through an in-depth analysis of a large number of empirical cases. The methodology in this article is instead to search for underlying categories of drivers and restrictions that tend to influence actor strategies and together form an analytical framework that (a) gives a general understanding of the preconditions for international collaboration on environmental problems and (b) could serve as a point of departure for case studies and management undertakings.

strategies that we could assume to be adopted. This reasoning is in line with the notion of coping strategies adopted in this paper, although we place more emphasis on possible feedback loops on individual coping strategies from sub-optimal collective outcomes.

A second aspect Mitchell found to be of importance concerns links between actor *capacity* and agency. From a coping perspective, an argument can be made that the perceived capacity of other governments to take action, to implement agreements made, to enforce signed and ratified conventions and so on substantially influence the strategies adopted. It has been observed that when capacities in terms of economic resources differ significantly among countries facing a trans-national problem, side-payments could be used as an instrument to facilitate joint action (Chayes and Chayes 1995). In the Baltic Sea region, a large number of support projects were, for example, undertaken during the 1990s to assist especially the Baltic States and Poland in stabilizing democracy and to reduce pollution. Typically, these projects included financial components as well as collaborative schemes (Hassler 2003) and since they were selected according to benefits to donor as well as recipient countries, the support provided can be understood as side-payments (Hassler 2000). In other words, side-payments could be portrayed as a part of a self-interested coping strategy, where the estimated gains from joint action to Sweden were perceived to be larger than the cost of these payments.

A third aspect Mitchell elaborates upon concerns what he calls *information.* The distinction he makes between information (knowledge about other actors' preferences) and uncertainty (knowledge about the relevant biophysical states of the world) is important, since these aspects could be expected to influence coping strategies and the emergence of institutional structures quite differently. The preferences of other actors can never be fully known, but in the field of nature protection and natural resource use, economic considerations often influence government policies in rather intuitive and understandable ways. States that, for example, have substantial fisheries sectors tend to be more reluctant to accept reduced fish quotas compared with states with weak or non-existing fisheries sectors and nations where there is a substantial demand for whale meat are much more reluctant to reduce quotas compared with countries with low demand (Andresen 2000). In a similar way, countries such as Sweden and Finland with extensive and valuable archipelagoes – but no strong interests in oil transportation – have been shown to be more proactive on increased marine safety measures (Hassler 2003).

These examples indicate that forming viable national coping strategies largely depends on how counterparts can be assumed to perceive their respective national interests to be affected. In other words, an important part of states' coping strategies consist of getting better informed about others' economic, environmental or other types of interests in relevant issue-areas.

Uncertainty regarding the biophysical systems plays a rather different role in coping compared to information shortages. Mitchell suggests that when there is a relatively high degree of scientific uncertainty, institutional structures where production of knowledge is more central than in issue-areas with less uncertainty tend to emerge. However, whether this is caused by a linear, causal link between a high degree of uncertainty and states investing in science, as suggested by Mitchell, or by more complex mec

hanisms is a question that is difficult to answer (Pielke 2007). Even though high levels of perceived uncertainty can be assumed to put pressure on governments to invest in production of knowledge, it is an open question if these pressures lead to increased investment within countries, in international bodies or in a mix of both, especially since scientific knowledge could be seen as a collective good. A reasonable assumption is that even though pressures of uncertainty affect all countries, consequences upon national interests differ substantively. Therefore, coping strategies vary as well.

An aspect not brought up by Mitchell, but one that sometimes plays important roles, concerns the observation that issue areas characterized by considerable levels of uncertainty tend to be more politicized and open to stakeholder strategizing (Wilson 2009). Higher levels of uncertainty tend to lead to weaker or even competing epistemic communities which in turn open up possibilities for political factions and sector organization to line up with different groups of scientists, embracing dissimilar scientific arguments in order to give their case more clout. When issues in this way become *politically malign* in the sense of being permeated by conflictual interests, norms and ideologies, the formation of national coping strategies can be assumed to be less predictable compared with areas characterized by less uncertainty.[9]

In my modeling of coping and adaptation, I use Mitchell's distinction between uncertainty (knowledge about the biophysical system and other

[9] For an assessment of how political malignancy may influence international environmental collaboration, see Stokke 2012 and Andresen et al. 2000.

systemic factors) and information (knowledge about other actors' preferences), but emphasize more strongly, that whereas uncertainty is important in both collective adaptation and in forming coping strategies, information exclusively concerns actors' knowledge about other actors' interests and priorities.

Fourth and finally, Mitchell argues that *norms* constitute a separate and important aspect of an environmental issue-area´s problem structure. The main argument is that the more norms on e.g. how important the environmental problem is, the more far-reaching institutional regulations and mechanisms relevant actors would be willing to accept. This interpretation of the importance of norms seems to imply that what matters is to what extent governments due to public pressures, NGO influences etc. share similar attitudes or ideologies on how to relate to the environmental problem at hand. It should not imply, though, that shared interests are at stake, since actors' interests have already been accounted for in the aspect of incentive patterns described above.

However, from a rationalistic coping perspective, it seems to be unclear in what way shared norms could affect how governments form coping strategies, apart from conveying information on other actors' interests and priorities. The standard argument suggesting that norms matter, is in simplified form, that countries that in some sense share moral standpoints or ethical outlooks can also be assumed to be more collaborative than those who do not share these traits. This suggestion may seem intuitively convincing, but it could be argued that when state interests and access to information have been accounted for, it seems hard to substantiate what more the concept of norms could contribute with. If a country adopts what may be labelled a "moral standpoint" such as reducing nutrient leakage more than required according to trans-national agreements, this axiomatically has to be explained by perceived self-interest in the type of rationalistic approach adopted here. In other words, a separate aspect of norms is not needed from a coping perspective, since it is embedded in the three other aspects described above. However, it should be noted that norms still could be of relevance, if they are assumed to be carrying valuable information. Interpreted from this perspective, norms (i.e. information) shared by many actors in a given situation may reduce transaction costs and thereby facilitate communication and cooperation. But if this is the case, this feature is part of the information aspect described above.

Summing up on problem structure aspects, it is clear that important factors related to links between social institutions and biophysical systems

have been captured in this research. Especially the shift of perspective where the over-arching question posed is how different biophysical restrictions tend to influence coping behavior rather than asking what kind of institutions could effectively contribute to environmental management has been valuable.

Before discussing what an integration of agency-driven coping and systemic approaches could imply in terms of mechanisms and suggesting areas where this framework potentially could be of value, the latter needs to be briefly described and commented upon. In the following section, a selection of systemic models related to adaptive governance will be discussed, before turning to how the two perspectives together can contribute to a better understanding of potentials for adaptation to trans-boundary marine pollution.

Biophysical boundaries and adaptation pressures

Changing perspectives on the concept of problem structure and looking instead at how biophysical systems may place restrictions on human behavior, the emphasis is set on limits posed by sustainability requirements at systemic levels rather than on collective action. Human agency is downplayed in this literature, arguing that biophysical systems cannot be negotiated with, but rather place definitive boundaries on human behavior. In the planetary boundaries literature, the focus is placed on what restrictions biophysical limits place on economic development and human-induced threats to system integrity in relation to areas such as Climate change, the Nitrogen cycle and loss of biodiversity (Rockström et al. 2009). Clearly, the point made here is that biophysical restrictions are immutable and if critical thresholds are passed, system-wide changes with cascading effects may result. However, as these large-scale systems are not known in detail, considerable uncertainties remain. Given that these uncertainties will not be uncovered in the foreseeable future, adaptation, learning by doing and precaution have to form integral parts in future paths to sustainability. An important aspect of uncertainty in this literature concerns what has been called *non-linear* relationships, that is, further increased nutrient leakage or chemical pollution, for example, may cause abrupt systemic changes rather than a predictable, linear change (Gundersen et al. 2010; Duit and Galaz 2008; Folke et al. 2005). This non-linearity, or so-called tipping point or flipping regime, has been observed in various types of biophysical systems. It has also, by analogy, been suggested to be important

in relation to institutions such as transnational environmental regimes (Vormedal 2010).

However, given that most processes in most intervals in fact are linear, or at least close to linear, the question is how to handle possible – albeit not very likely – abrupt changes in the future, rather than to assume that non-linearity is the rule (Davidson 2010). Clearly, there is ample room for politicization of this concept, since it is seldom possible to estimate how close we are to abrupt, system-wide changes. Given that reductions in e.g. nutrient leakage or chemical pollution is costly, these costs have to be balanced against largely unknown consequences of continuing business as usual.

A possible mechanism to increase adaptive capacity in management and possibly also to handle *irreducible uncertainty* (Funtowicz and Ravetz 1990) or *ontological uncertainty* (Cooney and Lang 2007) suggested in this literature, is so-called *institutional redundancy* (Low et al. 2003). The literature on institutional redundancy has primarily been inspired by so-called *functional redundancy* in ecological theory, where it is argued that increased biodiversity tends to improve ecosystem resilience. It should be noted that the transfer from ecological to institutional redundancy has not yet been fully elaborated, but rather rests on a presumed analogy. For example, whether institutional redundancy in terms of diverse incentive structures builds on similar mechanisms as ecological redundancy as suggested by Jones (2014) needs further theoretical development. In contrast to the emphasis on effectiveness and optimization in especially New Public Management (NPM) where the primary ambition is to reduce all forms of unnecessary cost in public administration, the institutional redundancy hypothesis suggests that NPM types of optimization may increase administrative vulnerability. Institutional redundancy can be seen as a way to prepare for the unexpected, arguing that it is better to be safe than sorry. Also here, the intuition seems sound. When not knowing future challenges in detail, an argument could be made for having some extra capacity in case of unexpected events. Partly, this preparation for being able to handle unexpected events could consist of improved sector integration within as well as among nations (Hassler et al. 2013). However, it should be noted that institutional redundancy as such does not necessarily increase adaptive capacity. To enlarge, but not broaden or diversifying, existing administrative capacity most likely results in improved potential to handle similar events. However, adaptive capacity in relation to unexpected events not previously being faced is not necessarily improved by "more of the same". On the other hand, broadening of the adaptive capacity scope of the admin-

istration may increase institutional complexity, which in turn may increase, or decrease, adaptive capacity. In other words, the call for institutional redundancy, understood as "extra" management capacity in public administrations that could be used in case of unexpected events, as a means to improve adaptive capacity seems intuitively reasonable. But in what form and how much to invest in this extra capacity remains largely unclear.

The Ecosystem Approach to Management (EAM)

Emanating from a somewhat similar thinking on how biophysical characteristics ought to influence transnational institutional structures but here in the field of environmental regulation, the *Ecosystem Approach to Management* (EAM) seems to be becoming a defining feature of EU marine management in, for example, the Marine Strategy Framework Directive, MSFD (Directive 2008/56/EC 2008). In this approach to management of marine areas, water bodies rather than social constructions such as administrative and national borders are taken as points of departure for management, despite the often extensive and difficult changes in routines and institutions required, including disagreements among representatives from different scientific disciplines such as environmental and fisheries science (Wilson 2009). The argument is here that biophysical systems set the stage and social systems have to adapt to these boundaries, rather than the other way around. However, it should be noted that even though a holistic and systemic management perspective should be adopted and biophysical conditions are assumed to guide new administrative borders, management is still presumed to be forward-looking and goal directed according to the MSFD. Interestingly, there are signs in the contemporary resilience and adaptive governance writings indicating a possible turn towards emphasizing adaptivity as well forward-looking perspectives, e.g. so-called *anticipatory* approaches, building on forecasting, scenario-building, simulations, modeling and similar, more than on precise predictions of single outcomes or unique equilibria (Boyd et al. 2015). Turning towards anticipation as a necessary complement to adaptation, a possible implication could be that more focus on agency and collective action is needed since anticipating systemic outcomes can only be achieved by looking carefully at underpinning micro conditions, as argued in this paper. However, to what extent this area will expand in the near future or not, is yet too early to tell.

In MSFD, rather than adapting to unexpected changes in large-scale and transboundary biophysical systems, the emphasis is placed on identifying

Good Ecological Status (GES) and strategies to reach these goals within established timeframes. Obviously, for this to work linear processes and existence of identifiable, stable equilibria are required. According to the directive, each EU member state is required to define Programmes of Measures no later than 2015 that will reach GES in relevant marine areas no later than 2020 (European Commission 2014).

The fundamental structure in the MSFD is built on the assumption that existing ecosystems set boundaries for creation of social systems (the EAM approach), but also on the conviction that targets could be defined beforehand, that is, scientific communities are assumed to be able to define GES in all type of marine water bodies. Furthermore, it seems to be assumed that existing environmental disturbances could be rolled back making the damages done undone. Whether it is possible to turn back ecological change to a previous state – the Baltic Sea as it supposedly were in the 1950s has been suggested as such a state – could be questioned, especially if ecological change is not assumed to necessarily be linear (Tynkkynen 2014). A more realistic approach seems to be to accept continuous change, but to attempt to limit those that seem to be obviously negative (e.g. excessive eutrophication, toxic chemicals, over-fishing) and are practically possible to limit.

EAM is normative in nature and has specific implications for what is believed to improve management of ecosystems. Stakeholder participation is a key component of EAM for at least three reasons (Arkema et al., 2006; Murawski, 2007; Tallis et al., 2010). First, time- and placed-bound knowledge of relevant stakeholders (e.g. local users, practitioners, NGOs, sector organizations) is assumed to be an important complement to existing scientific knowledge. Since EAM is primarily a management tool, stakeholder knowledge is important in the management of particular marine areas where detailed knowledge on local conditions can be of substantial importance. Scientific knowledge, on the other hand, is vital in understanding ecosystem characteristics and functions as well various types of causal mechanisms. Thus, both types of knowledge are needed in EAM, it is argued, in order to achieve long-term sustainable management. Second, implementation typically is improved when relevant stakeholders have been included in the decision-making process. While this argument has an intuitive appeal, inclusion of stakeholders in the decision-making process before the implementation phase can make negotiations over complex agreements harder to reach. Third, whom to include and when to include

stakeholders in a deliberative process is a highly complex issue, that has to be decided on a case by case basis (Greene 2004).

From the collective adaptation perspective adopted in the paper where a general theoretical framework is envisioned rather than case-specific analyses, it could be argued that a normative management-oriented approach such as the EAM is not of relevance. However, while it is true that management of specific objects is not relevant in this context, the suggestion that stakeholders tend to influence not only how environmental problems are handled, but also how problems are described and perceived as well as solutions promoted, is of relevance in relation to adaptation pressures and therefore also to formation of coping strategies.

Finally, a somewhat different aspect that has been suggested to influence adaptive capacity at the systemic levels is what has been called *polycentricity* in this literature (Ostrom and Ostrom 2014). The concept of polycentricity was picked up by Ostrom et al. in 1961, building on an original formulation by Polanyi (1951). By having several rather autonomous centers it is argued that social order can be created without dependence on a hierarchical structure. Apart from having important implications for deliberation, democracy and participation, such a polycentric system is suggested to have important adaptation capabilities. Ostrom compares a social system building on several autonomous centers with that of a liberal market. Despite not having a hierarchical structure, order and efficiency are created in such markets because of the competition between the centers (companies) and the resulting selection mechanism (Ostrom 1991). Because of the closeness to local contexts, individual centers can adapt to local environments more efficiently than would be possible in a hierarchical and centralized structure, it is argued. This reasoning behind polycentricity has been picked up in the adaptive governance and resilience literature (Lebel et al. 2006), although not much has been written on whether a direct analogy could be made between the Ostrom understanding of polycentricity and polycentric regional or sub-regional institutions at the international level. First, it is not clear that selection pressures exist among such trans-national environmental institutions or that, if it does exist, whether it would translate into enhanced efficiency through continuing adaptation. In competitive markets, consumer demands make companies improve efficiency, also if companies would prefer not to adapt, since the alternative is to be driven out of competition. If there are similar pressures on institutional centers to adapt to local contingencies, it is not clear what these mechanisms would look like. Second, even though it could be argued that

polycentric institutional structures might be able to adapt to local conditions more efficiently than a centralized system and thereby enhance adaptive capacity, polycentric structures could be more vulnerable to large-scale environmental hazards. Centralized decision-making structures may in these situations be more efficient, given that extensive coordination of abatement strategies would be called for.

Summing up on biophysical boundaries and adaptation pressures, it is clear that uncertainty plays a crucial role. Uncertainty means that institutions need to adapt in order to be able to cushion unexpected changes in large-scale biophysical systems. Institutional redundancy is not the only response to uncertainty, polycentrism can also be seen as a deliberate strategy to increase social plurality and thereby presumably adaptive capacity. Somewhat paradoxically, the emphasis on uncertainty on these bodies of literature is often coupled with goal-directed management where not only present status of ecosystems are assumed to be possible to verify, but also desired future states, that is, socio-ecological management goals. Presumably, this means that it is deemed possible to define ecosystem states that are more desirable that those we face today, but that paths to reach these states cannot be prescribed in detail because of the substantial uncertainties in science and management.

In the concluding discussion below, I will elaborate briefly on how the problem structure aspects and coping may be related to systemic outcomes and adaptations. This discussion will mainly suggest ideas and mechanisms that could be in the analysis of particular environmental disturbances in concrete, transnational settings.

Discussion – Implications derived from connecting coping to collective adaptation

The power of incentives

Having outlined the basis for coping behavior, the underlying incentive structures determining actors' formulation of coping strategies needs some further elaboration. A key departing point concerns to what extent actors' interests on transnational marine governance are *conflictual* (zero sum game type of situations), *mixed* (possible mutual benefits from cooperation possible but temptations of free-riding threat against the realization of these benefits) or *harmonious* (similar interests among actors, but coordination may be required). As argued in the problem structure literature, down-

stream up-stream conditions often result in incentive structures that lead to sub-optimal outcomes at the collective level, as up-stream actors have few, if any, incentives to take the plight of down-stream actors into consideration. However, the down-stream up-stream is not a unique type of situation, but rather a special case of a broader category of cases where biophysical conditions influence who will bear the costs from pollution. The only case that is unproblematic from an incentive distribution perspective is when all costs and benefits fall on a single actor. By definition, collective action problems can then not emerge. In all other cases, negative effects from ecological disturbances are distributed among actors, often in a highly uneven way and with limited or no relation to who caused the disturbance. For example, eutrophication of the Baltic Sea is to a considerable extent caused by agricultural run-offs that differ dramatically among the coastal states both in amount as in ecological impact depending on local conditions. However, the benefits from reduced run-offs and improved nutrient balance leading to less euthrophication would benefit the Baltic Sea states very differently. Those with long coastlines, valuable archipelagoes, substantial recreation values etc. would most likely benefit more than countries with short coastlines, no archipelagoes and relying on other types of recreation environments. In other words, the up-stream down-stream incongruence is as important here as in the simpler case of two actors up-stream and down-stream a particular river. Similar cases could be made for fisheries, marine transportation pollution, chemicals and most other transboundary environmental disturbances. From this perspective it is surprising that although in-depth estimates of cost-benefit ratios for reducing e.g. eutrophication have been carried out at the collective, regional level for the Baltic Sea as well as mapping of how much different countries contribute to Baltic Sea eutrophication, no attempts to my knowledge have been made to map benefits country-wise. Without such a mapping, coping strategies at country levels can hardly be understood.

Uncertainty fluctuations and adaptive pressures build-up

Environmental hazards tend to fluctuate over time. Although knowledge of ecosystems and environmental hazards increase over time, this does not necessarily mean less uncertainty. Scientific research may lead to realizations that system structures are more complex and interconnected than previously thought, which in turn might increase perceived gaps between what we thought we knew and what our observations seem to indicate. For example, there has been a growing concern that the focus on

protection of single fish species and Total Allowable Catches (TACs) has been too restricted (Wilson 2009). As a response to this, as well as suggestions to increase inclusion of stakeholders into management, ICES (International Council for the Exploration of the Sea) seems to have begun to turn towards EAM (Hassler et al. 2013). The emphasis on EAM modes of management may have influenced coping strategies in the face of increased, perceived complexities and a need for centralized decision-making (i.e. the Common Fisheries Policy, an exclusive competence of EU) and a substantial reliance on international scientific assessments by especially ICES. A possible interpretation of this increased centralization in spite of normative claims for decentralization, subsidiarity and devolution could be that perceived complexities of marine ecosystems have increased adaptive pressures, bringing coping strategies of (involved nations) closer together. However, this does not mean that tensions between regional adaptation and national coping strategies have come to an end, which the regular overshooting of fish quotas in relation to ICES recommendations bear clear witness of.

In contrast, impacts from, and distribution of, eutrophication primarily caused by agricultural run-off in the Baltic Sea is relatively well known. Since the strongest stakeholder interests are not directly related to the Baltic Sea but rather to agricultural interests, where nutrient run-off is a practically complete externality to most farmers, the driving forces for centralization have here been weaker. Despite the centralized and exclusive competence of the EU (the Common Agricultural Policy; CAP, and related directives) and the HELCOM BSAP (Baltic Sea Action Plan), the most important decisions on how to reduce run-off and how to enforce regulation pour down to the national and local levels, where the protection of the Baltic Sea environment is pitted against strong, sub-national stakeholders such as farmers and sector organizations. As the distribution of major eutrophication impacts (shortage of oxygen) is on the one hand local (typically most severe closest to the source) and on the other hand depending on natural settings in different sub-basins of the Baltic Sea, incentives for governments and even sub-national authorities may vary considerably. A possible interpretation of this development in relation to the model suggested here could be that although the major causes to Baltic Sea eutrophication are comparably well-known and individual countries' contributions to nutrient inflows have been mapped, government coping strategies vary considerably because of national interests and priorities. The difficulties of turning BSAP agreements on national reductions (CARTs;

Country Allocated Reductions Targets) of nutrient leakage from agriculture into effective policies and the recent conclusion by HELCOM that eutrophication targets will not be reached by the 2021 deadline seem to strengthen this interpretation (HELCOM 2014).

Knowledge driving pressures – Potential consequences from irreducible uncertainty

Transnational environmental disturbances are by definition collective in the sense that at least two countries are affected by negative consequences. However, this does in most cases not mean that the countries are equally affected. A considerable degree of uncertainty is typically attached to how the effects propagate geographically over time, an aspect that can be exploited by governments in negotiations based on cognitive coping aspects. For example, the location and timing of a future severe shipping accident can largely be classified as an irreducible uncertainty aspects from a practical point of view. Although data on traffic intensity, type of vessels, navigation difficulties etc. could be used to identify where risks for an accident may be high, particular accidents cannot be predicted. Knowing this, it could be argued that marine safety as such has important aspects of a collective good in the sense that no Baltic Sea country that has vessels flying its flag can rule out accident risks. However, despite this apparent common interest in improving marine safety, different countries typically have (a) quite divergent economic interests in shipping sectors and (b) would suffer unequally in case of, for example, a major oil spill. This aspect of practically irreducible uncertainty can be exploited by countries that have weak interests in marine transportation, but are vulnerable in terms of an oil spill due to e.g. long or particularly sensitive coastlines along shipping routes, by arguing that this is a collective problem that all Baltic Sea countries need to address in concert. In other words, a proactive country may adopt a strategy building on assumption of degrees of collectiveness at the higher end of the scale in order to find arguments for increased investment in marine safety, financed multilaterally (Hassler 2010).[10]

Another example of how irreducible uncertainty – situations when risk in terms of probabilities cannot realistically be estimated – can affect policies adopted concerns the impact from large-scale accidents im-

[10] Peter Haas (1990) made a similar argument when observing that proactive countries in the Mediterranean region managed to convince less engaged countries to improve marine environmental protection based on the questionable assumption that the most important problems actually were substantially collective.

mediately after such an event has taken place. It has been observed that large-scale accidents often create political pressures to "do something", even though a single accident says little or nothing about how future accident scenarios. Also here, countries with proactive coping strategies may seize the opportunity to increase investments in improved safety, which countries with somewhat less engaged coping strategies may find hard to resist. This may be the case also in situations where added regulations could lead to so-called regulatory overload, and actually may reduce over-all safety (Knudsen and Hassler 2011).

Information and strategic coping

Negotiations are important for getting better information on others' priorities and interests, but signaling to others is as important as gaining more information. From a strategic perspective, those who are pro-active can be expected to exaggerate how far one is willing to go, while laggards could be expected to exaggerate how little they want to do. Using these strategies could be expected to lead to aggregate outcomes closer to their respective ideal levels. But, when numbers are made concrete or when implementation is supposed to take place, incentives may be strong to move closer to the ideal points. Actors who perceive themselves to be closer to the "median" are likely to adopt positions closer to their ideal points, expecting outcomes to be not too far away from what they would prefer. Withdrawal from earlier positions are then likely.

This means that it is pivotal for states to be able to make as correct assessments of other states' ideal points as possible, in order to formulate adequate coping strategies. This is not only problematic because other actors may have incentives not to be fully honest about coping preferences as alluded to above, but often as importantly when wanting to convince others that the expressed priorities actually are honestly revealed and in this sense true. This issue of *credible signaling* has been on the agenda for a long time in various research themes related to international relations studies and *realism* theory related to state security, but does not seem to have been used in analysis of international environmental problems. This is most likely due to the fact that security studies traditionally has been regarded as *high politics*, fundamental to state survival, whereas international collaboration on the environmental has been classified as *low politics*. However, this might be changing, with global environmental issues such as greenhouse gas emissions' effect upon the climate rising on the political agenda (Gemenne 2014). If so, the concept of credible signaling could

become useful to better understand states' adoption of coping strategies. For example, developing methods and schemes to improve monitoring of others' compliance with agreed upon conventions could be useful (Stokke 2012). Notably, governments that want to send credible signals could actually have considerable incentives to allow others to monitor their behavior, because this might be the most effective way to show commitment.

Institutional responses

It may seem as a realistic assumption that it generally can be presumed to be easier to cooperate for countries with similar coping strategies than for those with more different strategies. Although intuitively reasonable, this pattern is not self-evident, since differences in capability and interests often drive mutually beneficial cooperation (Axelrod 1984). It has been observed in the Baltic Sea region that many sub-regional initiatives have been taken among small numbers of often neighboring countries, where cooperation has been taken further than what has been possible in regional or global environmental regimes (Hassler 2008). These sub-regional institutions can be interpreted as outcomes of interactions among these countries coping strategies. The primary goal of the involved states has presumably been to promote national interests, but these interactions fuelled by national interests sometimes result in evolving institutional structures at the collective (regional or sub-regional) level. From a collective adaptation perspective, these types of largely self-organized structures can furthermore be interpreted from a polycentricism perspective, possibly suggesting that social resilience – or system robustness – has increased. With varying institutions more closely adapted to the sub-regional levels, the institutional setting may be less vulnerable compared with a single centralized, hierarchical system (e.g. an international convention or regime).

However, it might be argued that choosing between hierarchical, centralized institutions and polycentrism should not be seen as either-or, but rather complementary frameworks. It has been shown that sub-regional groups of countries in the Baltic Sea region have been able to develop their cooperation on shipping safety further than what has been possible at higher levels (Hassler 2010). By focusing on benefits from cooperation among a smaller group of countries, joined together because of e.g. geographical proximity, common interests or comparative advantages, may self-organize as sub-regional institutional centers in effect contributing to a more effective regime at the higher levels. However, it should be noted that the contribution from such local centers to regime effectiveness cannot be

taken for granted, as the local centers have emerged to benefit the sub-region, but not necessarily outcomes at higher levels. Therefore, sub-regional institutional centers may interact in synergistic as well as antagonistic ways with higher level institutions. How these interactions play out in specific cases is an important issue for further research.[11]

Strategies for increasing impact by re-scaling

Increasing impact by rescaling represents an emerging theme in the study of transnational environmental hazards that have important links to interactions between coping strategies and adaptivity. This form of rescaling bears some resemblance to *forum shopping,* a concept that mainly has been used in relation to international trade issues describing how countries may choose different forums for raising complaints to e.g. preferential treatment depending on where they predict the ruling will be closest to their ideal (Busch 2007). In similarity with in forum shopping, rescaling emphasizes the incentives facing the relevant states rather than what could be seen as optimal from a collective point of view. However, while the actor's intention in forum shopping is to reach as good ruling as possible, rescaling aims at moving decisions to a different regulatory body, aiming at getting more or less strict regulations. In the few examples so far described in the literature, the ambition has typically been to make existing rules stricter, to improve enforceability or to obtain a new set of rules such as a new classification. For example, the design of the Baltic Sea Action Plan (BSAP; adopted 2007) was consciously tailored to the parallel work on the EU Marine Strategy Framework (MSFD; adopted 2008) (Hassler et al. 2013). HELCOM was here used as a jumping board by the most proactive member countries to (a) formulate a coherent strategy for the ecological rehabilitation of the Baltic Sea and (b) to rescale this to the EU level to increase impact, foreseeing that the MSFD will have wider geographical reach as well as being easier to enforce (at least among EU member countries). By adopting such a two-tier strategy, behavioural change was clearly assumed to be more likely to be forthcoming, compared with only relying on either form of initiative.

In a somewhat similar vein, the adoption of the Baltic Sea as a Particularly Sensitive Sea Area (PSSA) by IMO in 2005 could be interpreted

[11] Although a considerable amount of rserach effort has been put into attempts to better understand interactions between regimes and between regimes and other international institutions (Oberthür and Gehring 2006; Rosendal 2001; Stokke 2001), the issue of interplay between sub-regional and higher level institutional centers have so far been given limited scholarly interest.

as an example of re-scaling (Uggla 2007). After discussions in Sweden and Finland, involving public authorities and environmental NGOs as well as others, these countries concluded that it would be in their interest if the Baltic Sea achieved an IMO PSSA status. However, in order to increase expected impact, i.e. to convince IMO to side with Sweden and Finland on this issue, government coping strategies were designed where the key idea was to first get an agreement in HELCOM, then to hand in an application to the IMO. To go directly to the IMO was not seen as a viable option (Uggla 2007). However, despite several attempts, it was not possible to get Russia on board, despite all other HELCOM Contracting Partners being in favour of a PSSA application. Clearly, Russia based its formulation of government coping strategy on different aspects compared with the other states. Despite this, the Swedish/Finnish initiative eventually was successful, leading to a classification of the complete Baltic Sea *except* Russian waters as an IMO PSSA. By successfully rescaling this issue from national to a global arena, via the regional HELCOM jumping board, regulation on Baltic Sea shipping became stricter, in line with most Baltic Sea governments" priorities.

A third, and final, example of rescaling concerns strengthening of Port State Control (PSC), probably the most important contemporary mechanism for enhancing shipping safety (Hassler 2015). Because of the difficulties in enforcing Flag State responsibility, PSC has become increasingly important in the enforcement of safety requirements on ships. This case is somewhat different from the two above, since it primarily concerns two international institutions, EU and IMO, and the coping strategies of the key governments that drove this process have not yet been described. It has been stipulated for some time by IMO (based on the International Convention for the Safety of Life at Sea 1974 - SOLAS 74) that Port States may inspect 25 percent of arriving vessels. However, the enforcement of the PSC has been perceived as uneven and a decision to rescale the global IMO convention into a binding EU directive (Directive 2009/16/EC on Port State Control). An important consequence from rescaling a global convention into an EU Directive that the latter is considerable easier to enforce, albeit only concerning EU member countries, since failure to follow EU directives could lead to substantial penalties. Thus, rescaling PSC to the EU level has led to stricter regulations in European ports, without directly influencing the relevance of the IMO convention on PSC in other parts of the world.

These three brief examples show that increasing impact by rescaling could be a relevant aspect of management of transnational environmental

hazards. They also seem to indicate that the distinction between government coping and collective outcomes could be useful. To understand collective outcomes in these areas, individual nations' coping strategies need to be pinpointed. Considerable more research is needed in order to understand how actors' varying incentives influence adoption and effectiveness of regulatory instruments at the international level.

On redundancy

Institutional redundancy could be of at least two different kinds, institutional capacity redundancy and institutional functional redundancy, where the former refers to improved capacity to handle a particular kind of outcome with uncertain probability to occur, while the latter refers to ability to handle unexpected types of outcomes. Although functional institutional redundancy is more similar to ecological functional redundancy, capacity redundancy typically more relevant when the type pf disturbance can be reasonably well anticipated, but place and time for the event is difficult to estimate. Improved capacity to combat marine oil spills is an area where capacity redundancy is most relevant (Hassler 2008). Although type of incident and its impact on the local environment is difficult to predict, it is quite certain that cleaning up capacity will be needed. What is difficult in this type of situation is to determine how large the capacity should be, given the uncertain probability of the event to occur, especially since the number of vessels is not stable over time, while the average safety of individual ships seems to have been improved during the last decades (Knudsen and Hassler 2011). Moreover, since the cost of a spill for a particular country depends on the likelihood of being affected as well as how these costs are assessed, the willingness of invest in national clearing-up capacity could certainly differ between countries, but the issue is still largely about this specific capacity, rather than preparing for different types of events. It could be noted that mutual benefits from cooperation could be achieved by transnational cooperation in this area, in terms of building up sub-regionally coordinated cleaning up preparedness. If the affected countries can avoid too much of free-riding temptations, plans to cooperate on oil spill combat can be prepared in advance. There have been a few examples of such sub-regional collaboration in the Baltic Sea during the last decade (Hassler 2008).

Institutional functional redundancy, derived in analogy with ecological redundancy, is more complex, since adaptive capacity here needs to be broader in order to be able to better cushion various forms of events.

Ecological functional redundancy is centered around the assumption that there are certain functional overlaps in ecosystems that depend on e.g. biodiversity. The argument is then that the more redundancy there is and the more diverse this redundancy is, the better capacity it can be assumed to have to be able to cushion disturbances (Rosenfeld 2002). However, to assess actual ability to cushion disturbances depends on type of disturbance as well as what part and how a particular aspect of an ecosystem is affected, as redundancy cannot be assumed to system-wide homogenous.

The analogy from ecological to institutional ecological redundancy can be questioned, and possibly should be interpreted in a metaphorical rather than analogous way (Davidson 2010). The main reason why a direct analogy between ecological and institutional redundancy cannot be drawn is the human capacity to anticipate and intentionally design institutional structures.[12] While ecological systems evolve evolutionary, human institutions emerge as combinations of adaptive pressures and actors' intentional coping strategies as argued throughout this paper. To consciously design institutions with higher degree of functional redundancy is something different from evolutionary adapted system redundancy and since our knowledge of possible factors that might influence institutional redundancy, design becomes inherently problematic, especially since the main design driver is actor coping strategies rather than what would in some sense be optimal at the collective level.

However, the suggestion that it might not be possible to optimize institutional functional redundancy does not necessarily mean that this type of redundancy cannot be improved. A possible way to address the issue could be by looking closer at the roles of *multi-disciplinary depth* and *trans-sectoral* cooperation in existing as well as envisioned collective adaptation structures. It could be argued that if multi-disciplinary competence is improved in national as well as intergovernmental administrations and institutions, functional redundancy would in many cases increase. If successfully implemented, the knowledge base in these institutions would be broad, but at the same time interconnected trough overlapping and complementary expertise. In fact, implementation of the Ecosystem Approach to Management seems to require such a broadened capability (Hassler et al. 2013). In a somewhat similar vein, it could be argued that improved cross-sectoral collaboration could influence institutional

[12] Although it is true that certain species other than humans can anticipate and plan ahead to some extent, the difference in degree is so large that treating them as different categories in this respect seems reasonable.

functional redundancy. For example, robust management of ecological hazards related to e.g. eutrophication require environmental and agricultural sectors to interact in order to find sustainable practices. Having found effective forms for such interaction, could possibly lead to improved preparedness for handling unexpected events, especially those that otherwise could fall between administrations. At international levels, transsectoral collaboration can suffer from high transaction cost that may make effective interaction difficult. Availability of regional platforms for cross-sectoral interaction among representatives from different sectors and countries, e.g. the HELCOM AGRI/ENV Forum, can important facilitators for improved effectiveness.

Finally on institutional redundancy, it could be noted that the emergence of increasingly thick multilevel layers on environmental governance can be of importance. As noted already in the early 1970s (Dawson 1970), overlapping jurisdiction from local levels up to global conventions can improve possibilities to cushion unexpected ecological disturbances. The primary mechanism would here be the ability to address the disturbance, e.g. propagation of an oil spill in patterns difficult to predict, where authorities at different administrative levels coordinate their efforts over sector and jurisdictional borders.

The value of the concept of institutional redundancy cannot yet be fully assessed. Clearly, drawing analogies between ecological and institutional functional redundancy is not sufficient. Before being useful as a scientific concept, the mechanisms determining institutional redundancy have to be elaborated, including how government coping strategies influence robustness in terms of redundancy.

Conclusions – Why combine collective action and systemic adaptation?

I have in this paper elaborated an analytical framework combining key elements of collective action and adaptation approaches respectively in relation to trans-national governance. A legitimate question to ask in relation to this endeavour is what the expected benefits were, that provided the impetus for this undertaking. A possible answer to this question may build on two mutually reinforcing aspects: (a) that collective action theory underplays collective pressures to adapt and (b) that systemic approaches often base arguments on analogies between ecological and social system, without giving due notice to that key drivers and mechanisms may differ between ecological and social systems, even though they at first may seem to be quite similar.

Departing from the assumption on maximizing of expected benefits, it could be argued that collective pressures to adapt are irrelevant, since states will only act upon factors that are believed to influence their own interests. In this sense, these pressures are not collective. However, to the extent that a large-scale disturbance to marine ecological systems affects several countries, albeit to different extents, it influences the utility functions of *all* these countries and could thus be perceived to be collective from this point of view. It seems reasonable to assume that if, for example, scientific reports indicate that eutrophication of the Baltic Sea is more severe than previously assumed, governments would have incentives to revise their respective coping strategies in this area. Although these revisions – adaptations – are predicted to be small, as investments in nutrient reduction schemes will only be rational as long as benefits from those investments *to the investing country* is larger than the costs, they may not be insignificant. Since governments cannot be assumed to include positive external effects upon other countries, investments will most likely be smaller than what would be optimal from a collective perspective. However, it is important to note that modelling adaptive pressure as is done in this paper, means that investments can assumed to be forthcoming, although not to the extent that would may be hoped for. This argument shows that including the concept of adaptive pressure in collective action analysis may make it more in tune with empirical observations, where the free-rider problematique seldom leads to total inaction.

In order to better understand links between ecological and social systems, it is not sufficient to rely on simple analogies. Drawing analogies may be inspirational, but without including aspects related to human agency and intentionality in defining social systems, they cannot be adequately understood. At least not as long as it cannot be convincingly shown that mechanisms exist that make the system evolve in a predictable manner (i.e. to adapt to changing contextual environments). Thus, modelling social systems has to include modelling of intentionality. It has been argued in this paper that collective choice theory can be used to model intentionality, to show possible drivers of agency. However, this is not the only way to model intentionality. Alternative modes and approaches can certainly be envisioned, building on e.g. bounded rationality, constructivist approaches. The important point made here is that intentionality cannot be excluded.

Finally, as shown in the Discussion section above, further theorizing on interactions between social and ecological systems is necessary in order to better understand preconditions for reaching more adequate adaptation in

transnational settings. However, it is equally important to undertake case studies in order to fine-tune models in relation to concrete, empirical settings. Only then can the type of modelling suggested in this paper be validated, and potentially useful for management objectives.

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