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Governing Power, Knowledge and Conflict in Complex Commons Systems

CHRISTIAN STÖHR

Department of Applied Information Technology
CHALMERS UNIVERSITY OF TECHNOLOGY
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CHRISTIAN STÖHR
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Department of Applied Information Technology
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

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Abstract

This thesis contributes theoretically and empirically to the research about complex commons governance systems that are characterized by numerous and diverse agents, complex distributions of power, incomplete and competing knowledge as well as diverse contestation and conflict processes. Governance refers to a system of public and/or private coordinating, steering and regulatory processes established and conducted for social (or collective) purposes. The thesis identifies challenges and responses for the governance of natural and digital commons systems based on case studies of Baltic Sea Fisheries, Wolf governance in Europe, an action research project in Polish fisheries and a meta-synthesis of the governance of Open Source Software. The analysis of the different governance systems is thereby guided by a universal governance framework enabling a comparative perspective.

The findings suggest that while both hierarchical and self-governance can be successful, cases characterized by agents with diverse cognitive-normative frames and by high socio-ecological or socio-technical complexity tend to struggle to achieve the desired collective action outcomes. As a consequence both natural and digital commons systems appear to move towards middle-ground forms of co-governance attempting to combine hierarchical governance modes with means of participation and inclusion. The research shows that it is not participation per se, but its quality that is critical to overcome the struggles created through powers relations and competing knowledge claims. The findings support a process-oriented and context sensitive approach to participation, which has to be seen in the existing institutional and cultural landscape. Rather than a focus on consensus, well-designed communication processes fostering trust building, learning and capacity building are identified as key mechanisms. The thesis provides some guiding principles for participatory governance in environmental commons scenarios. Indicative evidence suggests those share important characteristics with success factors in digital commons governance. As theoretical contribution, the thesis enhances the development a unified conceptual framework for the analysis of different governance systems based on distinguishable categories of socio-organisational and cognitive-normative governance features. Through its universal applicability to governance analysis, the framework fosters the accumulation of a broad empirical base for theoretical development that is essential to cumulative science.

Keywords: Governance, Commons, Fisheries, Wolf governance, Open Source Software governance, Participation, Co-management, Power, Knowledge, Conflict, Neo-institutionalism, Science-policy

LIST OF PUBLICATIONS

This thesis is based on the work contained in the following papers:

Article I. Burns, Tom R., and Christian Stöhr. 2011. Power, knowledge, and conflict in the shaping of commons governance. The case of EU Baltic fisheries. *International Journal of the Commons* 5(2):233–258.

Article II. Stöhr, Christian, and Ilan Chabay. 2010. Science and participation in governance of the Baltic Sea fisheries. *Environmental Policy and Governance* 20(5):350–363.

Article III. Stöhr, Christian, and Ilan Chabay. 2013. From Shouting Matches to Productive Dialogue – Establishing Stakeholder Participation in Polish Fisheries Governance. *International Journal for Sustainable Development* (forthcoming). Preview available at http://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijsd

Article IV. Stöhr, Christian, and Elsa Coimbra. 2013. Wolf governance in the European Union. *European Studies Review* 5(4):1-18.

Article V. Stöhr, Christian, Bergquist, Magnus, and Jan Ljungberg (submitted): Open Source governance in the face of emerging complexity. *Research Policy.*

Other relevant publications of the author include:

Burns, Tom R., and Christian Stöhr. 2011. The architecture and transformation of governance systems: Power, knowledge, and conflict. *Human Systems Management* 30(4):173–194.

Stöhr, Christian, Lundholm, Cecilia, Crona, Beatric, and Ilan Chabay. 2013. Learning platforms and sustainable fisheries: An integrative framework for assessing adaptive co-management processes. *Ecology and Society (in review).*

Lundholm, Cecilia, Stöhr, Christian, and Beatrice Crona. 2013. Participation, learning and sustainable fisheries: the case of co-management at lake Vättern, Sweden. *Proceedings of the COCE 2013* (forthcoming).

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Christian Stöhr

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Contents

1 Introduction

The sustainable management of shared resources is an ongoing challenge for today's societies. Much commons research has focussed on issues of natural resources such as forests, water, air (pollution) etc. Issues such as resource depletion (e.g. fish, forests), loss of biodiversity, eutrophication, climate change or pollution are filling the daily news. These issues have in common that cannot be handled in an adequate manner by individual action alone, but require complex forms of collective action (Levi-Faur 2012:20) as "'*answers' to changes in societal dynamics and ever growing societal diversity and complexity*" (Kooiman and Jentoft 2009:820). Centralized government command and control structures as the traditional approach to manage environmental issues often appear to be incapable of managing resources in an ecologically, economically and socially sustainable manner, the proclaimed global common goal (Pahl-Wostl 2007, Holling and Meffe 1996, Armitage et al. 2008, Pielke 2004, Renn 2011).

As a response to this challenge, one can find an increasing promotion of more inclusive forms of organization based on arguments that can fundamentally be grouped along the following two lines:

1. The democratic argument: those who are affected by collective decisions (stakeholders, users, society at large) should have a say about the issues (e.g. Barber 1984, Bohman 2000)
2. The effectiveness argument[1]: Participation will increase the quality of decisions (e.g. by inclusion of local knowledge), the capacity to adapt to changes as reduce the risk of non-compliance and conflict. Therefore better outcomes are expected to be achieved at lower cost (e.g. Bell and Morse 1999, Berkes and Folke 2002, Margerum 1999, Dryzek 1990, 2000, Wynne 1996)

These developments in contemporary societies have also affected the corporate world. Classic top-down approaches of companies are increasingly confronted with issues of accountability and shareholder control. Amplified by the increasing development and distribution of information technology, new forms of production and innovation systems emerge, most prominently represented by Open Source Software development (e.g. Feller and Fitzgerald

[1] Effectiveness is a judgement about the performance of a governance system and can be defined as the capability to achieve a desired result. In environmental governance, for example, this usually refers to some forms of sustainability goals. Sometimes, one would add in an efficient way, meaning at the lowest possible cost. As indicated here, there are other performance characteristics that are used to evaluate outcomes of collective processes. Examples include normative considerations (e.g."*principles of good governance*") or aspects of flexibility (e.g. "capacity to adapt to changes") (Pahl-Wostl et al. 2012:28). The distinction I make here is fundamentally related to normative aspects that are present in a society at a time (the democratic argument) and considerations related to more "rational" performance characteristics.

2002) that is inspiring many other areas of innovation and is not compatible with the traditional means of top-down management.

Governance has become the central concept for the steering of collective action arrangements, where multiple public and private boundaries become blurred and powers are distributed among multiple agents. The study of governance addresses key issues of *power*, *knowledge* and *conflict*.[2] Numerous scholars from various disciplines engage in the difficult but necessary effort to better understand how governance systems form, function and transition and how shared resources can be governed in a sustainable manner. Governance analysis is challenging due to high degree of complexity in terms of the material and social conditions. Governance systems are characterized by a high number of actors,[3] relations and dependencies between them, different regulatory processes, diverse forms of knowledge, interests and values that are difficult to understand and coordinate, create non-linear dynamics and may therefore lead to unforeseen developments and outcomes of the governance system as such.[4] Thus, the phenomena under examination are often multivariate, path-dependent and reflexive (e.g., to the process of studying it, Stern et al. 2002:445f.). Causation is hard to discover due to the complexity of the subject and the difficulty of finding measurable variables.

This thesis attempts to contribute to governance research in the context of commons research. First, the thesis provides empirical analyses of three distinct areas of commons governance research, thereby adding to our understanding of governance architectures and challenges and governance research as a cumulative science. Second, through two studies of two particular participatory mechanisms, the thesis improves our understanding of the issues of collaborative governance including the extraction of key principles for successful participation. Third, by suggesting a universal governance framework, this research contributes to conceptual and methodological development of commons governance analysis. Lastly, by including natural as well as digital commons in an attempt to apply knowledge from one area to the other, the thesis also promotes an interdisciplinary approach to governance research. In sum, this thesis results in five papers that cover a broad range of empirical governance issues over different academic disciplines, but that are nevertheless connected through their empirical focus or conceptual grounding. Through this, I attempt to make a contribution to our understanding of the various mechanisms issues and solutions to collective action problems in modern societies.

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[2] The concepts will be discussed later in the theoretical section.

[3] As actors (or agents) I thereby refer to ”*any social unit possessing agency or power of action*” (Kooiman et al. 2005:18).

[4] Flood (1999) referring to Senge (1990) distinguishes two kinds of complexity – detail complexity and dynamic complexity. Detail complexity refers to a high number of variables, “*which are difficult, if not impossible to hold in the mind and appreciate as a whole*” (ibid.:13). Dynamic complexities arises where the effects over time of interrelatedness are subtle and the results of actions are not obvious; or where short term and long term effects are significantly different; or where effects locally are different from effects on a wider scale. I stress here that complexity is not only whether one can keep the number of relevant variables in mind simultaneously, but whether they interact in ways that lead to behaviours that are different than the “sum” of the individual components.

2 Overview / structure of the thesis

The thesis consists of a cover paper and a collection of four published peer-reviewed articles and one paper submitted to an international journal. The papers are based on four separate empirical studies. The thesis is structured as follows:

The next chapter, Aims and research questions, I discuss the general and specific research questions of the thesis and the different research papers.

In the third chapter, The process of the dissertation, I reflect on the process of my PhD studies that underlie this thesis.

In the fourth chapter, Background and theoretical points of departure, I introduce the theoretical perspectives relevant to this thesis and position them within the wider field of existing research on commons governance.

In the fifth chapter, Research design and methods, I discuss the different methods and data collection methods that were applied, including their benefits and limitations for the purpose of this thesis.

In the sixth chapter, I provide a Summary of the articles that provides the research aims, methods and main conclusions.

In the seventh chapter, Discussion, I will synthesize the results of the articles in relation to the overall research question and aims of this thesis.

In the eighth chapter, I provide a Conclusion reflecting on the implications of the thesis findings for commons governance followed by a discussion of the Limitations of the thesis in the final chapter.

The second part of the thesis consist of the five article (I-V) in their thematic order.

3 Aim and research questions

The thesis attempts to improve our understanding of governance by problematizing the challenges that commons governance system face when striving for the effective and sustainable utilization of shared natural or digital resources. It further aims to enhance the theoretical tools and practical guidelines that can be used to analyse and implement commons governance arrangements. Accordingly, my first overall research question of this thesis can be formulated as follows:

RQ1: What are the governance challenges that arise in complex natural and digital commons systems in modern societies and what responses are applied to address those challenges?

This question has a vertical and horizontal dimension in relation to its contribution to the level of analysis. On the horizontal level, I will analyse the three fairly distinct empirical cases of fisheries, wolf governance and OSS software in order to identify and compare the particular issues and governance responses that arise in the face of complex commons systems. Though each of the cases is embedded in its own unique context, a comparative perspective is expected to identify commonalities and particularities of the different cases and thus provide some indications of generalizable results. Accordingly, this question is addressed in all of the papers, whereby the Article I, IV and V use the same conceptual lens of a universally applicable governance framework. For the specific contexts, the following sub-questions can be derived:

RQ 1.1 What are the main characteristics of Baltic Sea fisheries governance? What are the main challenges? (Article I)

RQ 1.2 What are the similarities and differences between the wolf governance arrangements in Germany, Sweden, Portugal and Galicia despite a joined European framework and what challenges can be identified in the different regions? (Article IV)

RQ 1.3 What main characteristics and challenges of the governance of Open Source Software projects that have been examined in the literature and what gaps and inconsistencies can be identified? (Article V)

Besides its contribution of the cases to commons governance in general, RQ 1.1 was motivated by a lack of empirical studies in this region. Studies of fisheries are plentiful within the academic literature on the commons. However, empirical case studies related to participation in European fisheries are still rare, because the European fisheries governance system is still to a large extent a command and control structure and participatory and co-management initiatives are limited to a few member states and/or a very local context (Symes et al. 2003). The general shift of European fisheries governance towards a more participatory paradigm was only recently initiated through a major policy reform in 2002. Thus, earlier studies of European Fisheries (e.g. McCay and Jentoft 1996, Gray 2005, Daw and Gray 2005) that consistently call for increased stakeholder participation as the way forward were not yet able to study the consequences of this shift. The few newer studies (e.g. Griffin 2007, 2009,

Dengbol and Wilson 2008) focus almost entirely on the North Sea Regional Advisory Council as the first implementation of institutionalized participation after the policy reform. We were not aware of any published research related to the participation in the Baltic Sea Regional Advisory Council (established in 2006) by the time of the project.

Similarly, wolf governance (RQ 1.2) has rarely been analysed from a comparative social science perspective in Europe. Most of the existing research focuses on the US context (e.g. Sharpe et al. 2001, Nie 2001) and language barriers in South European countries as well as the fairly recent re-appearance of wolves in Sweden and especially Germany might be among the factors the lack of empirical research. A descriptive, comparative study of these governance systems offers therefore a valuable contribution to the field. The case of wolf governance was also chosen for purposes of similarity and variation among the different empirical studies. While wolf governance shares with fisheries the common dimension of resource degradation as the key issue at hand, wolves – unlike fish - do not have an attached economic value providing an potentially interesting difference in terms of its implications for governance.

The governance of Open Source Software projects is a very young but rapidly growing area of academic research. The Open Source phenomenon is attractive to scholars of commons governance as it is seen as a blueprint case of highly successful self-governance with no formalized authority and regulation. To verify this assumption and understand the mechanisms that explain the success of this mode of organising is not only relevant for the development of this academic discipline in the light of an increasing intertwining of OSS communities and traditional software companies. It can also provide insights that are relevant for other areas of commons governance including environmental issues. Attempts to integrate the various approaches and theoretical perspectives on OSS governance are nevertheless rare. RQ 1.3 is therefore also motivated by the dominance of organizational and management literature in OSS governance. That entails the danger of creating path dependencies and tunnel visions in the academic discourse resulting in approaches that are unlikely to be able to capture the complexity of modern large-scale Open Source projects. Since this thesis uses a conceptual framework that I claim to be applicable to most collective action systems, the objective is to account for such complexities and potentially identify new and understudied areas of research.

The research questions above fall within the discourse of an institutionalist perspectives on commons issues which is most prominently represented by the work on self-governing communities by Nobel Prize winner Elinor Ostrom and her colleagues. Institutions are the focus of much research about natural resource issues and – inspired by this literature – institutional approaches to governance appear more and more in the literature about digital commons as well. In general this approach is characterized by more structural perspectives on governance.

A parallel research tradition in the analysis of natural commons can be summarized under the headings such as co-management theory and environmental communication. These lines of research acknowledge that for the sustainable governance of common resources, the inclusion

of a variety of actors in the decision-making process is of major importance. They often apply a more process-oriented perspective to understand the ways in which grass-root stakeholders and authorities can usefully interact in the face of social, technical and ecological complexity, uncertain information from multiple sources and diverse interests. Thus, the nature of participation including aspects of communication, learning and shared decision-making become more central. I call this a vertical dimension, since the study of such aspects of governance as conducted in this thesis requires a deeper and comprehensive understanding of on-going processes. For this reason, such in-depth studies are only provided for fisheries as one of the three commons fields examined in this thesis. The following two questions therefore focus on the process of participatory governance in the context of fisheries.

RQ 1.4 What is the role of scientists and other stakeholder participation in Baltic Sea fisheries governance? (Article II)

RQ 1.4 addresses the more general issue of the (problematic) relation between scientific expertise and other stakeholders in participatory governance scenarios. It is often claimed that governance processes can benefit from inclusion of science and stakeholders, where science provides a sound factual base for all actors involved, while participatory measures may determine and make evident the relevant values and interests and potentially provide means to manage the conflicts between those values (Stern 1991). However, as stakeholders bring their own "truths" to the table and scientific information tends to be incomplete (Daw and Gray 2005), it is less clear if and how governance systems handle the resulting multiplicity of knowledge claims, knowledge systems and information sources. The Baltic Sea Regional Advisory Council (BSRAC) as the recently institutionalized participatory mechanism for the purposes of knowledge inclusion and consensus finding in a prior technocratic command and control regime was chosen as a well suited case to study this particular question.

As on of the outcomes of this project and the intensive interactions with the members of the BSRAC a follow up project was formed that aimed at improve the fisheries governance process in Poland by establishing a multi-stakeholder forum on the Polish national level. Through this project, the last research question was motivated:

RQ 1.5 How can Polish fisheries governance be made more effective by creating an improved stakeholder participatory process and institution? (Article III)

RQ 1.5 addresses an actual need to for change in the existing fisheries governance process expressed by fisheries stakeholders, environmental NGOs as well as policy makers in Poland. Accordingly, the project was based on the mutually agreed, normative assumption that the actors in Polish governance could benefit from improved stakeholder participation. RQ 1.5 is normative in the sense that it assumes that stakeholder participation can lead to better governance. By "improved" and "more effective" I mean a more inclusive and participatory approach that is able to achieve higher legitimacy and quality of management decisions, at the same time stimulating learning, creating more trust, understanding and capacity among the stakeholders, decision-makers and scientists and that enables Poland to participate more effectively in the European fisheries governance arena. Narrative evidence and failed previous

efforts nevertheless suggested that the specific historical, political and socio-cultural conditions would provide a fairly difficult context. The project was conducted as action research adapting Adler and Birkhoff's collaborative process model (Adler and Birkhoff 2002) for the action planning and implementation of the participatory arrangement – the Polish Fisheries Roundtable. Though the findings were expected to be highly context specific, the results were discussed in relation to the existing literature to derive more generalized findings. Together RQ 1.1, RQ 1.4 and RQ 1.5 also follow the call to study environmental governance systems on various levels (e.g. Brondizio et al. 2009).

The second main question of this thesis concerns the theoretical and methodological issue of how to describe the architecture and functioning of governance systems in a way that allows for comparisons between various kinds of cases:

RQ 2 How can governance of complex natural and digital commons systems with diverse actors, objectives and knowledge systems be conceptualized in a coherent way?

This question is motivated by the argument that much research on governance tends to exist only within the silo of the empirical focus a specific discipline and that a major reason for lack of linkages is the need for better analytical tools that go beyond single case studies (Ostrom 2009). Building on previous efforts and a neo-institutionalist approach to governance (e.g. Carson et al. 2009, Machado and Burns 1998) this thesis aims to enhance the development of a universal governance framework for the analysis by applying it for the comparison of diverse cases of commons governance. The major argument put forward here is thereby the distinction between a socio-organisational configuration and a cognitive-normative configuration.[5] RQ 2 is addressed by three of the five articles (I, IV and V). Article I presents the framework, which is then used for the analysis of three empirical cases of commons governance (Baltic Sea fisheries (Article I), wolf governance in different European countries and regions (Article IV) and the governance of Open Source Software development projects (Article V)). The framework is thereby contributing to answer RQ 1. Thus, the it is both a result and an analytical tool of this thesis.

[5] It can also be seen as an effort to revitalize a systems approach to the analysis of collective action systems that can be applied to various forms of social organization, even beyond commons governance. Some of the ideas can be traced back to Talcott Parsons action systems (e.g. Parons 1938) though he lacked the institutional and cultural concepts and tools, which we have at our disposal. However, the system approach is not systematically developed in this thesis and has to be subject to further research.

4 The Process of the Dissertation

The research and writing of a dissertation is a long process under which the PhD student undergoes a learning and development process that is subject to different influences, foci and experiences. My journey was no exception to this. On reflection, I see this thesis as a synthesis of three major directions I followed during different phases of this process.

The time prior to and at the beginning of my PhD studies and research was heavily influenced by a strong interest in the relation between science and society. As a member of the newly formed Gothenburg Center for Public Understanding of Science (gcPLUS) headed by Ilan Chabay, I gained the opportunity to be part of several projects. Such projects included for example the scientists‘ engagement in public communication of science or the study of science knowledge of different population groups in China. The common denominator of my activities in this group was that they were driven by a strong interest in the relation between science/scientist and different “publics”, but also the normative willingness to actively contribute to an improvement of the existing situations. Within this frame, we started the first fisheries project with the Baltic Sea Regional Advisory Council. It is valid to state that fisheries governance in Europe is a system in crisis. For a long time 80% of the commercially harvested European fish stocks were classified as overfished (European Commission 2007). One of the major motivations thereby was the fact that though the Baltic Sea is a comparatively small eco-system, the institutional complexity is extremely high. It is has nine bordering states, each with an own national arrangement and the EU as supra-national governance body. The focus of this project was the role of science and participation within the context of fisheries relying on the STS (Science and Technology Studies) literature to a large extent. During this time, I had the opportunity to participate in many meetings of the BSRAC and conduct interviews with all kinds of stakeholders, scientists and policy makers. With no previous experience in marine biology or fisheries as such these experiences were extremely valuable for me to create an in-depth understanding of the processes and issues of European fisheries governance and the struggles within the science-policy context in particular.

Through the experiences and communications of this project, we discovered that there was interest and a need to establish a participatory mechanism in Poland that – more than in all other participating EU member states – had difficulties with the engagement in participatory mechanisms such as the BS RAC. In conjunction with Polish stakeholders, scientists and policy makers we successfully initiated a follow-up project that established and institutionalized a new multi-stakeholder fisheries forum on the Polish national level. Our focus switched slightly from a more observational role to active participation in the “action arena”. It became quickly apparent that such an endeavour would not only have to focus the issues of science and participation that were the central theme of the first project but also aspects of communication, trust building and productive dialogue between highly diverse actors, who had little prior experience in analytic discourse towards developing consensus solutions.

A second direction emerged in parallel through my interactions with more general scholars of organisation and political science, e.g. Tom R. Burns. Through our discussions, the idea was

motivated to bring the experiences gained through the Baltic Sea fisheries project to a higher level and make it comparable with other fields of governance. Thus, my perspective shifted somewhat from an in-depth, action-oriented focus on fisheries towards a more theoretical and comprehensive view on governance with neo-institutionalism as its main theoretical core. Within this context, the general governance framework emerged and applied to Baltic Sea fisheries governance. In addition, I was looking for other empirical cases, where I could collaborate with colleagues as experts of a particular field to apply and further develop the framework. In the environmental sphere, I started collaborations related to the governance of forestry and wolf governance. The latter was finally included in the dissertation.

Finally, still following the search for other governance contexts in which the framework could contribute to the existing research, the focus shifted again somewhat to realms outside environmental governance. Inspired by the placement of my PhD studies in an Applied Information Technology department, the discussion and exchange with regard to the governance of digital commons resulting in a project regarding the governance of Open Source Software (OSS) projects at the later stages of my PhD project. A key motivation thereby was thereby the insight that although environmental governance and the governance of OSS projects might appear fairly unrelated they share a significant number of parallels. In a nutshell, I felt that in both contexts, similar collective action dilemmas (e.g. free-riding) arise over a shared resource, which is supported by the observation that popular authors of environmental collective action dilemmas and self-governance such as Garett Hardin and Elinor Ostrom are also occasionally referred to in the OSS literature. They also share the issue of a growing complexity and diversity that the governance systems are supposed to regulate. A key difference lies in that the traditional answer to those challenges in environmental management was the creation of highly centralized and regulated command and control regimes (potentially comparable to "classic" companies), while the phenomenon of Open Source Software emerged from apparently non-regulated communities that somehow manage to self-organize in a way that produces high quality outcomes. Again, one can see the parallels to the work for example of Ostrom on self-governance (e.g. 1990) and factors like institutions, trust and learning etc. are key concepts in both realms. I am motivated to explore these connections further and feel that despite the different empirical contexts, both disciplines can benefit greatly from each other and this thesis contains a first step in this direction.

As a trained sociologist with foci on mathematics and computer science I encountered positivist as well as constructivist epistemologies. The positivist tradition or "crude realism" as Jones et al. (1999) call it, is common among the natural sciences. Constructivists challenge many of the assumptions of the realist worldview and are more widespread within the social sciences. Since central parts of this thesis concern the role of diverse knowledge systems in governance systems, I also found both epistemologies during my interactions with different actors in the field. The sum of the experiences resulted in my own ontology and epistemology. It can be placed in between the two poles of a radical constructivist view that argues that all knowledge is purely socially constructed and a radical, naïve realism. Such a middle ground is reflected in methodological choices made in this thesis.

5 Background and theoretical points of departure

In this chapter, I will provide an overview of the most important concepts and research streams of prior commons governance research that are relevant to this thesis. Due to the broad empirical focus of the thesis on different governance cases with their own academic discourses, the papers touch on a variety of research traditions and disciplines that are sometimes not well linked to each other. In the first part, I will try to clarify the term governance. Then I will discuss how common resources have been conceptualized and what fundamental social dilemmas arise from shared utilization of common pool resources. After that I will introduce two of the main streams of commons governance research – common pool resource (CPR) theory and co-management (CM) theory - and discuss their implications and usefulness for the analysis of governance systems. Both theoretical perspectives are important foundations for the papers in this thesis, but are not well presented in the articles due to the limited space. In the last part, I will present the governance framework that was presented in Article I and used as analytical tool for the analysis of fisheries, wolf and OSS governance (Articles I, IV, V).

5.1 Governance

The concept of governance (Campbell et al. 1991, Ostrom 1990, Glasbergen et al. 2007, Held and Koenig-Archibugi 2005, Hirst 1993, Keohane 2002, Kohler-Koch and Eising 1999, Kooiman 1993, Marks et al. 1996, McGinnis 2010, Young 1997, among others*)* was articulated since the 80s. It can be seen as a result of the emergence of complex hybrid and entirely new forms of coordination and regulation in contemporary society – first appearing through extensive public sector reforms in the US and the UK. Public-private boundaries became blurred, where business interests as well as NGOs became intimately involved with centralized decision-making arrangements such as governments. In some cases private agents have become even more important than government agents. Decision-making authority and sovereignty has been shifting upwards to meta-organizations and supra-national bodies, downwards to regional and local levels and outwards to multiple agents in civil society. Diverse stakeholders, “organizational citizens” (Organ 1988) and the new politics of "organic democracy" (e.g. Machado and Burns 1998) are part and parcel of a major transformation of contemporary governance arrangements and, more generally, “democratic politics”. Academic research from the political sciences reflected these transition processes through a growing body of literature about governance that is central to this thesis.

A parallel research stream emerged in relation to the governance of production systems and corporations. Classic corporate governance studies examine the process of giving overall direction to a private actor (enterprise) and to monitor and control the executive actions of management (Tricker 1984). As in political science, the central phenomenon is the observation that direction and control of companies is increasingly moving away from centralized top-down decision making towards complex stakeholder arrangements. In addition, new forms of production communities have emerged that apply highly decentralized coordination and steering mechanisms. From this stream of research, some notable theoretical directions emerged. System science (e.g. Senge 1990, Checkland 1999) that grew among other things from natural science and management research, acknowledges that the analysis of

social systems has to take into account both the power and influence of rational design but cannot ignore the cultural dimension (Checkland 1999:121). Flood (1999) for example has suggested that organised collective action can be best understood by examining the four categories of process, structure, meaning and knowledge power as "windows" of equal concern (ibid.:94ff). Agency theory (e.g. Eisenhardt 1989) and transaction cost economics (Williamson 1979) examine the conditions under which actors apply bureaucratic hierarchies or market oriented governance structures. However, as both of these theories are focusing on internal rules and procedures, it has been criticised that there is a need for new form of governance analysis that is able to capture the nature of highly complex multi-stakeholder arrangements in modern corporate governance systems (Bhimani 2008, 2009).

Due to the application of the concept in very different fields of study, governance has been defined and conceptualized in many ways. A study by Levi-Faur (2012:5f) of almost ten thousand articles identified over 60 different fields that use the term governance, most importantly from economic journals, management, political science, business, environmental studies, public administration, planning and development, geography, business and finance, international relations, law, urban studies and sociology. The understanding and use of the concept is often explicitly or implicitly adapted to the particular object under examination. Different authors define governance as:

''*the system by which companies are directed and controlled.''* (Cadbury Report 1992:15)

"*as the manner in power is exercised in the management of a country's economic and social resources for development*." (World Bank, 1991:1)

Those definitions, however, appear too narrow for the way I use the governance concept in this thesis. Therefore I define governance as:

"*a complex of public and/or private coordinating, steering and regulatory processes established and conducted for social (or collective) purposes where powers are distributed among multiple agents, according to formal and informal rules.*" (Burns and Stöhr 2011:234f).

Power, knowledge and conflict are key factors of governance. *Power* is a somewhat ambiguous, often pragmatically used concept. As a highly interdisciplinary notion it is used in many different social science disciplines and can refer to a wide spectrum of phenomena. Thus, power means different things to different people. A widespread and useful conceptualization was provided by Lukes (1974) distinguishing three dimensions of power. Inter-agential power, social structural power, cultural power. Inter-agential power goes back to the classic interactionist model of power provided by Weber (1968) as the ability of a actor (or actors) to realize his or her will in a social action, even against the will of others. This one-dimensional view of power, however, tends to neglect the importance social forms of powers that are built into institutional and cultural formations without obvious agential action. Structural power refers to the way structural environments advantage or disadvantage certain agents. So the focus is put less on the direct interaction between to agents but the ability of

one actor to influence this setting against another. This does not only refer to, for example, excluding certain interests from the decision-making process (e.g. by agenda setting) and resource advantages, but the ability to shape the whole institutional arrangement. The latter aspect is sometimes referred to as Meta-power (Burns and Hall 2013, Kooiman and Jentoft 2009).[6] Cultural power addresses the influence of interests, norms, ideologies and values on human behavior. Power in this category refers to the ability to shape collective understandings, orientations and predispositions (e.g. through discourses of normality) (Burns and Hall 2013:25).[7] Thus, when while often power as used in this thesis refers to the interactionist model of power, one should also be aware of the other more subtle forms. Commons governance systems are characterized by a multitude of power relations that can take various forms and affect the performance of the system. The bases of power are diverse: ownership rights, government authority, contractual relationships, powerful laws with sanctioning capacity, norms, knowledge based and expert power, power based on position in communities and informal important networks, etc. As power is moving away from centralized patron-client types towards hybrids that include horizontal, network, market or democratic-like decision making structures and increasingly also various forms of "soft powers" (Carson et al. 2009), these relations become increasingly complex and are not always visible.

Further, complex governance systems rely on a multitude of information and entails *knowledge* acquisition and production processes, particularly about the object(s) of governance to learn more about the issue(s) and increase the likelihood of effective decision-making. Often however, there will be a variety of knowledge claims about the state of the world by different scientific disciplines or stakeholders and uncertainties remain. Governance

[6] The meta-power perspective stresses the separation between actors exercising power and control activities within existing institutional arrangements, normative orders, cultural forms, and, on the other hand, actors exercising power and control over institutional arrangements, normative orders, cultural forms, that is, to alter or transform existing orders (Burns and Hall 2013).

[7] In this book, the authors present and develop a Causal-Mechanism theory of power. They outline that power in social life is typically characterized by complexes of potential causal factors, mechanisms which entail "control", "influence", power over, power to, etc. with respect to states of the world, agents, activities, developments. Power systems are therefore based on causal factors or complexes, which can be "owned" and manipulated in relation to social action and interactions and their outcomes. Some rules, for instance relating to ownership or positional authority, give to particular social agents control ("control rights") over resources and agents, which are a major basis of social influence or power. Under particular conditions, rules and rule complexes may habitually or routinely cause X to happen rather than Y. The agents involved might not know of the causal process or its effects. The agents involved may not have willed the governing process and its outcomes. Power is then understood as potential causality or capability that may or may not be exercised. Causality is thereby understood as manipulability. Expending on existing conceptualizations of power (e.g. Lukes 1974), they distinguish between agential, social structural and material/ecological mechanisms as qualitatively distinct categories of power modalities (families of causalities) (Burns and Hall 2013:30). While this conceptualization appears very convincing, it is not systematically followed in this thesis.

systems therefore tend to prioritise certain forms of knowledge over others (e.g. scientific expert knowledge). Complex commons systems are nevertheless increasingly dependent on the ability to integrate diverse knowledge systems and allow for learning and adaptation, increasingly in efforts to realize them through forms of stakeholder inclusion in the decision or knowledge creation processes. Renn and Schweizer (2009) distinguish six forms of stakeholder and public involvement (ibid.:180). They argue that in environmental governance, a combination of functionalistic and deliberative approaches appears to be well suited to the aim of incorporating all problem-relevant knowledge and values and finding the best possible consensus among the affected parties. The question about *how* this can be practically achieved is nevertheless challenging and subject to further debate (see later).

Lastly, as multiple forms of power, regulatory processes, knowledge and interests are entailed within a governance system, tensions and *conflicts* about the proper design and functioning of the governance system are likely to occur on various levels. Adapting Rahim's definition (1992:16) I use conflict as "*an interactive process manifested in incompatibility, disagreement or dissonance within or between individual and/or collective agents*". Those directly involved as well as those affected in one way or another are likely to be concerned about issues such as definitions of problems, goals, preferred governance forms and procedures (public, private, hybrid, etc.), procedures for deciding what are "problems" or "solutions", or what are strategies and methods to use in finding solutions. If not addressed, strong conflicts can (but don't necessarily have to) lead to a shift in but also failure of the governance system. Thus, governance systems apply measures to coordinate and integrate this diversity within their governance conceptions often accompanied with explicit mechanisms of conflict management and resolution.

Levi-Faur (2012:8) argues that governance has at least four different meanings that are often not clearly elaborated: governance as structure, process, mechanism or strategy.[8] Rhodes (1996, 1997) identifies six distinct applications of governance in contemporary society:

1. The minimal state
2. Corporate governance
3. New public management
4. Good governance
5. Socio-cybernetic systems
6. Self-organizing networks

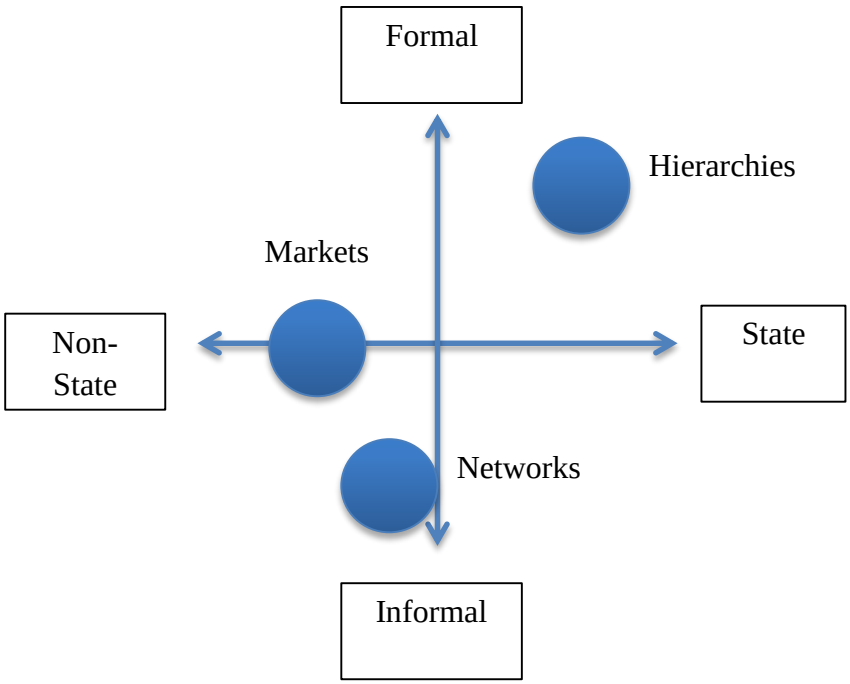
Nevertheless, it appears that most definitions of governance share some key factors that appear to reappear in one or the other form. Ruhanen et al. (2010, similarly Bevir 2011:2) in their review of governance literature identify three common aspects. First, there seems to be consent that governance is not the same as government. Governance is more and involves aspects of steering and "rules of the game" (tasks that nevertheless can be executed by a government). Further, governance seems to imply moving power and control away from the

[8] The parallels of this observation to Flood's (1999) suggestion to integrate the categories of process, structure, meaning and knowledge power as "windows" of equal concern in a system-thinking approach should be noted, even if he does not use the word governance.

top resulting in less predictability, self-evident leadership and no given hierarchy (although some form of government may have the role of monitoring and overseeing the task that are to be completed, which the concept of "steering" actually refers to, see e.g. Offe 2009). And third, governance involves multiple stakeholders and thus some form of stakeholder relationship management.

On a structural level, Williamson (1973) was the first who introduced the fundamental distinction between markets and hierarchies as fundamental modes of governance structures, which was later added by network governance (Powell 1990, Rhodes 1990) that pointed at the importance of networks as governance structure and institutional arrangement as well as the informal spheres of authority (Levi-Faur 2012: 6, Thompson et al. 1991). In this structural perspective on governance, the different modes can be distinguished along the dimensions of "state actors involvement" and "formality of institutions" (Wostl 2009) (see Fig. 1).

Fig 1. Bureaucratic hierarchies, markets and networks according their degree of formality of institutions and the importance of state actors (adapted from Wostl 2009)



Kooiman and Jentoft (2009) distinguish three distinct governance modes: Hierarchical governance, self-governance and co-governance. *Hierarchical* (or top-down) *governance* relates to steering and control mechanisms that characterize the interactions between a state and its citizens or in large corporations. The authors also point at the fact that in recent years, hierarchical governance has become redefined from the view of a commanding top-level actor towards a more regulatory one. *Self-* (or bottom-up) *governance* refers to the capacity of actors to organize themselves without state intervention and that emerges "from the bottom" (unlike deregulation or privatization). To examine the conditions under which self-governance emerges effectively is the key mission of Elinor Ostroms work on commons and Open Source Software projects are often seen as a prime example of self-governance in the area of digital commons. *Co-governance* refers to governance arrangements, where different actors in

societies collaborate for a common purpose giving up some of their identity and autonomy in the process. Co-governance arrangements appear under different headings in the literature such as public-private partnerships, collaborative learning, networks and co-management. In contemporary societies, governance is exercised through mixtures of these modes. The last two modes – self-governance and co-governance - will be subject to further discussion in the next two sections of this chapter that introduce common pool resource theory and co-management theory.

5.2 Commons governance – resources, actors, rules

To narrow the scope of governance systems that are examined in this thesis, it is helpful to look at the kind of goods that are supposed to be governed. What characteristics are shared by fish stocks, wolf populations and Open Source software products? In the commons literature it has become popular to follow the conceptualization of goods has been provided by Elinor Ostrom (e.g. 2005). Rejecting (or better enlarging) Samuelson's (1954) conditions for public goods, she suggested a two-dimensional matrix along the axes of subtractability of use and difficulty of exclusion (Table 1).

Table 1: Characterization of goods

	Non-subtractable (Non-rivalrous)	Subtractable (Rivalrous)
Hard to exclude actors	Public goods	Common pool resources
Easy to exclude actors	Private goods	Club goods

For this thesis we are particularly interested in resources that provide some form of yield and where it is difficult to exclude somebody from using it. Fisheries stocks (Articles I, II and III) are a classic example for a common pool resource (CPR), since in addition to the difficulty of exclusion, using the resource implies that the harvester subtracts items (fishes) from the resource pool that then are not available to other users. Agents can, however, try to turn the CPR into a private good as done in fisheries by right-based management. Thus, CPRs are always also social constructions.

Software under an Open Source License can be considered as an example for a (quasi) public good. Everybody can download and use the software, but this does not limit the potential for others to use the software as well. However, the condition for this non-subtractability is that the software is protected from proprietary appropriation. It has been argued that while software under an Open Source licence generally meets the characteristics of public goods in the present, it also shares some characteristics with common pool resources in that the future stream of benefits might be at risk (e.g. O'Mahony 2003). Again, it becomes apparent that there is a social component – in this case the rules of the Open license – that determine whether or not a good is considered a public good, CPR or private good.

To characterize wolves in this scheme appears less obvious and some might argue that it is not possible at all. As fish and OSS software, wolves can be characterized as non-exclusive

good, but to answer the question of whether its use is subtractable or not is not as trivial. One has to think about the question – what is the use that might or might not be subtractable? While some might see a use value out of hunting wolves (e.g. as trophy), others see a value out of maintaining bio-diversity. Others again might not attach any use value as such, but experience costs through the damage caused by wolves on livestock (sheep etc.) and some might see a danger in the presence of wolves due to the (true or false) risk of attacks on humans. This is an illustration of the general difficulty of this conceptualization to take account of the different values that humans put on goods since this classification assumes a more or less uni-dimensional utility that is often connected to some form of monetary value. Goods like sacred forests, animals or cultural artefacts are difficult to fit in this conception, but are nevertheless relevant for the governance of bio-diversity issues. In the "hunting resource" paradigm, wolves would be a common pool resource similar to fish stocks. In a protection-value paradigm, wolves would be considered as public good since, the joy of knowing that wolves are present does not influence the joy of others. However, since the presence of wolves might cause perceived or real costs (in terms of feelings of threat or damaged livestock) to other actors, it also can be considered a common pool resource in a wider sense that the increased protection of wolves leads to increased costs for others as well. Once more, the social construction of "goods" becomes apparent as wolves (and many other resources) can be both considered being harmful and beneficial to the environment depending on the actor's perspective. There is no fixed point in terms of the observer or system boundary. Thus, while the conceptualization of these four types of goods has analytical value to illustrate some of the social dilemmas that arise from the joined use of resources, one has to be aware of its limitations (mainly due to its rooting in political economics).

As I demonstrated for the kinds of resources that are included in the empirical studies of this thesis, there are very few examples of definite "natural" CPRs. "Natural" here refers to resources where the difficulty of exclusion is a non-changeable fact. Rather, this aspect is always closely related to technical and institutional innovations in modern societies. Even though for example air might be considered as such, there is now way to know whether this will not change in the future as technology and societal developments might allow or require a privatisation of this good. In fisheries, for example, one direction of governance is in fact the attempt to turn the collective good into a private one by institutional mechanisms that are known as "right-based management" or "individual transferable quotas". I like to think that the term commons captures this aspect well, though I was not able to find a strict definition of the term commons in the literature. Commons do not only consist of a common pool resource or public good, but also include a well or ill-defined group of actors (a community) that share the resource based on a set of rules regulating the communing. This can be easily demonstrated with digital commons like Open Source Software. The same software stops being a common, if a proprietary license is applied. One could even argue that commons always include some form of management rules since otherwise (e.g. a resource used by all without any regulation) is simply an open access common pool resource. However, since we are interested in the governance of commons that by definition includes some form of management a final clarification in this matter does not appear of major importance to this thesis.

In the following I will discuss some of the most important streams in commons research. I will start with the "tragedy of the commons" as this concept, though heavily criticized (see later), has been very influential in the governance literature on natural resources and also appears frequently in the literature on digital commons.

5.3 The tragedy of the commons

A fundamental social dilemma of the governance of natural and digital commons has been firstly described by Gordon (1954) and Scott (1955) and became popular as the "tragedy of the commons" (Hardin 1968). Imagine a group of actors is individually utilizing a shared but subtractable resource (a common pool resource). The utilizing agent creates an individual benefit. The resource unit is subtracted from the common pool and therefore is lost for others. Thus, the costs (the subtracted unit from the common pool resource) are shared by the whole group. If all actors would limit their utilization efforts to a sustainable level, the resource would not be depleted. A in a game theoretical sense rationally acting agent (Neumann and Morgenstern 1944), however, will strive for the maximum individual share of the common pool resource to gain maximum profit (defect). This statement is true, no matter whether the other actors limit themselves or follow the same strategy, since in both cases, the individual profit for the rational agent will be higher than if he would limit his/her efforts (collaborate). Since this calculation is true for all actors, tragedy of the commons predicts that despite the fact that the maximal joined benefit could be achieved if all actors would collaborate (limit their utilization effort), everybody will strive for the maximal individual benefit resulting in the collapse of any common pool resource, given a population of a certain size. This concept is closely related to the prisoner's dilemma (Rapoport and Chammah 1965) in game theory and a related model has been brought forward by Mancur Olson in "The Logic of Collective Action" (Olson 1965). Olson states that once an individual member of a group cannot be excluded from the benefits of a collective good that the group is accessing, there is little or no incentive for that person to contribute to the provision of that good. So the explanatory core of all of these models is the problem of free-riding.

Especially Hardin's model became very influential not only in the scientific community but also politically because of its political implications. According to Hardin, there are only two solutions to solve this dilemma: a strong regulator (the leviathan or state solution) who is able to enforce communing rules to keep the individual utilization at a sustainable limit or the privatization of the common good (the market solution). The market solution would try to privatize the common resource by assigning shares of the resource to different actors. This would break the race for resources and motivate each single owner to sustain his share of the resource. Especially the idea of a single governmental owner had great influence on the policy making in the 1960s and 70s particularly in developing countries, e.g. through the establishment of state-governed National Parks. For the majority of these cases, however, the consequences of this transfer of ownership were disastrous for the common pool resource (Kopelman et al. 2002:11).

Thus, as influential Hardin's model became, it was also strongly criticized. Most popularly, 2009 Nobel prize winner Elinor Ostrom, but also others, argue that Hardin's analysis of common situations including its inherent assumptions does actually not represent an accurate

generalization of commons issue, but a rather special case under particular circumstances. In short, these conditions are (Ostrom 1990):

- No communication
- Very large systems
- High value resource
- Open access systems
- Diverse harvesters
- Fail to develop rule systems

Social mechanisms to moderate self-interest such as communication, trust and the ability to make binding agreements are not considered in Hardin's model but nevertheless empirically play an important role in terms of creating self-organized communities that do not result in the scenario described by Hardin. Increased coordination and communication can affect the likelihood of free-riding which might then lose its potential for being the dominant strategy (Runge 1984a, 1984b).[9]

Further, since common pool resource scenarios are usually characterized by a high degree of detail and dynamic complexity (Flood 1999), the knowledge about the system and its dynamics usually contains a significant amount of uncertainty. Experimental research in social psychology suggests that there is tentatively evidence that uncertainty reduces the collaborative potential in resource dilemmas (Kopelman et al. 2002:125). Decision-makers therefore often rely on science to offer assessments and prognosis about the state of the commons system and potential issues. The assumption is thereby, that complexity can be managed by a technocratic "get the facts and act" model, where scientific expert statements enter the policy process as reliable and valid "truths" (Polany 1962, Proctor 1991) to base and legitimate decisions. This "modern" understanding of science faces its limits, as in complex commons systems, technological, methodological and epistemological uncertainties[10] tend to

[9] In terms of game theoretical considerations a commons situation is therefore not necessarily best formalized by the prisoner's dilemma. Often such a situation can be better conceptualized as "assurance" or "chicken" game. Although all three models are similar in their set-up, the difference lies in the pay-offs for the different strategies. In the chicken game, the costs of defecting behaviour are much higher for the players compared to all other strategies. The most prominent example for a chicken game is a scenario, where each player is driving a car towards the other. If all players defect the costs of crashing into each other are enormous. In the assurance game, the pay-off of cooperative behaviour is much higher than all other strategies but only if all players decide to cooperate. The important inherent critique is that unlike in the prisoners dilemma, where non-cooperation is the only rational strategy, neither of these models has a dominant strategy, since both have multiple equilibriums. Thus the players would benefit from investing in coordination.

[10] Technical uncertainty relates to issues of precision and accuracy like "How many digits are reliable"?" Methodological uncertainty is in the choice of appropriate research methodologies and

remain (Funtowicz and Ravetz 1990). Wilson (2002) argues that scientific institutions often develop certain approaches (like single species approach, the definition of statistical areas) that create path dependencies through the established scientific patterns. These patterns do not necessarily reflect the best scientific approach, but are still used today due to this path dependency. Appell (2001) goes as far to as suggest that the amount of uncertainty and necessary assumptions in the examination of complex socio-ecological systems are of such a high level that it might be better to describe the process as art rather than as real science. In practice that means that for many parts of the scientific process, a lot of experience is needed. This results in a strong dependency on the individual scientist rather than an objective method that can be repeated by another scientist.

Hardin's model provides a valuable grounding for thinking about commons issues and much research about natural and digital commons tries to specify the conditions under which the tragedy can be avoided. Applied to the commons governance cases in this thesis, overfishing can be viewed as a case of the tragedy of the commons. In fact the influential works of Gordon (1954) and Scott (1955) use fisheries as empirical cases. In a shared pool of fishing resources (e.g. in the Baltic Sea) it appears rational for each individual fisherman to catch as much fish as possible despite the risk of a collapse of the fish stock. This is because no matter whether the other fishermen use the same strategy or try to limit their efforts, this strategy gives maximum profit to the individual. Therefore it is assumed that if all fishers act rational, all will choose their dominating strategy, which is to catch as much as possible. In consequence, the fish stock will collapse at some point and the overall benefit of the population will be smaller than if the fishers would have been collaborating. Given the difficulties to achieve sustainable fisheries all over the world, the model of the tragedy of the commons seems to be highly relevant and applicable in this context. Even in its conclusion the tragedy model seems interesting for analysing the European fisheries governance. Fisheries was one of the first political areas in Europe, where the decision making power had been centralized by transferring fundamental powers from the national level to the EU level. From there, the EU tries to limit fishing effort through the setting and enforcement of quota regulations. However, after 40 years of centralized European fisheries governance it must also be concluded that this solution has not been very successful.

The tragedy of the commons model has also been applied to OSS projects (e.g. Weber 2000, Schweik and English 2007). In natural resource management the tragedy is overharvesting. The direct parallel to OSS would be the download and use of the developed software, which does however not fit the tragedy of the commons model. Software is not a subtractable resource, so the extent of downloads and use of the software does not limit the use opportunity for others to utilize the software as well. Intense utilisation is actually considered as highly beneficial to the OSS project as the more people download and use a software, the more popular it becomes and eventually even turns into a de-facto standard. But a theoretical

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methods. Epistemological uncertainty means the lack of knowledge about what actually can be known about the system and how one verifies that one knows it.

tragedy of the commons in OSS development can be found in the problem of lacking individual incentives to contribute to an OSS project (Schweik 2005). Since everybody can download and use Open Source software whether or not he or she contributed to its creation, nobody has a rational incentive to spend time (costs) to contribute to the necessary programming efforts. Thus, the tragedy of the commons model (or more precisely the logic of collective action) would predict that no software would be developed at all. Similar to the empirical evidence of the existence of self-organizing communities in natural resource management (Ostrom 1990), the existence of successful OSS projects such as Linux, Apache or Debian make clear that Hardin's prediction can not be true under all circumstances and the question how collective action systems overcome this dilemma has stimulated a rich body of research about natural and digital commons.

As we have seen, wolves are more difficult to conceptualize under the commons model as they lack the direct attachment of an economic value. Therefore it is also not as straight forward to apply the tragedy model. For wolves as hunting resource the tragedy would follow a similar logic as with fisheries. But although there might be some yield for hunters in terms of wolves as trophies for most part of the last centuries, this yield would generally be considered to be outweighed by the damage that wolves caused and thus the depletion of wolf populations was generally not considered to be a tragedy. This has changed however during the past century, where a paradigm shift can be observed. The functional role of large carnivores for eco-systems, but more importantly the general conservationist movement put a higher value on biodiversity and the existence of wolves (e.g. Ray et al. 2005). Survey research in several countries suggests that the result of this development is comparable with a "not in my backyard" effect. The support for wolf conservation is generally high, but opposition can be especially found in areas where wolves actually exist (e.g. rural areas, see e.g. Williams et al. 2002). These conditions can be interpreted as a tragedy of the commons scenario as even though there is a general interest to preserve the "shared resource" wolves, the individual interest in not having wolves the actor's local environment would – if realized - lead to the disappearance of wolves in the whole area.

However, as shown here and in many other examples, empirical evidence created doubts about the general validity of tragedy model and its implications. Out of this observation, insightful research emerged that put the role of social mechanisms to control self-interest in the centre. In natural resource management, that research follows two streams that until recently tended to ignore each other (Symes and Hoefnagel 2010). One direction focuses on the study of commons institutions (e.g. the common pool resource theory, Ostrom 1990) and the other on co-management theory (e.g. Jentoft et al. 1998). Both provide important groundings for the study of commons governance systems.

5.4 An institutional perspective on governance analysis

Institutional approaches to theorizing and empirical research have contributed, in general, to increasing interdisciplinarity in the social sciences. Among the major contributions here are the works of March and Olsen (1989), North (1990), Ostrom (1990, 2005), Powell and DiMaggio (1991) and Scott (1995). Institutions are "systems of rules" that govern social interaction and may be normative (shared understandings) or formalized (e.g. laws, procedures etc.) (Carson et al. 2009:22, see also Rosenau 1995, North 1990, Burns and Flam 1987). They also generate inertia or path dependencies based on how similar issues have been handled in the past, and based on the power-relationships defined in those rules and the underlying assumptions embedded in them (Steinmo et al. 1992). There may be substantial inconsistencies, incompatibilities, or incommensurability between what is considered the most compelling way of thinking about a set of issues or problems and the way in which existing institutional rules dictate that it should be dealt with. This can result in obstacles to effective problem solving, undermined legitimacy, tensions and conflict that destabilize the existing social order (Burns and Carson 2002).

Neo-institutionalists attempt to integrate the reciprocal influences of socio-cognitive phenomena and structural forces on human action and agency. Actors do not see the world only through their individual perspective, but through collective frameworks with which they take part in, evaluate, sort, and in other ways manage the information available to them (Sabatier 2007). These models are socially constructed and transmitted and may have real material consequences. Neo-institutional theories challenge perspectives in which the role of rationality dominates the governance process. They recognize that collective action outcomes are not merely the result of packages of bargains made by actors pursuing their economic self-interest. Rather, they are the result of bargains and compromises made by changing configurations of influential actors who are guided by their own cognitive models of how the world is constructed, and from which they pursue their perceived ideal and material interest. "*People act in part upon the basis of myths, dogmas, ideologies, and 'half-baked' theories.*" (Denzau and North, 1994:3). Rationally constructed explanations are nevertheless relevant in the process of giving accounts for the decisions made. But, rationality is context bound, operating within the parameters of these cognitive models (Simon 1957, Nee 1998, March and Olsen 1989). Therefore, the institutional approach stresses the structural contexts, which shape agents social relations and interdependencies as well as their situational action opportunities and constraints, their knowledge and models of reality, their values and interests, and modes of judgment.

Institutionalist theories tend to stress the enduring and stabilising of collective action. Nevertheless one should not get trapped in the assumption that cultural and social-structural forces (values, norms, structures, routines etc.) only circularly self-reinforce a given situation (Bresser and Millonig 2003:234) and therefore struggle to explain how institutional innovation and change occurs (Powell and DiMaggio 1991: 29).

5.5 Common pool resource theory

Common pool resource (CPR) theory has the question of voluntariness of collective action as its essential core. Elinor Ostrom argues that theoretically, there is an alternative solution to the tragedy dilemma than suggested by Hardin. She shows that self-organization of the harvesting population in form of binding contracts among the population individuals solve the dilemma, whereby the individuals design their own contracts in the light of the information they have at hand (Ostrom 1990:17). She suggests using an institutional perspective for common pool resource issues by asking the question under which circumstances resource users collectively seek to overcome the tragedy of the commons. Out of the empirical analysis of numerous cases studies of self-organized collective action systems, she identified factors that make successful self-organization more likely. She developed her famous design principles that seem to apply in a general context. These design principles are:

1. Clearly defined boundaries of the CPR and the individuals (or households)
2. Congruence between appropriation and provision rules and the local conditions
3. Collective choice arrangements
4. Monitors are accountable or are the appropriators
5. Graduated sanctions by other appropriators, by officials accountable to these appropriators or both
6. Conflict resolution mechanisms
7. Minimal recognition of rights to organize
8. For CPRs that are part of larger systems: nested enterprises

Other authors provide similar design principles with sometimes slightly different foci (e.g. Hanna et al. 1995, Pinkerton and Weinstein 1995). These design principles have been become widely accepted within the research community and confirmed in a large number of studies (Cox et al. 2010 for a review). Although these are mainly situated in the context of natural resource self-governance, scholars have acknowledged the value of Ostrom's design principles for digital commons and suggested ways in which they can be usefully translated and/or adapted for the design of online-communities (e.g. Kollock 1998, Viégas et al. 2007, Kondratova and Goldfarb 2003).

The CPR theory also addresses the question how an existing system can be changed and develops towards these favourable conditions. Institutional change happens if new institutional rules are implemented. Institutional rules are thereby: *"prescriptive statements that forbid, require or permit some action or outcome"* (Ostrom 1990:138). From a theoretical perspective, the investment in institutional change is a similar issue as the prisoner's dilemma. The first order problem of resource utilization reappears at the second order level of institutional change. Self-interested individuals that act rationally and take the maximum out of a given common pool resource do not have an incentive to invest in the creation of new rules and institutions. Ostrom, acknowledging the pessimistic theoretical prediction of game theory for institutional change, nevertheless shows empirically that institutional change is possible. In the cases she studied, she discovered that change is more likely to be achieved, if it happens in small steps avoiding big investment in the beginning without knowing what the other party does. In addition, early successes are helpful in giving the process of change a momentum. McCay (2002) stresses the importance of considering

values and cultural aspects in addition to a pure methodological individualism of classic rational choice theory. It is suggested that a more useful approach in analysing common resource issues is "economics of flexibility" that views flexibility as the prior goal for an adaptive process as the "uncommitted potentiality for change". Other neo-institutionalist researchers address mechanisms of institutional transition by changes in existing power configurations (e.g. Burns and Stöhr 2011) and/or the application of meta-power as the as the ability of agents to alter an existing institutional order (Burns and Hall 2013). Increasingly, one can also find attempts to link institutional approaches to aspects of individual and social learning (e.g. Pahl-Wostl 2009).

The CPR theory with its focus on self-governing communities has gained a lot of attention from the research community. Five major lessons can be drawn (Stern et al. 2002:456f):

1. The tragedy of the commons model has its limitations
2. Three conditions are necessary but not sufficient for the emergence of self-organized institutions – salience of the resource, autonomy of the users to devise and change rules and the ability of users to engage in direct communication
3. One form does not fit all
4. Success means different things to different people
5. Indirect and mediated effects are important

These conclusions support approaches that argue for the empowerment of the local actors, the communication processes between the actors and arrangements that show maximum adaptability to the local conditions and context.

Nevertheless the theory has been criticized for being too limited in order to provide sufficient explanations for failures of collective action in common pool resource scenarios, since it assumes that the common pool resource is a single-use resource and it tends to focus on only internal factors that support environmental management processes (Steins and Edwards 1999:540). Further, though Ostrom's design principles provide valuable guidelines for institutional design on the community level, translating these principles to higher levels of institutional design is still an unsolved challenge. Young (2002) points at the importance of cross-scale linkages between the supranational, (sub-) national and local resource regimes. These cross-scale linkages create tensions that are necessary to put the differences between higher-level decisions and local conditions on the table. While higher-level institutions are capable of considering functional interdependencies, they are often not able to consider regional particularities both in terms of the conditions of nature as well as interests and knowledge of local stakeholders (Young 2002:283). The commons framework, however, tends to focus too much on the predefined design principles instead of focusing on the process by which collective action is constructed and social capital can be built up for linking governance systems across levels of social organization. Similarly, Dietz et al. (2002) point at the multiple levels governance, the effects of group size on the performance of institutional arrangements and the role of different mechanisms of conflict management as major understudied fields of research about common property resource management. Ostrom in her later work (e.g. in Dietz et al. 2003, Brondizio et al. 2009) tends to argue for solutions consisting of a mix of institutional types that despite its nested and layered form allow for

experimentation, learning and change. Practical examples and empirical research do not yet allow for an evaluation of such strategies. Several of these areas are addressed by one or several papers included in this thesis, but are also in the centre of co-management theory, the other major stream of commons governance.

5.6 Co-management theory

Co-management (CM) starts from the assumption that participation in environmental governance is connected with a positive input on the overall performance of the governance system in terms of compliance, effectiveness, legitimacy, knowledge gathering and local adaptation. It is based on a critique of high level centralized management approaches that can be briefly summarized as (Young 2002, Berkes 1999, 2002):

- Centralized management tends to find equal regulations for a wide area and number of ecosystems, which creates problems, if the local variation is high.
- Centralized management tends to ignore the local knowledge, which is used in local institutions and rely on internationally accepted (scientific) practice.
- Higher level institutions encourage the larger and more influential stakeholders (such as environmental NGO) as opposed to local organizations and groups that reside within the ecosystem that they exploit.

CM accepts that the design of some form of centralized governance mechanism can be beneficial (as opposed to e.g. pure self-governance), but argues that a conscious effort has to be made to protect and include local interests and rights. CM therefore stresses the importance of partnerships between the different levels (Young 2002).

CM gained considerable attention both by scholars and political actors in the last two decades and can be defined as "*the term given to governance systems that combine state control with local, decentralized decision making and accountability and which, ideally, combine the strengths and mitigate the weaknesses of each."* (Singleton 1998:7). Most definitions of CM see the some form of power sharing between a central authority and local resource users in terms of the rights and responsibilities with regard to a particular resource, as the central element (Berkes et al. 1991) However, it should not be ignored though that communities as well as the state are usually characterized by a variety of arrangements, which can take very different forms (Carlsson and Berkes 2005). Over time, the term co-management has been used synonymously with a whole range of inclusive governance schemes including participation, partnerships and community-based management. Berkes (2009) identifies a number of different aspects of co-management that appear in the CM literature: CM as power sharing, institution building, trust and social capital, as a process, as problem solving, CM as governance, as innovation, as conflict resolution, as knowledge building and CM as social learning.

Carlsson and Berkes (2005) argue that the classic view of CM entails the danger of putting too much focus on the formal side of power-sharing while disregarding the actual function of co-management as an ongoing problem-solving process. Successful co-management therefore

also relies on the existence or development of social sources on and between all levels such as trust, understanding and reciprocity, formal and informal social networks, social memory and leadership and social capital both within the affected community and society at large (Folke et al. 2005, Pretty 2003). Thus, scholars of CM, particularly adaptive co-management (ACM), highlight the social context of adaptive management (Lee 1993) and the concept puts particular attention to the process of governance through shared authority and decision-making, learning and the ability to adapt to changing conditions (Plummer and Armitage 2007, Plummer and Fitzgibbon 2004, 2006, Plummer 2009). ACM scholars point out that while CM must be tailored to specific contexts (Armitage et al. 2009, Berkes 2009), it can potentially address the problem of "fit" by e.g. enhancing the congruence between social institutions and biophysical systems (Olsson et al. 2007, Galaz et al. 2008), and provide arena in which to embrace uncertainty (Fennell et al. 2008) and, build adaptive capacity (Armitage 2007, Fabricius et al. 2007).

The move towards more cooperative governance and CM with inputs from government and citizens is usually developed supplementary to existing environmental regulations and therefore context- and path-dependent, experimental and often incremental. In a complex environmental governance regime with multiple scales, levels and varying degrees of linkages between them, it is unlikely to that ideas are pushed at the same point in time at all levels. Instead, such a process is typically initiated by one or a coalition of public or private actors that put pressure on the existing system. This can be from top-down (as the introduction of Regional Advisory Councils by the European Union see Article II), bottom up (e.g. the Polish Fisheries roundtable, see Article III) or mixtures of it. It can also entirely rely on private actors, where the public administration is rather marginalized in the beginning (e.g. certification schemes). ACM scholarship recognizes that such a process typically involves a number of phases across multiple scales. Such phases include preparing the system for change by engaging actors and building networks; seizing windows of opportunity to affect change and working to build the resilience of the governance system by continuous learning, negotiation and experimentation (Plummer 2009, Olsson et al. 2004). They are influenced by the socio-cultural and political context in which the process is situated as well as the properties of the social networks between actors, assets and attributes of the actors involved. For example, Folke et al. (2005) outline that the creation of an ACM approach is connected to a number of conditions and pre-conditions on all levels that make success of self-organized governance structures more likely. Among others (like social networks, trust, leadership) they point to the fact that "to emerge and be effective, self-organized governance systems for ecosystem management require a civic society with a certain level of social capital" (Folke et al. 2005:452.) While ACM work stresses the importance of adaptive capacity, social learning, communication and shared authority, and shared decision making to achieve desirable environmental governance outcomes (Plummer and Armitage 2007), a recent review of the growing body of ACM work (Plummer et al. 2012) concludes that the ACM literature has been rather vague on how these features are practically achieved. On the other hand, literature from the field of environmental communication (e.g. Cox 2006), collaborative and social learning (e.g. Wals 2007, Ljung 2001) and trust building (e.g. Siegrist et al.2007) provide numerous practical examples using these concepts as both design principles and successful tools that might not be well integrated into the ACM literature. In this thesis, in addition to the

institutional analyses of the different commons governance systems, Article II and III (and also Stöhr et al. forthcoming) address those issues in detail.

5.7 A general framework for governance

As outlined above, commons do longer refer to natural resources only. New commons governance arrangements have emerged that fall under categories such as digital, information or knowledge commons. Open Source Software (OSS) that today reached significant economic impact and successfully competes with traditional proprietary software solutions in many areas. The formation, functioning and transformation of these types of digital commons are mainly studied by organisational and management disciplines as well as in academic research about information systems and related fields. Given the different academic roots of the research about digital (organisational and management sciences) and natural resource commons (sociological and political sciences) it is not surprising that despite some remarkable exceptions (e.g. Hess and Ostrom 2007, Schweik 2003), bridges between the two areas remain marginal. This reflects a general issue of governance research in which, due to its major focus on case studies approaches, their scope is often conceptually and empirically limited to a specific field of interest and discipline. However, it appears though that there is broad agreement that the way forward in digital and natural commons governance analyses are cross case analyses including the development of the theoretical and conceptual tools that allow for such endeavours (e.g. Ostrom 2009, Markus 2007).

In this last part of the theoretical section I will therefore introduce the governance framework that is applied as in Article I, IV and V. The general goal is to provide a common framework to organize governance findings to be able to cumulate otherwise isolated knowledge (Ostrom 2009:419). Following a neo-instiutionalist foundation, governance systems are seen as institutional and cultural arrangements that serve one or several explicit or implicit purpose(s). They entail a variety of normative and symbolic bases and consists of heterogeneous modes of organising with own organizing principles, constitutive rules, norms, cognitive models of the situation, social positions and roles with defined rights and obligations as well as its own mechanisms of integration and conflict management, identity building and boundary forming mechanisms (Machado and Burns 1998). Such systems have a particular architecture consisting of two major building blocks, the social organization one and the cognitive-normative one. The social organizational part contains the key roles and social relationships for the problem solving and choice processes. It specifies the particular classes of designated agents, their roles and relations of power/authority, and procedures for making collective decisions including the management or resolution of conflicts. The cognitive and normative part refers to "*coherent systems of normative and cognitive elements which define in a given field, 'world views', mechanisms of identity formation, principles of action, as well as methodological prescriptions and practices for actors subscribing to the same frame*" (Surel 2009:30). It contains the definition of relevant or appropriate "problems" or "issues", the goals or priorities relating to the problems and to favourable states of the world, conceptualizations or models of sources of the problems, the causal linkages, and strategies and methods to solve problems or deal with issues.

The distinctions between these two basic building blocks of governance systems are not just analytical. Although they are interwoven, they exert different kinds of influence. Social-organization exerts a direct pressure influencing and regulating overt behavior, while the influence that stems from the cognitive-normative configuration is conceptual and normative. Together, they help to impose order on a chaotic environment in which actors engaged in making or influencing decisions are frequently required to make decisions with limited, inadequate or contradictory information.

In a concrete empirical setting, it may vary from context to context which of the complexes or their components constitute the core or most favored part of the paradigm. Some of the components or dimensions are likely to be considered more central than others. This is important to understand change (which components are first, where is likely resistance, whose identity is associated closest with core components etc.). The actions taken to implement solutions and the resulting outcomes stand outside the cognitive-normative model and feed back into it. To the extent they are visible, the range of actual outcomes will tend to either reinforce or undermine the various elements of the paradigm (in addition to exogenous factors that may also intervene to modify the outcomes that would otherwise be produced, although these interaction effects may not be obvious or clear cut.). In instances where the level of institutionalization is low, such as in periods of transition or confrontation over paradigmatic elements, one would expect many gaps and inconsistencies, as a new paradigm is constructed and struggled over. Persistent failure to produce the desired outcomes will tend to undermine one or more elements of the governance regime, creating pressure for adjustment or might lead to a paradigm shift.

The governance framework (Table 2) utilizes this perspective and provides a general tool for the analysis of governance systems with the help of these few dimensions, their major components and interlinkages. The framework is expected to be universally applicable to all governance systems as a lens to describe how collective action in a governance regime is directed, controlled and coordinated. For the application of the framework to describe the architecture of a specific governance system, one would usually reflect the institutionalized view of the most powerful actor (e.g. the EU). However, in governance systems with major cleavages or a low level of institutionalization, the cognitive-normative and social organizational framework might significantly differ among different agents or groups of agents. One of the applications of the framework is to compare the different conceptions of an appropriate governance paradigm among different actors in order to identify and explicate sources of conflict that might lead to dysfunction and ultimately transformations of the governance system (Carson et al, 2009).

Table 2: Elements Comprising the Architecture of a Governance Paradigm

Feature of the governance system	Explanation
Social Organizational Configuration	
Authority and Responsibility	Actors with formal or informal responsibility for addressing and /or resolving key issues and problems
Expertise and knowledge requirements	Actors that are legitimate knowledge sources and producers to explain sources and solutions of any particular issue
Other affected actors, Stakeholders	Actors that are not directly part of the governance regime itself but are affected by it and / or try to influence it
Procedures for (legitimate) decision making	Designation of persons with authority to make decisions or define who and how actors should be involved in a collective decision making process Also includes deliberating, resolving or settling conflicts, and deciding the nature of the problem and the right strategy and solution
Cognitive-Normative Configuration	
Problem or issue	Framing and characterization of the key issues that the governance system is supposed to regulate
Goals and Priorities	Definition of legitimate values and appropriate goals which are expected to be applied in the policymaking and governing processes
Conceptualization / Model of the situation or issues	The applied model(s) of the social arrangements, the natural or technological system and the interaction between them (which may or may not be correct)
Solutions	Specification of form and range of acceptable methods to achieve the goals including the appropriate, available institutional practices, technologies and strategies

The approach shares important elements with similar efforts provided by Ostrom and other scholars (e.g. Kooiman et al. 2005) to understand how institutions operate and change over time. A prominent example is the Institutional Analysis and Development (IAD) framework (Ostrom 2005) and its variations e.g. the Social-Ecological Systems (SES) framework (Ostrom, 2007, 2009) that also applies a system approach. With its neo-institutionalist foundations the IAD framework also stresses, for example, the importance of norms and mental models of the actors involved. Nevertheless the framework presented here also contains a number of elaborations. In the tradition of Ostrom's focus on self-organising communities many applications of the IAD framework with action situations as main units of analysis appear to have a large focus on community attributes. For example, the SES framework includes norms, mental models and the knowledge about the SES and as variables within the subgroup "user" within a social-ecological system. While is conception is important for but does not for the analysis of the sub-group governance system. Our approach in this thesis suggests an analysis of underlying models and rationalities not only for the "users" but also –and especially – for actors that constitute the dominating governance paradigm in place. It also emphasises the importance of an expert complex. In a more elaborated form (that is not further developed in this thesis) the framework would also specify operational, collective choice and constitutional rules, the bio-physical conditions and knowledge as key concepts for analysing and understanding complex governance arenas. Such an approach, stressing the systemic character of collective action arrangements should also be appealing to natural scientists and engineers and enable or facilitate interdisciplinary collaboration.

6 Research design and methods

In most social science, the link between theory and the applied methods is strong. Governance issues have been addressed by various disciplines and research traditions, which are reflected in different methodological approaches, ontologies (beliefs about the nature of the world) and epistemologies (beliefs about how knowledge can be gained). In this section, I will situate the research methods that were used in this thesis followed by a discussion the main methods of data collection.

The research approach of this thesis contains four empirical studies of commons governance systems resulting in five papers. The studies are:

Study 1: Baltic Sea fisheries and the Baltic Sea Regional Advisory Council (BSRAC) (2008- 2010)[11]

Study 2: The Polish Fisheries Roundtable (2009-2011)

Study 3: Wolf governance in Sweden, Germany, Portugal and Galicia (2010-2011)

Study 4: Open Source Software Governance (2012 – 2013)

Each of these studies had a specific purpose in relation to the final synthesis and contribution to our understanding of commons governance and therefore use different research designs, namely case studies, action research and meta-synthesis.

The three methodological approaches will be explained in more detail below. They share the characteristic that can be conducted in a positivist, interpretative or critical manner (Klein and Myers 1999, Hoon 2013). The positivist approach follows a realist epistemology and is characterized by "*formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from a representative sample to a stated population*" (Klein and Myers 1999:69 referring to Orlikowski and Baroudi 1991). Interpretative research on the other hand does not pre-define dependent and independent variables but puts a larger focus on the social construction of knowledge, the complexity of human sense making and the interdependencies of the context of social situations and the ongoing processes (Klein and Myers 1999:69). Therefore, instead of aiming to identify independent and generalizable "laws", the meaning-making practices of actors are at the center of research, which is often conducted from an experience-near perspective and allows concepts to emerge through the encounters in the "field" (Bevir and Kedar 2008). A critical approach finally attempts to be emancipatory in that it critiques an existing social situation by

[11] Study 1 resulted in two papers, of which one provides an analysis of the Baltic Sea fisheries governance system in general (Article I) while the other examines the interplay between science, decision-making and participation within a particular participatory mechanism in Baltic Sea fisheries governance – the BSRAC.

bringing (hidden) restrictive or alienating factors to the foreground and seeks to help eliminating them (Klein and Myers 1999:69). In line with my epistemological position, the three applied research approaches are connected in that they follow an interpretative methodological paradigm.

The Articles I, II and IV (based on the Studies 1 and 2) I chose a case study approach for in-depth investigations of complex real-life phenomenon. Unlike ethnographies, I relied on diverse sources of data to gain a holistic view of the situation.

Article III (based on Study 2) applies an action research design. This decision was based on the fact that although the empirical phenomenon under examination shared characteristics with the other case studies, the project's objectives were somewhat different. We did not only attempt to study the participation in commons governance in the case of Polish Baltic fisheries. We also aimed for an improvement of the existing practice of the different actors in Polish fisheries through active participation in designing and implementing a new participatory mechanism that we could study at the same time. For the governance of OSS projects in Article V (based on Study 4) we used a meta-synthesis approach building our empirical base from the existing literature on OSS governance. We considered studying OSS governance through a case study of one or several particular OSS project (as Articles I, II and IV), which would have provided a greater methodological homogeneity in terms of data collection and levels of analysis among the different studies in this thesis. Motivated by the lack of systematic reviews and syntheses of the OSS governance literature, the growing complexity of OSS governance arrangements and the lack of theoretical integration, we nevertheless decided to conduct a qualitative meta-synthesis under a general conceptual framework. This methodological choice would promise a richer account of OSS governance phenomena and better conform to our available resources. Homogeneity and comparability between the different research approaches was thereby somewhat compromised for the aim to collect rich information about OSS governance.

The next sections, I briefly discuss different research approaches in more detail followed by some considerations related to the most important data collection methods.

6.1 Case studies (Articles I, II, IV)

Case study research is a central approach in many social science disciplines and at least partly a result of a growing scepticism towards large case quantitative analysis and econometrics and the need to capture the complexity of social behaviour that large scale cross-case studies often lack. A clear definition of what a case study is and what not appears difficult as researchers can mean a number of things when they talk about case studies and the usage of the term is often ambiguous. I approach case study analysis from an interpretist frame and follow Simon's (2009:21) definition of case studies:

"*Case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a "real life" context*.

As others, she stresses that to her case study is less a method, but a design frame that may incorporate a number of methods (as in this thesis). As such "*we could study it analytically or holistically, entirely by repeated measures or hermeneutically, organically or culturally, and by mixed methods—but we concentrate, at least for the time being, on the case."* (Stake 2005:443)

The techniques of data collection are largely determined by the subject and usually involve a variety of data sources (Fidel 1984), none of which is unique to case study analysis. Typical methods of analysis include qualitative interviews, participant observations, literature reviews as well as micro- and macro-level data analysis (Engel and Nicolai 2012).

Case studies are particularly suited for holistic, in-depth investigation (Feagin et al. 1991) to get a strong context-dependent understanding of the phenomenon. The choice of case(s) is often influenced different reasons, like the nature of the phenomenon to be studied, whether or not the analysis should allow for comparison or stand for a larger population of cases as well as more pragmatic reasons.

As seen from the definition, case can refer to different things in different contexts. In practice, it is often difficult to provide an absolute and strict separation of what is within the unit of analysis and what not. Ragin and Becker (1992) therefore argue that the answer to the question "What is the case" will often develop and change over the course of the research process. They suggest that it often is better to ask and constantly think about "What is this a case of?"

In this thesis, three of the articles (I, II and IV) use a case study approach. For the study of Baltic Sea fisheries governance, science and participation in fisheries governance and wolf governance in Europe the choice of a case study approach appears well justified, especially against the background that these cases are empirically not well examined, complex and context was considered of major importance. The cases were less selected for their representativeness, but on their similarities and variation in terms of governance modes and the commons characteristics (see the section "Aims and research questions" above) and partly pragmatic grounds (funding, empirical interests).

The units of analysis (the cases) can be thereby be described as:

1. Baltic Sea fisheries governance system (one case, Article I)[12]
2. The Baltic Sea Regional Advisory Council (one case, Article II)
3. The wolf governance system in Sweden, Germany, Portugal and Galicia (four cases, Article IV)

[12] At the end of Article I, the case study of Baltic Sea fisheries governance is compared to other case studies of European governance, namely Chemicals and Gender. Since the cases are only presented very briefly and refer to the according literature I will not refer to those cases in detail.

The central parts of Article I and III analyse cases of environmental commons governance, while Article II examines a case of participation in commons governance. The case study approach allowed us to use a multitude of data collection techniques to study the phenomena. As most case studies, the studies are qualitative in character and use qualitative data collection methods. However, standards of what a "good" research design is and especially how data are collected and presented varies between disciplines and research focus. As a consequence, what is common and good practice in one field might be seen as inadequate in others. Methodological stringency might be seen of less importance in favour for rich information within the limited space for publication or vice versa.[13]

6.2 Action research (Article III)

Study 2 of the Polish Fisheries Roundtable was conducted as action research (AR) project. As case studies, AR is a fairly wide and mostly loosely defined research design, with a great variety of approaches. On a general level, AR approaches share the characteristic that they are grounded in experience, action-oriented and sometimes participative (Reason and Bradbury 2001).

Baskerville and Myers (2004:33) provide four premises that underlie AR. They argue, that first, the (theoretical) purpose of any action including the applied theory should be explicated beforehand since otherwise the action might be meaningless. On the other hand, there must be practical action in the problem setting revealing the truth-value of the theoretical concepts. Third, the action must develop the theory according to the practical outcomes of the action in order to induce learning. Finally, reasoning and action must be socially situated in that the researcher is participant observer and the AR process must be conducted by a collaborative team. These premises stress the importance of the reciprocal relation between theory and action.

AR shows a lot of parallels with case study research and the typical concerns and criticism that are expressed. As in case study research AR has the issue to attempt to provide some generalized research findings and contribute to theory despite the very limited sample (usually just one). While the practical experiences gained in the AR projects might be of great value to the participants involved, the research community has a particular interest in findings that can also be applied in other contexts. The term generalization does thereby not imply that e.g. discovered causal relationships should apply under all circumstances. The outcomes of a project might be (and usually are) highly context dependent, which is one of the main arguments to apply AR in the first place. Nevertheless, it is important not only to develop solutions for the specific context (which is more important to the practitioners) but also to develop more general principles that are more important to the research community and other practitioners. One could for example try to define the kind of context in which the findings are likely to be valid on a more general level, for example through comparative studies with other cases. For the study of the Roundtable we try to achieve this by publishing a comparative

[13] For example, Article I, though published in a fairly high-ranked journal, does not include a method section at all or just in a footnote.

study of the AR project and a similar project in Sweden (Stöhr et al. forthc.). This article however, is not part of this thesis.

As a response to the critique of difficulty in judging the quality of the AR research, quality criteria for the assessment of qualitative research including AR have been developed (e.g. Davison et al, 2004; Klein and Myers, 1999). In Article III, we adapted the principles of canonical action research (CAR) (Susman and Evered 1978, Lindgren et al. 2004) providing formalized standards for the AR research process consisting of cycles of five phases:

1. Diagnosing
2. Action planning
3. Action taking
4. Evaluating
5. Specifying learning

Still it feels like a challenge to keep a rigorous research processes of this kind in the "messy" practice, where the attempt is to follow at least two objectives – the "action goal" leading to some kind of improvement of the reality of the practitioners and the "research goal" cumulating in high quality research results. Since AR projects in general and the Roundtable project in particular are problem-solving exercises, there is a significant risk to focus too much on the "action" side of the project, while compromising the gathering and interpretation of theory-relevant data. This appears natural, since the problem solving process is beneficial to both researchers and practitioners, while there is a scientific part that is outside the joined learning oriented process and only of interest to the researcher. These two objectives can be complementary, but in many cases they also collide sometimes. For example, the early stages of the study 2 demanded very careful communications with different sorts of stakeholders in order to motivate them to participate and invest in the multi-stakeholder forum. This measure was taken to counter the common fishermen's opinion, that meetings are generally a "waste of time". In such a context, it is very difficult, to conduct, for example, a comprehensive series of interviews, since the additional time that the stakeholders are asked to provide for the "research" part undermines at least to some extent delicateness of the situation.

Action research – as all qualitative research - and the applied methods involve interpretations of data that are shaped by the researches own position in the field (e.g. Herr and Anderson 2005) and by his or her dual role as participant and observer. As participant, we had an interest to take action to support the goal of the AR project, which should nevertheless not be reflected in the evaluation of the process and the outcomes. Since this can hardly be avoided, there is a need to clarify the researchers' role in producing the research findings. In the article, we did this by describing our involvement in the process. Methodologically, we used several methods of data collection (observations and informal talks, semi-structured qualitative interviews, document analysis) and thus mixing the researchers' interpretations with interpretation of others to create a valid basis for informed judgments, where the sources of knowledge were identified.

6.3 Meta-synthesis (Article V)

Meta-synthesis is a relatively new research design that is becoming especially popular in health care related disciplines, but is also increasingly seen in organisational and policy research. Meta-syntheses attempt to take the essential idea of quantitative meta-analyses (e.g. Sutton et al. 2000) and apply it to qualitative research, particularly case study analysis. It attempts to build theory by integrating the results of different but interrelated qualitative studies[14]. Hoon (2013) identifies three distinct ways of using meta-synthesis approaches based on different ontologies and epistemologies. First, as in quantitative meta-analyses it can be used to aggregate the results of other studies following an accumulative and averaging logic based on a positivistic understanding of truth and objectivity. More often, however, research syntheses follow a postpositivist logic aiming for interpretative explanations rather than prediction to understand general patterns of behaviour and perception as valid part of theory building. While objectivity is aimed for, this approach accepts that knowledge can be generated from various sources of evidence that go beyond pure observable facts and include the researchers interpretations of findings as long as they can be justified (Hoon 2013:4f). The third approach that she calls research synthesis as translation is based on a constructivist paradigm in which social reality – including the research process – is seen as context-dependent and not fixed. In this paradigm, the researcher is seen as part of the social setting in which the research is placed. Knowledge is therefore constructed and result of interpretative processes of the researcher that might therefore differ between different researchers. Meta-syntheses following this approach aim to meaningfully reconstruct how studies came to their own understandings and "*embrace hermeneutic or dialectic processes to translate studies into one another with the aim of drawing cross-case conclusions*" (Hoon 2013:5 based on Noblit and Hare 1988).

Though some of the technical aspects of this research approach are not yet fully established, there is evidence that meta-synthesis techniques can usefully applied to deepen the understanding of the contextual dimensions of the studied object (Walsh and Downe 2005). Recent literature also tries to provide guidelines about how to conduct systematic well designed meta-synthesis research. Hoon (2013:8) specifies eight steps to be followed when conducting a meta-synthesis of case studies. These are in brief:

1. Framing the research question to conceptually embed the meta-synthesis in the particular research field
2. Locating relevant research that is relevant for the research question including the definition of keywords and search strings

[14] Glaser and Strauss (2009:176ff) in their book about grounded theory (which shares some parallels to the Meta-synthesis approach) discuss the advantages and disadvantages of using "libraries" as empirical source compared to field studies. Among other things they point at accessibility, the large range of comparisons groups, and the chronological arrays as advantages that might or might not outweigh the disadvantages, e.g. the potential lack of detail and the missing own experiences compared to field research.

3. Inclusion and exclusion criteria to determine what studies to include
4. Extracting and coding data by carefully reading the full text of each study and providing a valid coding form and categorizations
5. Analysing on a case-specific level to identify a sequencing of variables that have been found in each case to be the most influential
6. Synthesizing on an across-study level to merge the case-specific causal networks into a meta-causal network and to arrive at a general pattern among these variables.
7. Building theory from meta-synthesis and link the results back to the literature
8. Discussing of the results of the meta-synthesis study and potential limitations including rigor, reliability, and validity

For the analysis of the literature on OSS governance a meta-synthesis approach appeared well suited as we wanted not only review of the literature for common topics but also to extract existing relationships that were frequently identified by the literature. Since the OSS governance literature is characterized by both qualitative and quantitative studies, the meta-synthesis allows inclusion of these contributions within one research design. The systematic review of the literature as part of the analysis ensures that the results can be replicated, since the means of inclusion and exclusion of literature are explicated. This is one of the major advantages of this approach, though on the other hand, reviews tend to be costly and time-consuming and comparing the different qualitative and quantitative research findings can be challenging.

For a review of the literature about OSS governance we attempted to build up a systematic and broad literature foundation. In a first step, we performed searches on “Open source software” and “Governance” in different databases and in a first screening, we selected literature, in which title and abstract indicated a focus on OSS governance. Those articles were entered into a closer review process. Furthermore, a small amount of papers published in lower-ranked journals and conferences had been chosen because they seem to represent promising OSS governance research streams and thus should be included in a comprehensive and up-to-date literature review. The articles were coded according to pre-defined categories which also involved subjective interpretations and translations, for instance for deciding whether a certain aspect of an article is a governance factor or not.

The analysis method results in a large number of governance factors and their linkages. In the next step, we summarized the factors and relations into groups of similar or the same factors and relations in order to find a useful taxonomy summarizing different governance factors under a common category. Such an exercise is subjective and interpretive so that other researchers might come to different results and categories. We tried to minimize interpretation biases summarizing the factors in several rounds of interpretation with very narrow conditions in the beginning and slowly loosening the categories until a reasonable and presentable culmination point was reached.

6.4 Data collection methods

6.4.1 Qualitative Interviews

In addition to personal communications, participant observation and document analysis, qualitative interviews formed a highly important source of information for Article I, II, III and IV. Qualitative interviews are a widely applied method in social science. Interview situations are shaped by different kinds of cognitive, situational and normative influences (Alvesson 2003) that the researcher has to be aware of in conducting an interview and interpreting the results. Response processes consist of numerous cognitive steps (e.g. Tourangeau et al. 2000) and information about a particular phenomenon is influenced by social factors such as norms of political correctness, prejudices and culturally accepted truths. Culturally and popularly endorsed beliefs act as a filter through which the interviewee interprets the world and which thus shape his/her answers.

These considerations have consequences for the interpretation of the interview data. At least two fundamental distinct ways of interpretation can be distinguished - the instrumental approach following a more realist epistemology and the social-constructivist approach. In the instrumental view of qualitative interviews, the information gathered is treated as facts about the phenomenon that is studied. The interviewee is seen as an expert from whom knowledge can be elicited (Holstein and Gubrium 1995). Unlike for example surveys, the qualitative interview might help the researcher to create an in-depth understanding about the phenomenon he or she studies. He or she can, for example, learn about how different processes work, compare formalized rules that are provided by documents with actual behaviours, detect informal rules, the characteristics of the context and to some extent even evaluations and opinions based on genuine experience. The information given by the interviewees is interpreted as "truth". Therefore, researcher has to make assumptions that are in line with a positivist tradition (Schultze and Avital 2011) and that might or might not be valid. In essence, these can be summarized with two principles of validity and reliability of the information provided by the interviewee. Validity (am I actually measuring what I want to know) in that the interviewee is assumed to understand the question right and his / her answers are credible and truthful. Reliability in that one assumes that the question refers to some kind of objective fact that other interviewees would answer in a similar way. Typically, for some questions (e.g. demographic questions) this would be taken for granted, while for others (e.g. processes and procedures) one would interview a number of persons on the same aspect to gain empirical saturation (Baker and Edwards 2012).

On the other hand, information can also be treated as interpretations of the world in which no absolute truth exists. What the researcher analyses is talk – not the world, but how a person talks about the world (Schultze and Avital 2011, Alvesson 2003). This view is based on the social-constructivist and constructivist paradigms. This perspective rejects the purpose of an interview as an extractor of objective knowledge about a particular phenomenon and also stresses to varying extents the artificiality of the interview situation as a special social situation. Localists (Alvesson 2003) would argue that all one can analyse out of an interview is the interview situation as such.

Myers and Newman (2007:16ff) provide seven guidelines for how interviews should be conducted and presented:

1. Situating the researcher as actor (details reported about the researcher(s) and their relationship to the subjects and the organization).
2. Minimizing social dissonance (reducing the social distance between the subject and the interviewee so as to improve disclosure)
3. Representing a variety of "voices" (variety of subjects in their sample at various levels)
4. Everyone is an interpreter (sensitize the researchers to the interpretive world of the subjects, the researchers themselves, and the audience they write for)
5. Use Mirroring in questions and answers (focus on the subjects' world and use their language rather than imposing the researcher's)
6. Flexibility (Flexibility, improvisation and openness in semi- and unstructured interviews)
7. Confidentiality of disclosures (reports on security, confidentiality, and feedback)

These guidelines are measures to either minimize different influences or to make sure that the researcher acknowledges them in the reported results.

This thesis uses semi-structured qualitative interviews in the fisheries and wolf governance case studies as well as the action-research project of the Polish fisheries roundtable. The question about the selection and number of interviewees was not guided by statistical considerations, but the objective to reach empirical saturation (Baker and Edwards 2012). That means that we started with a highly diverse interviewee pool of stakeholders, scientists, and public officials to get access to the experiential life and social reality of the different groups of participants. The number of interviews and the selection of interviewees for the different studies were adjusted until no new radical views are expressed.[15] Exemplary statements from the transcribed interviews were used to support the arguments and findings in Article II and III (but not in Article I and IV). In order to maintain anonymity for the interviewees, the main level of interpretation was on a collective level looking for patterns of meanings across the individual interviews. We grouped most statements into perspectives that were expressed by a certain group (e.g. fisheries stakeholders). This simplification seemed appropriate, since there was a tendency for these groups to express uniform views (at least with less variation as between those groups).

In line with the epistemological positioning in the beginning of this chapter, interpretation of the interview data followed what Alvesson's (2003) calls "pragmatic reflexivity". This idea suggests that unless there is a reason to think otherwise, data from interviews can be handled

[15] The challenges of such an approach are the impossibility of specifying the required number of qualitative interviews at the start of the project and the necessary combination of interviewee selection, data collection, and data analysis that we conducted as parallel processes instead of separate steps in a linear process (Baker and Edwards 2012).

as reliable truths about the studied phenomenon that nevertheless "*should be treated with scepticism, but not outright contempt*" (Schultze and Avital 2011: 4). I applied this idea and used both kinds of interpretation – instrumental as well as from a more social constructivist view. Instrumental in that the information was used to gain an understanding of the current situation in the governance setting, the issues at hand and the kind of formal and informal procedures in place. We also applied a more social constructivist view to learn about the differences between stakeholders in their understanding of science, certain issues and how other stakeholder groups operate. Focus was thereby to capture cultural and group-specific features that act as filter for the different social realities the groups live in. A major part of the argument made was derived from a comparison of these different realities without any sort of judgment whether or not a particular world view is "true" or not.

The principles underlying the guidelines suggested by Myers and Newman (2007, see above) provide a way to examine academic papers with regard to the quality of the used interview methods. Since I conducted major parts of the interviews of Study 1 and 2 myself (unlike in Study 3), I am able to report here, whether or not the different guidelines were applied and presented. For Study 3 no reports about the interviews have been made at all (similar in Article I) and Study 4 does not include interviews as data collection technique.

Table 2: Study 1 and 2 benchmarked against the seven guidelines of Myers and Newman (2007)

Guide Line	Study 1		Study 2	
	Application	Reporting	Application	Reporting
Situating the researcher as actor	Not applicable	Not reported	Not applicable	Not reported
Minimizing social dissonance	Conscious trust building process with stakeholders as part of the research	Not reported	Conscious trust building process with stakeholders as part of the action research	Reported
Representing a variety of "voices"	A variety of stakeholders from different groups and levels	Reported	A variety of stakeholders from different groups and levels	Reported
Everyone is an interpreter	Aware of the issue, different persons, cross validation of interpretations by different persons	Not reported	Aware of the issue, but no measures taken, cross validation through different data collection techniques	Reported
Use Mirroring	Yes	Not reported	Yes	Not reported
Flexibility	Yes	Not reported	Yes	Not reported
Confidentiality of disclosure	Purpose of the research and anonymity was explained	Reported	Purpose of the research and anonymity was explained	Reported

Myer and Newman (2007) conclude that in most of their analysed articles, very little is reported about the seven guidelines. The two studies examined here are no exception to this. On the other hand, the table also shows that several of the guidelines have been applied and the action research project (Study 2) contains better reporting. That is also partly due to the fact that study 2 was conducted at a later stage of the PhD studies and thus included some more maturity in qualitative research. On the other hand, as shown here, the lack of reporting is also due to the constraints given through the practice of communicating research results. In a paper that is limited to 8000 words the specification of in-depth methodological considerations as well as extensive reference to the interview texts are impossible and therefore compromised in favour of the presentation of results.

6.4.2 Participant Observation

Observations, including participant observation, is a common method of data collection in anthropological and sociological studies. Observation can be defined as "*the systematic description of events, behaviours, and artefacts in the social setting chosen for study*" (Marshall and Rossman 1989:79). It aims to provide the researcher with a holistic understanding of the studied phenomenon and often serves to capture the context for other methods of data collection, e.g. interviews, surveys or document analyses (DeWalt and DeWalt 2002) and is thus especially important in the early stages of the research process. In fact, the observation of social events in combination with interviews capturing the explanations of its meanings by the participants is one of the riches ways of gathering information and understanding about the event compared to any other sociological method (Becker and Geer 1957). Sometimes the combination of interviews, observations and document analysis is summarized under the term "ethnographic method". Observation as a method is often categorized depending on the degree and kind of participation of the researcher in the scene that is studied. A widely used typology is the distinction between complete observer, observer as participant, participant as observer and complete participant (Gold 1958).

Observations can vary in their level of systematic data gathering from ranging from descriptive and unstructured documentations of nearly everything to highly systematic and pre-defined data collections of specific matters of interests. Depending on the purpose, observations and informal talks can be documented through field notes (Schensul et al. 1999:65). In practice, observers often experience limitations due to their dual role as participant and observer and additional tools as video and audio recording might be impossible to use due to ethical considerations and the bias that these tools might create through there influence on the actions of the observed. Different guidelines have been provided for collecting useful observation data and analysing field notes depending on the specific circumstances of the observational context (e.g. Kawulich 2005).

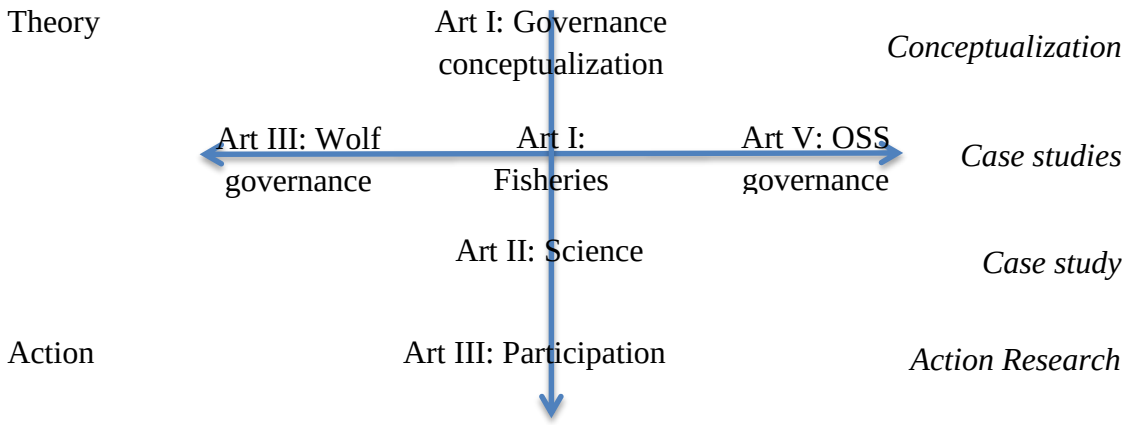
In this thesis, Study 1 and 2 involved active and passive observational participation in numerous formal and informal meetings of participatory stakeholder forums accompanied by various informal talks with different actors. The observations provided the stimulus for some of the in-depth questions in interviews and informal discussions and were primarily used to provide the researcher with a better understanding of the context and interaction situation to

build a basis for interviews and/or evaluations of the effects of measures, upcoming issues etc. Thus, the methods supported each other. The participation also allowed building trust between the researchers and stakeholders. This rather pragmatic approach is also reflected in the rather vague reporting in the later articles. The observations were recorded in form of field notes. Sometimes the meetings also involved audio-recording and later transcriptions of parts that were seen as critical and relevant in the context of the different studies. Video-recording would have been a way of capturing extensive data, but was discarded. Besides the extensive resources video recording and analysis require, it could be suspected that a video camera would have significantly influenced the sensitive interaction situation and would thus be an additional obstacle to an open dialogue between the different participants.

7 Summary of the articles

In this section, I will summarize the five articles and provide some information about the context in which they were produced. The five articles cover a wide range of perspectives and factors of governance in different empirical settings or different analytical perspectives. Nevertheless, the articles are connected with each other by either its theoretical or empirical grounding as indicated in Figure 3. The Articles I, II and III examine different aspects of governance in the shared empirical context of Baltic Sea fisheries. Article I analyses the Baltic Sea fisheries governance using the conceptual framework that is also presented in this paper. Article II focuses more in-depth on the aspects of science and participation in Baltic Sea fisheries and Article III presents the results of an Action Research project to improve stakeholder participation in the Polish part of Baltic Sea fisheries. Therefore these three articles built the vertical axis of this thesis. The Article I, IV and V examine different empirical contexts of commons governance but share the theoretical and conceptual framework as the lens for analysis. As already outlined, Article I examines Baltic Sea fisheries governance. In Article IV the same framework is applied to examine the existing literature on the governance of Open Source projects and Article V provides a comparative study of wolf governance in four European countries, again with the same framework. Altogether, the thesis gains a wide empirical base for the theoretical concepts applied while at the same time providing in-depth studies of one empirical governance context. In the following I will provide brief summaries of the five articles, their aims, design and major findings. The articles are presented in their thematic order but do not reflect their chronological appearance. Article I builds the theoretical groundwork for many parts of the other papers but its empirical base is the same study as Article II, which was also presented earlier.

Figure 3: Placement of the different articles in the overall conception of the thesis



Summary of Article I

Power, knowledge and conflict in the shaping of commons governance. The case of EU Baltic fisheries

The paper was motivated by an invitation to publish in a special feature "The 20th anniversary of 'Governing the Commons'" of the *International Journal of the Commons* in honour of Nobel Prize winner Elinor Ostrom and her major achievements in the field of environmental governance and common's research. The paper attempts to make a contribution to the problem how governance can be conceptualized and applied to case study analysis with power, knowledge and conflict as the key aspect of governance systems.

In the first part of the paper, Tom Burns and I suggest a theoretical framework for governance analysis based on an institutional perspective on governance. The framework specifies major components of governance systems and their inter-linkages and can be applied to a wide range of different governance systems, hence increasing comparability and providing better conditions for knowledge accumulation about governance systems. It also allows for comparison of different conceptions of an appropriate governance paradigm among different actors in order to identify and explicate sources of conflict that might lead to dysfunction and ultimately transformations of the governance system.

We argue that governance systems are institutional and cultural arrangements characterized by two distinct complexes of rules. The first complex consists of social-organizational features (particular classes of designated agents, their roles and relations of power/authority, and procedures for making collective decisions) that put direct pressure on the agents of the system influencing and regulating overt behaviour. The other complex is built by normative-cognitive features (the definition of relevant or appropriate "problems" or "issues", the goals or priorities relating to the problems and to favourable states of the world, conceptualization or models of sources of the problems, the causal linkages, and strategies and methods to solve problems or deal with issues), which have a more conceptual and normative influence on the actions of actors.

The framework is then applied to the analysis of the European fisheries governance system as a complex, multi-level case of commons governance with Baltic Sea fisheries as a focus. This was partly motivated by the fact that we had just finished a project on Baltic Sea fisheries and were able to draw on extensive data from this project. We use the categories of the framework to describe the governance system as it is institutionalized by the European Union, by far the most powerful formal agent (actually a group of agents) articulated through the DG Maritime Affairs and Fisheries at the Commission. We show, however, that other actors such as the fisheries stakeholders or ENGOs prefer other governance paradigms based on different organizational forms and different goals, and with different conceptualizations and models of problems and solutions as well as proper knowledge sources. These differences are an ongoing source of conflict and tension challenging the effective operation of the governance system. In the third part of the paper we use the framework to identify these differences in

both the preferred organizational as well as the cognitive normative configuration and specify the sources of conflicts and instabilities.

As we show in the article, many of the differences in views about how the social organization of fisheries governance (e.g. power and decision-making structures, knowledge and expertise requirements) should be structured relate to the agents' particular cognitive-normative configurations starting with different goals and priorities (e.g. socio-economic or environmental concerns, standardization etc.) but also different causality models and diverging opinions about effective solutions (e.g. eco-system approach, management plans, quota system). While such conflicts are rather common in environmental governance and do not necessarily lead to a non-functioning of the system, some agents in the system might be able to mobilize powers to induce a shift or failure of the current governance system (e.g. by non-compliance). At the time we wrote the paper, we provide some indications for such shifts towards greater stakeholder inclusion and regionalization in the next reform of the Common Fisheries Policy that are largely connected with the hope for more legitimacy and acceptance of policy decisions, its scientific base and higher rule compliance.

For illustrative purposes, the last part of the paper also provides a brief comparison of the fisheries governance system with the European governance of chemicals and gender relations as additional cases that have been analysed by Burns and others in earlier projects. By this, we attempt to demonstrate the usefulness of the presented approach for interdisciplinary, comparative governance research.

Summary of Article II

Science and Participation in Governance of the Baltic Sea Fisheries

This paper is the result of a project "Facilitating Governance of Baltic Seas Fisheries by Improving Communication Among Stakeholders" funded by the Baltic Sea 2020 Foundation as an initiative of Ilan Chabay in response to a request from the then head of Fiskeriverket. In an attempt to encourage stronger participation in the European fishery governance, the European Commission established the Baltic Sea Regional Advisory Council (BSRAC) in 2006. Conceptualized as a functionalistic and deliberative forum, the BSRAC consists of representatives of the commercial fishery sector (e.g. fishing industry, food processors, fishermen) and other interest groups (e.g. ENGOs, consumer organizations, recreational fishers). The BSRAC is charged to provide consensus advice to the Commission on behalf of the fisheries sector and other interest groups in the Baltic Sea. The BS RAC members must consider scientific data on the status and prognosis for the fisheries in their deliberations. The data is collected, organized, and interpreted by scientists from the International Council on Exploration of the Seas (ICES) and national research agencies of the Baltic Member States and submitted to the policy makers as "scientific advice". It should be noted that the scientific advice does also include recommendations about annual catch quotas based on the scientific assessments and the precautionary approach to account for uncertainties in the assessments. Thus, the discussion about the annual quotas is also the key topic for many fishery stakeholders within the BSRAC.

In the paper we examine the role of science in the commons governance case of Baltic Sea fisheries by asking how science and scientific advice is perceived, interpreted and used by stakeholders in the BS RAC. The analysis is based on data we collected within the time of 2007 to 2009 and consists of 30 semi-structured interviews, observations of the BSRAC meetings, document analyses and a workshop with the BSRAC members.

In the first part of the paper, we show that the European fisheries governance paradigm essentially follows a technocratic logic, where science has a privileged status and acts as a reliable provider of "truths". However, marine eco-systems – as many areas of environmental governance – are characterized by a high degree of socio-ecological complexity resulting in different kinds of uncertainties that create challenges to the "modern" understanding of the science policy relationship including that the necessary distinction between values and facts is illusionary in practice.

The establishment of the BSRAC can be seen as part of a general trend within the European policy arena towards stronger stakeholder inclusion. The (debatable) rational for this development is that a wider exchange of ideas and values will result in higher quality decisions with greater acceptance and legitimacy. The preference of the European Commission for consensus statements of the BSRAC members also shows the attempt to "outsource" the competition between conflicting stakeholder views. Science thereby is supposed to provide the "factual" basis for selecting among different policy alternatives

according to an EC representative. However, we found it difficult to find a clear statement about the role and weight that science should have, e.g. in comparison to other sources of information. Through the study, we show that science and the scientific advice frequently became a controversial topic in the deliberative, consensus-forming process of the BSRAC and therefore did not facilitate cooperation between stakeholders. Unlike most environmental NGOs, fishery representatives tend to show low levels of trust towards the scientific data and the resulting advice as well as scientists in general. This is partly due to the fact that even scientists admit that in the political arena, a strict separation between science and facts within the scientific advice is hardly possible and that science becomes politicized. As a consequence, science lies often in the centre of the debate, where one side uses the scientific advice as the foundation of its position while the other side points at scientific uncertainty and/or competing knowledge to promote its alternative. Further, while there are strong indications that the scientific and political process would benefit from a stronger integration of the experiential knowledge of the fishermen, the technical, methodological and institutional make this a huge challenge that is intensified by the existing power imbalance and distrust between ICES and the fishermen's organizations.

Summary of Article III

From Shouting Matches to Productive Dialogue – Establishing Stakeholder Participation in Polish Fisheries Governance

This article reports on a project to create and institutionalize a multi-stakeholder platform in Poland. The project was a direct follow up from the prior study one with the Baltic Sea Regional Advisory Council. In the BSRAC meetings it appeared to be particularly difficult for the Polish representatives to participate effectively in the consensus-finding processes and many other representatives perceived Poland as somewhat of the "Black sheep of the family". This impression is strengthened by the fact that Poland experienced a complete fishing ban of cod in 2007 due to high amounts of illegal fishing. After several talks to two Polish BSRAC representatives, one from fisheries and one from WWF, we agreed that it would be a worthwhile attempt to build a similar participatory forum – the Polish Baltic Sea Fisheries Roundtable - on the Polish national level and adapt it to the Polish context.

The breakdown of the Eastern bloc led to a severe destabilization of the fishing industry with major breakdowns in the number of state-owned and cooperative-based fishing boats, a highly fragmented organization of the fishing communities and decreasing catches. The existing governance arrangement failed to reduce the fishing effort to sustainable levels. Around the Baltic, Poland has the highest amount of illegal fishing. The perceived legitimacy of EU regulations and their scientific base is very low and along with institutions, the cultural norms of localized collaboration vanished giving room to an ideology of pure self-interested behaviour on the part of individual fishers. The communication within and among the different stakeholder groups was poor or not existent. The set-up of a participatory initiative had therefore to be carried out in a rather unfavourable and complex context that had to be considered through careful planning and specific measures. Early accounts of participation have focused on the degree that stakeholders were involved in the decision-making process. In more recent research, the nature of the participation processes itself and the role of communication is increasingly central.

The project was conducted as participatory action research project consisting of five phases: Situational analysis, Action planning, Action taking, Evaluating and Specifying learning. To minimize interpretation biases through our own position in the field, we used different data collection techniques (semi-structured interviews, observations) to cross validate our findings and make informed judgments. For the concrete action planning we chose the Collaborative Process Model (CPM) providing a number of action steps to move forward in the participatory process and that proved to be a useful approach through its particular focus on planning and forethought that other processes often lack.

Evaluating the outcomes after nine meetings of the Roundtable we conclude that successes could be achieved on social and institutional outcomes, while economic and ecological outcomes are difficult to measure after such a short time. Communication, learning and trust building improved significantly and long-term funding also ensured that the Roundtable is

continuing to this day. We conclude essential features involved the *focus on the process of communication*, especially in the beginning. This includes a *key role of the moderator/mediator* and an attempt to gain *early successes* to get momentum. There are also challenges that were not resolved. As in other case studies of participation, we experienced struggles around the right balance between functionalistic (gathering best knowledge) and deliberative (formulating joined positions and find consensus) participation. Unlike in many of these studies, public authorities in Poland evidently encouraged a stronger and more formal role of the PFRT in the decision-making process, that was actively prevented by some of the stakeholders in explicit consideration of potential negative effects of visible and hidden power imbalances on a joint and productive exchange of knowledge, social learning and trust building at least in the beginning. These issues address the question of the *right development speed* of the PFRT and challenge the often-made implicit assumptions that consensus is desirable under all circumstances and that such initiatives can be considered in isolation from other strategies employed by stakeholders. Instead, improving the pre-conditions, especially the capacity of disadvantaged groups to participate more effectively, has been demonstrated to be of major relevance. Our study supports the call for a process approach to participation and stresses the importance of context factors. Our conclusions are generally consistent with principles of participation extracted by other studies.

Summary of Article IV

The governance of the Wolf-Human relationship in Europe

This article was inspired by talks with Tom Burns and Elsa Coimbra in a workshop on Governance. Since especially in Europe wolf governance has rarely been analysed from a political / social science perspective we felt that we could make a useful contribution to the field and at the same time apply and develop the governance framework suggested by Article I. Thus, this paper examines wolf governance in four European countries, Sweden, Germany, Galicia (Spain) and Portugal. Despite the fact that wolf governance is regulated by a unified European framework in all of these cases, we ask the question whether one can observe considerable variations in the national, regional and local governance arrangements among those countries. The choice of the cases was partly based on the availability of empirical data but also inspired by the fact that in Germany and Sweden, the (re-) occurrence and settlement of wolves happened fairly recent (and unintentionally), while in Galicia and Portugal the presence of wolves has never been interrupted. Unlike in our studies of Fisheries and Open Source we could not rely on extensive existing literature nor did we have resources to start an own extensive data collection. But governance paradigms are expressed and can be analysed by discourses. Thus, our materials address institutionalized sources such as policy documents, law cases and reports from public agencies. Other sources include publications of mass media and private associations, as well as academic papers, research reports and other secondary literature. Still we were able to also make use of semi-directed interviews with various stakeholders, such as those representing administration, conservation groups, farm animal owners, hunters, experts and/or supporters of wolves. After providing some background on wolf populations in the examined regions and a brief introduction into the governance framework guiding the analysis we conduct a comparative analysis of the governance arrangements in the four regions.

On a general level, the cases show a number of similarities under the overarching framework of the European Union, expertise configurations and applied solutions. In all cases, public administration has the authority and responsibility to implement the European objective of wolf protection while also limiting the physical, as well as economic damage caused by wolves. In Portugal the authority tends to be more centralized, while in the other cases management responsibility is delegated to the regional level to a large extent. The implementation of the European framework is realized by direct administrative measures (e.g. criminalization of wolf hunting, licenses) in combination with economic measures (damage compensation, support for preventive measures for wolf damage), planning measures (e.g. regional management plans, zoning conservation areas) and information (monitoring, campaigns). All cases use biophysical science as the main basis for policy decisions and the monitoring of the wolf status and policy impacts.

Opportunities for stakeholder participation are also present in all cases, though they are much more institutionalized in Germany and Sweden, while in Portugal and Galicia such arrangements tend to be informal in character. As a consequence, though negative attitudes

towards wolves among certain groups (rural population in wolf regions, hunters, farmers etc.) can be found in all cases, organization, visibility and political influence of such opposing groups is higher in the two northern countries. The result is that clashes between the standardized European governance framework and its interpretation and implementation on the national and regional level are therefore also more apparent which we particularly demonstrate for the Swedish case.

We argue that hostility towards wolfs cannot solely explained by actual threats and damages. Rather, strong enduring cultural perceptions appear to play a key role implying that wolf management goes beyond its biophysical dimension. The governance of wolves stretches well beyond biology conservation know-how since it includes, and critically so, social management. Strong enduring cultural perceptions come into play, a complex and ancient arrangement of symbolic resonance that should not be limited to the most plain discourses, such as "wolves as pests – direct assailment to human interests" or "wolves as desirable – endangered pieces of the ecological set". In wolf governance it seems particularly crucial to work consciously on the diverging norms, values, interests and images people bring forth, thus becoming possible to understand their roots and their tenacity, but also to begin a collaborative process in which shared meanings and joint actions emerge.

Governance of wolves reveals that wolf issues take up more general political themes in addition to the actual issue of wolf politics per se. It relates to the multilevel nature of environmental policies and consequent articulation of power between local and macro scales. The four cases seem to illustrate interesting differences but also converging orientations in governance. The surging of context sensitive Management Plans, a growing emphasis on prevention strategies beyond financial compensation and the involvement of stakeholders in the conception and decision process along with the implementation of an assortment of negotiating tools are all examples of governance building a societal strategy complementary to the ecological/administrative one.

Summary of Article V

The governance of Open Source Software projects

The differentiated mode of governance in open source software (OSS) development has attracted attention among scholars within and increasingly also outside OSS related disciplines. While there is a basic agreement among researchers about fundamental aspects of OSS governance, empirical research shows significant deviations from the idealized paradigm especially in recent years. This paper provides a qualitative meta-synthesis of existing OSS governance literature discussing how different governance categories and their interdependencies have been theoretically and empirically examined. In order to structure existing research in a comprehensive way, to compensate for the inconsistent ways, OSS governance has been defined and to identify research gaps, we use a general governance framework distinguishing social-organizational and cognitive normative features of governance. The latter has not received much acknowledgement in OSS governance research.

The article contributes to OSS governance analysis by providing a synthesis of OSS governance research that goes beyond a case study approach while attempting to capture much of the existing diversity and its underlying mechanisms. The taxonomy confirms that there is not only no single mode of OSS governance and with a growing size, complexity and actor-diversity of a project the kinds of challenges that the OSS governance system has to address are changing significantly. Accordingly, different solutions to address these challenges are applied that often show similarities to classic approaches to organizing and governance and creates new effects, interdependencies and governance issues that also change over time. The result reveals that existing research to a large extent treats different governance factors in isolation and only few case studies capture the complexity and dynamics between for example power, knowledge and conflict in large OSS projects. With increasing size, actor and issue diversity of modern large-scale projects, the initial paradigm of open source faces increasing challenges of complexity, coordination and to integrate diverse interests and normative perspectives in a functioning social organization. This leads to new tensions, new effects, interdependencies and governance issues that change over time.

We identify upcoming areas of research that have not been covered well by the existing literature. Among them are the effects of increased knowledge requirements and expertise diversity in complex projects, and the governance of outside (e.g. inter-project) relationships. There is a need for further empirical grounding covering in-depth studies of the interplay between socio-organizational and cognitive-normative aspects in the steering of large and hybrid OSS projects including governance transition.

8 Discussion

In this section, I will provide a comparative discussion of the different studies in the light of the research questions of this thesis and the theoretical discussion. Three of the five articles from above presented studies of commons governance using a common theoretical lens. The other two studies examine particular aspects of governance in-depth within fisheries governance. A comparative perspective will not only allow to identify similarities and differences in the social-organisational and cognitive-normative configurations of the different commons governance systems, but also to compare the kinds of challenges that arise within the different systems and how they try to cope with them. The discussion provides answers to the research (sub-) questions 1.1, 1.2 and 1.3 by characterizing the governance systems, the identified challenges and the governance responses for Baltic Sea fisheries, wolf governance and the governance of Open Source. It will also address RQ 1.4 and RQ 1.5 by discussing the particular role of science and participation including the "lessons learned" for improved stakeholder participation in Poland. The comparative perspective of the discussion is contributing to answer the overarching RQ 1 asking about governance challenges that arise in complex natural and digital commons systems in modern societies and the responses that are applied to address those challenges. Finally, I will answer RQ 2 by reflecting on the framework that was applied for large parts of the analysis. The answers to the different questions will then be synthesised under the conclusion section.

For the purpose of the discussion I will often differentiate five classes of cases to bring all the studies to the same level of analysis. Thus, some classes aggregate several case studies that show high similarities:

1. Fisheries governance in the Baltic Sea
2. Wolf governance in Galicia and Portugal (South),
3. Wolf governance in Germany and Sweden (North)
4. OSS governance (classic, which refers to the way grass-root founded and managed projects are enabled to achieve collective action outcomes)
5. OSS governance (large scale/hybrid, referring to modern projects that typically involve a greater variety of actors, such as firms, public and academic authorities)

8.1 The cases in the light of the tragedy of the commons

In the theoretical section, I hypothesized that each of the different cases has the potential to be a Tragedy scenario due to the effects of free-riding. Ostrom enriched the discussion by her special conditions under which the Tragedy is more likely to occur (1990). In table 3, I used the information gained through the different studies to state whether or not the particular condition was given in the different cases. This feeds research question RQ 1 in pointing at some of the challenges with which the governance systems are confronted with. I also indicate whether the governance cases would be described as failing or not in reaching its objective(s). Such a judgement is somewhat superficial and would actually require some elaboration (see later), but the results of the different studies allow giving a first overall impression.

Table 3: Particular conditions supporting the tragedy of the commons (Ostrom 1990) for different governance scenarios

Factors and result	Fisheries governance	Wolf governance (North and South)	OSS governance (Classic and Large-scale/Hybrid)
No communi-cation	Predominantly	North: Partly South: Yes	No, supported by technical infrastructure and transparency
Very large systems	Yes	Yes	Some
High value resource	Yes	Partly (through damage)	Classic: No Large/ Hybrid: Partly
Open access systems	Rather Yes (illegal fishing)	Usually yes	Classic: Yes Large/ Hybrid: Partly
Diverse harvesters	Yes (e.g. through different nationalities)	Yes (different actors with different utilities)	Classic: No Large/Hybrid: Yes
Failure to develop rules systems	No, but existing don't function properly	North: Partly South: No	Classic: No Large/Hybrid: Partly
A tragedy of the commons / Failed governance	Predominantly	North: Partly South: No	Classic: No Large/Hybrid: Partly

Table 3 shows that the case of Baltic Sea fisheries governance fulfils most of the conditions and despite the efforts to create an institutional framework around this commons system, it can still be considered to be a classic Tragedy of the commons. For wolf governance the conditions are mixed. While I consider a lack of communication, the system size, the easy access conditions, actor diversity rather supportive for a Tragedy scenario, the existing rules appear to function especially in Portugal and Galicia, while especially Sweden experiences struggles to manage the wolf populations. This result might be connected to the difficult conceptualization of wolf governance under the Tragedy model but an important factor to remember is also that Portugal and Galicia look at a long history of managing the co-existence of predators and humans, while in Germany and Sweden the re-appearance of wolves was fairly recent. In the governance of OSS projects, early OSS projects have fairly favourable conditions. As projects grow larger and more diverse (e.g. through the participation of companies), this has changes somewhat since they tend to be larger, have higher actor diversity and the established rule systems of classic OSS governance do not function as

properly anymore. Given this framing conditions, we can now discuss the way the different governance systems approach the challenges of commons governance. The discussion is thereby informed by table 4, where I summarize the findings from the three empirical cases using the same conceptual framework.[16]

[16] As discussed earlier, one drawback nevertheless occurs through the methodological choices made for the different studies. While fisheries and wolf governance are case studies, the study of OSS governance followed a meta-synthesis approach, which implies a different level of analysis. This choice was appropriate for the purposes of the OSS governance study, but creates some difficulties with regard to a larger comparative perspective with the other case studies.

Table 4: Selected commons governance systems in a comparative Framework

	Fisheries Gov	Wolf Gov	OSS Gov
Social organizational configuration			
Authority and Responsibility	Council of Ministers (CFP including micro-management) European Commission (DG MARE) (Monitoring & member-state compliance) National governments (Implementation & enforcement)	Council of Ministers & European Parliament (Framework) European Commission (DG Environment) (Monitoring and member state compliance) Federal or/and national ministries (Implementation & enforcement)	Project founder as informal rule Corporate actors (e.g. foundations or companies) in most larger projects (decisions about project vision and direction)
Expertise and knowledge requirements	ICES (umbrella group for the national marine institutes) STECF: Socio-economic experts Fishers (monitoring data)	Different arrangements but usually biologists Administration officers, state rangers, scientific institutions Hunters and herders (observations)	No designated expert agents (“all contributors are experts”) Expert authority gained by high impact contributions and seniority
Other affected actors, Stakeholders	Fishers, fishing industry, NGOs	Farmers, herders, hunters, NGOs	(Early: none) Proprietary industry, other OSS projects, public authorities, academia users
Procedures for (legitimate) decision making	Council of Ministers, European Commission, National governments engaged Pressures for Multi-stakeholder participation: Fisheries stakeholders & NGOs	Council and Parliament provide framework prepared by the Commission Many management decisions delegated to national or regional level Stakeholder involvement in some countries	Hierarchical (e.g. charismatic leader, LINUX) or coalitional (e.g. Apache) Often hierarchical on technical level (release decisions) Free choice of individual contribution

Table 4 (continued): Selected commons governance systems in a comparative framework

	Fisheries Gov	Wolf Gov	OSS Gov
Cognitive-normative Configuration			
Problem or issue	Declining fish stocks in the Baltic, some at risk of collapsing	Wolf as endangered species (Wolf damage on farm animals)	Technical issue For some proprietary software as issue
Goals and Priorities	Substantial reduction of fishing effort Keep fishing pressures on Baltic Sea fish stocks within sustainable limits Healthy fishing industry	Protection of wolves, increase wolf population Avoidance of damages to farm animals and humans by wolves Balance/coexistence between wolves and humans	Highly diverse individual motivations Company goals Company goals
Conceptualization/ Model of the situation or issues	High fishing pressure is the main cause for declining fish stocks Anthropogenic A case of "the Tragedy of the Commons"	Sometimes as “hunting resource”, sometimes not Wolves cause damage on farm animals Humans threat species Sometimes strong fear is manifested among residents Numbers of wolves are important for genetic preservation	Hacker Culture Gift giving culture Technical rationality
Solutions	Catch quotas (TACs) based on Precautionary Principle, Technical Measures Monitoring (catches, boat positions, etc.) Diverse solutions on national and local level	Regional Management Plan Economic mechanisms (compensation & prevention); Administrative mechanisms (criminalization of hunting and/or edict hunting/culling permits) Information instruments (monitoring, education);	OSS license Technical infrastructure Modularization In larger projects incorporation

8.2 Socio-organizational considerations

When discussing different modes of commons governance, I started with the assumption through the emergence of new objectives in governance (democratic values, economic, social and environmental sustainability) and increased complexity of the natural, technical and social characteristics of commons systems, traditional top-down structures are unlikely to achieve the plurality of goals connected to this. From the theoretical discussions we learned that there appears to be broad agreement among researchers that commons governance systems will be more likely to achieve the desired outcomes (e.g. sustainable development, high quality software) under governance conditions that rely less on centralized regulation but on inclusive modes of governance where aspects of collective learning, knowledge integration and trust building are key. In the next sections, I will discuss the different cases in the light of their authority and decision-making structures, knowledge requirements and other actors and their implications for governance outcomes.

8.2.1 Authority and Decision-making

In fisheries as well as in wolf governance, the analysis showed that the authority over the governance system is transferred to an international regulative body. This is motivated by the need for internationally coordinated fisheries and wolves management. The approach is in accordance with Hardin's (1968) suggestion, to break the race for recourses by establishing a leviathan that establishes and enforces rules that allow for the sustainable harvest of resources. The cases differ in their degree of centralization of decision-making. The Common Fisheries Policy with over 2000 rules is one of the most comprehensive governance agreements worldwide regulates all kinds of aspects of fishing. The Habitat Directive as the most important framework for wolf governance is less detailed and restrictive. It specifies the frame conditions that the different member states have to achieve and is accompanied by a set of guidelines (rather than regulations). The specific questions of implementation is left to the national governments that often delegate significant parts of the decision-making authority to the regional and local level.

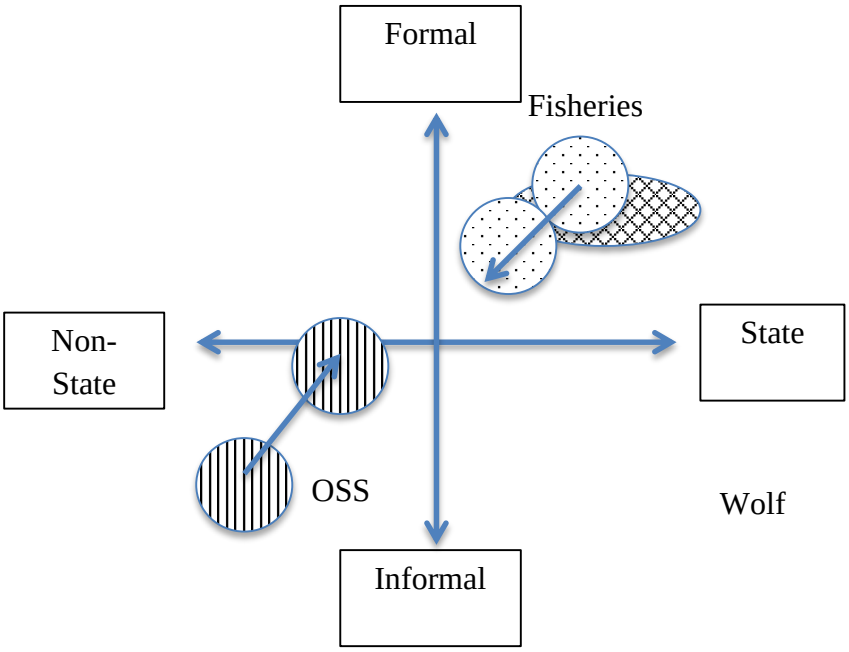
Fisheries clearly failed to achieve the objective to prevent overfishing with illegal fishing (non-cooperation) as the major unresolved issue. The case supports the arguments that were made about the problems of centralized management in commons governance and that I discussed earlier. The analysis of the wolf governance cases deviates somewhat from this picture, since the cases with the strictest hierarchical order (Portugal and Galicia), despite its larger populations of wolves, appeared to be more successful to manage wolf conservation than Sweden and Germany. An important factor to remember is thereby that Portugal and Galicia look at a long history of managing the co-existence of predators and humans, while in Germany and Sweden the re-appearance of wolves was fairly recent. So while the protective paradigm for wolf governance involves adaption and change processes in the Northern countries that was not so much the case in Southern Europe. This reminds us that bureaucratic hierarchies are not ineffective by definition. They provide permanence and stability due to their formalized procedures and predictability (Pahl-Wostl 2009). On the other hand, organizational learning and transition processes to adapt to changing conditions tend to be

very slow, which is a major governance challenge in fisheries and the Northern wolf governance cases.

Informal networks and community structures on the other hand are characterized by high flexibility and learning potential, which makes them an attractive alternative mode of governance and promoted by common pool resource theory through Ostrom's design principles (1990:17). OSS governance is often seen as a showcase of community or network governance and the studies about the superiority of OSS software (e.g. Capra et al. 2008) compared to proprietary software indicates that hierarchical organisation in traditional companies are not the most effective way of achieving the best collective action outcomes. Our analysis of the social organization of OSS projects revealed that while it is in fact true that traditional OSS communities successfully develop informal rules to organize their activities, and have effective monitoring, sanctioning and procedures for conflict resolution in place (see Ostrom's design principles, Ostrom 1990, Gallivan 2001 for OSS), they nevertheless rely to a significant extent on hierarchical authority structures (often called benevolent dictatorship). This might be a somewhat surprising result as it appears to be in conflict with the often-quoted need for democratic decision-making procedures as one of Ostrom's design principles (see Schweik and English 2013 for a recent similar observation). Further, I showed that the informality of OSS communities faces its limits in larger and hybrid projects. Without other means of governance, complex and diverse informal networks tend to have difficulties to coordinate collective action as their flexibility also means a lack of predictability, routines and practices (see Pahl-Wostl 2009 for a similar argument in the context of environmental governance). Thus, modern large and hybrid OSS projects that involve a greater variety of actors, such as firms, public and academic authorities appear to increasingly deviate from the community governance paradigm, involving an extended vertical hierarchy, more formalized role structures and decision-making procedures (O'Mahony, 2007, Schweik and English 2013). This shows that large OSS projects seem to move towards more bureaucratic approaches of social organization to deal with coordination and complexity issues.

Comparing the cases of fisheries and OSS governance it becomes apparent that although the governance arrangements started from very different decision-making approaches there appears to be a tendency to develop towards a common middle ground. Fisheries governance started from a fairly strict top-down hierarchical governance model that is ineffective and is gradually opening up to more stakeholder participation and even discussing to create spaces for self-governance opportunities for the fishing industry within certain limits (European Commission 2009). OSS governance can be seen as the opposite case as a self-governing system that with increasing complexity applies more and more bureaucratic and hierarchical means of coordination and steering. Thus the strict hierarchical mode of governance and pure self-governing paradigm are shifting towards middle grounds (see Fig 4) bringing participation in co-management forms of governance to the foreground. Thus, the observed shifts can be explained by the necessity of governance systems to find the balance between stability and change. It should be noted however, that for the different wolf governance cases such developments could, however, not be observed.

Fig 4. Fisheries, wolf and OSS governance according their degree of formality of institutions and the importance of state actors (adapted from Wostl 2009)



With the consideration above in mind, I can now discuss participation in the different cases. In wolf governance, participatory mechanisms though limited to the national context were found in the Germany and Sweden, while Galicia, and especially Portugal are essentially non-existent. In fisheries the EU aimed to become more collaborative and inclusive by establishing participatory mechanisms of which the Baltic Sea Regional Advisory Council and the Polish Fisheries Roundtable were studied in greater depth. Just looking at the participatory arrangements studied in this thesis, I do not find much support of the hypothesis that participation leads to better governance. The empirical analysis in Article I and II has shown that the actual implementation of the Baltic Sea Regional Advisory council is rather weak and did not lead to any visible improvement. In Article IV about wolf governance I showed that those countries with the strongest stakeholder inclusion are also struggling the most with Sweden as the prime example. Only Article III about the Polish Fisheries Roundtable identifies some achievements, particular in terms of learning and trust building. These results should not be taken as evidence that collaborative governance does not lead to better commons governance. It does however support the argument that it is not participation per se that is important for governance but rather its quality. This argument is relevant as in the literature about environmental governance, researchers have generally been somewhat over-optimistic about participation and openness being “good” while empirical evidence to support that claim has been marginal and often mixed with normative assumptions (e.g. Newig and Fritsch 2009). A somewhat similar argument is sometimes made for studies of OSS governance that focus almost entirely on successful OSS project, thereby ignoring the massive number of abandoned OSS projects (e.g. in Schweik and English 2013)

8.2.2 Expertise and Knowledge

A key dimension of this thesis was the question about the role of knowledge in commons governance. The articles show, that all the examined commons governance cases entail knowledge acquisition and integration processes that are believed to be essential to regulatory effectiveness. To achieve such knowledge, the cases share the preference for a positivist epistemology in which natural science and rationalistic approaches are prioritized. The cases differ in that in fisheries and wolf governance special expert units are created and that inform decision-making. Other actors are only involved for data collection purposes. OSS governance, expert and decision-making authority tends to be less separated. Demonstrations of expertise in form of technical code contributions with a high impact are closely connected with gaining decision-making authority (e.g. Mateos-Garcia and Steinmueller 2008), which is not the case in the other two arrangements.

For fisheries and partly wolf governance, we identified a number of difficulties with this approach that are connected with the deficiencies of the science itself as well as its integration. The information gathered through the scientific institutes remains incomplete and uncertain providing room for different interpretations and poor adoption. The artificially enforced consensus of scientific knowledge to be included into decision-making creates tensions between the realist approach to knowledge production and its translation into policy advice making the envisioned separation of "facts and values" obsolete. Questions like what size of a fish stock or wolf populations are considered sustainable cannot be derived by purely scientific considerations and remain an ongoing subject of debate. In the fisheries case, we saw that scientific findings are contested by actors with alternative knowledge systems. Especially the experiential knowledge of the fishermen is not integrated in the existing governance process. The literature (e.g. Neis et al. 1999, Daw 2008, Murray 2008, Griffin 2009) and almost all agents within the fisheries governance system agree in principle that the governance process could benefit from a stronger inclusion fishermen's knowledge. But despite the creation of participatory arrangements like the BS RAC is such an attempt highly challenging due to the existing multi-level structure of the institutionalized knowledge gathering process, the different nature of the knowledge (qualitative versus quantitative) and the distrust between scientific experts and stakeholders. The case of fisheries confirms the concerns that were discussed in the theoretical section and brought forward by authors like Funtowicz and Ravetz (1990) or Wilson (2002). They show the limit of a "get the facts and act" approach to governance. Expertise arrangements based on a modern understanding of science appear to struggle in complex common systems and often appear to be part of the problem rather than the solution.

OSS governance are also highly knowledge intensive undertakings in distributed environments (Ciborra and Andreu 2001) but usually have a different approach to knowledge production and integration that is seen as highly efficient and increasingly adopted in many areas of digital innovation. The key aspects identified from the literature are thereby:

- Knowledge integration is massively supported by the technical infrastructure (especially the internet)

- Norms of transparency make knowledge available to all actors at all times inspiring learning as a communication-based outcome of individual interactions (Au et al. 2009)
- Modularization reduces the complexity of particular units
- Knowledge is verified on a continuous base through early and rapid user involvement (e.g. bug-reporting).

These conditions allow that knowledge is incrementally implemented as different individuals contribute their particular expertise in a complementary manner without the need to fully understand the whole project (Osterloh and Rota 2004). The OSS approach to knowledge creation and integration is not easily comparable to natural commons systems due to the nature of the knowledge and the ease of its access. Nevertheless there are the parallels between the OSS mode of knowledge generation and newer approaches to knowledge-generation, which are remarkable. Scholars of "post-normal science" (Funtowicz and Ravetz 1992), "participatory sustainability science" (Kasemir et al . 2003) or "citizen science" (Irwin, 1995) suggest that moving towards participatory and dialogical science as bridge between complex systems and environmental policy (Funtowicz et al . 1999:8) might be productive. They share with OSS the promotion of the transparency of the scientific process, the communication of scientific concepts and uncertainty and the inclusion of stakeholders at an early stage of the research or knowledge production process.

On the other hand, the experiences gained the issues of knowledge integration in natural commons systems have implications for digital commons as well. We showed that with the increasing popularity and relevance of OSS for areas outside operating and middle ware systems, other forms of knowledge (e.g. domain knowledge) become more and more relevant. The traditional programming-centred OSS paradigm struggles to integrate alternative knowledge forms, particularly in relation to the meritocratic logic, though little research has addressed this issue so far. Lessons and experiences from natural commons systems (e.g. Jasanoff 1990, Gieryn 1983, Wynne 1996) might therefore be relevant to this emerging issue as well but has not been taken up by the literature so far.

8.2.3 Other actors

In natural resource management, stakeholders such as resource utilizers, ENGOs and the public at large are affected by the rules of the governance system and try to influence the system. In the cases of fisheries and wolf governance, the existing institutional structure is challenged by other actors that can be grouped, among the lines of nature conservation protagonist (ENGOs) and economic resource utilizers (fishermen, hunters, herders) with their different rationalities. Many of these differences in views relate to the agents' particular cognitive-normative configurations (see later). NGOs appear to be more suited to work with large international level than local stakeholders, while local stakeholders are more successful on the lower levels (e.g. Todd and Ritchie 2000 for fisheries, Fairbrass and Jordan 2001 for wolf governance) creating the risk of mismatches between different priorities. With Poland in fisheries, and Sweden in wolf governance we found examples of this phenomenon in both commons governance scenarios.

It becomes apparent that it is not always easy to provide clear boundaries of the governance system (who is in, who is out, who is affected). With the increasing trend towards participation, one might suspect that they are increasingly included within the governance system. This difficulty is not a purely analytical observation. Some authors (e.g. Griffin 2010) argue that through weak participatory arrangements, the actual power structures within the governance system become less obvious and thus there is a danger that although there might be an appearance of inclusive governance that involves all kind of actors, this - in practice - is actually not the case creating issues of accountability.

Classic OSS projects did not define any boundaries at all since there were not many other actors than the actual programmers and users. With the increasing popularity and influence of OSS projects, this has changed as companies and public agencies show interest and try to affect OSS governance arrangements. For larger projects, it therefore appears to be a consistent finding that such a fully open approach leads to significant challenges due to the diversity of interests, values and models of the situation (cognitive-normative elements) streaming into the projects decision-making processes. Thus, one can observe that most larger OSS projects create boundaries such as memberships that are often connected with some forms of entry barriers and with different rights and responsibilities connected to different membership roles (companies, public authorities, academic institutions, users, contributors etc.).

8.3 Cognitive normative considerations

In this approach to governance analysis, I argued for the importance of not only examining socio-organizational aspects of governance, but also include cognitive-normative factors consisting of problems and issues, goals and priorities, the model of the situation and appropriate solutions.

8.3.1 Issues and Goals

As outlined earlier, governance systems are purposeful collective action arrangements. What kinds of outcomes are most desirable differs between the three empirical contexts, but can also differ between different governance regimes within the particular domain, participating actors and over time. The cases of fisheries and the wolf governance the key issues are fairly well defined as the (perceived) threat of a collapse of the particular resource (wolves, fishes) in an otherwise unregulated environment. In OSS, the key issue is usually a technical problem “an itch worth scratching” (Raymond (1998). At least in the beginning such issues were mostly related to operations systems and middleware. In relation to the issues, governance systems can nevertheless several, sometimes conflicting goals and priorities. In fisheries, there is not only the goal of protecting the fish stocks but also to maintain a healthy fishing industry. For some OSS projects, the goal of and technically excellent outcome is compromised by the ideological objective to fight the proprietary software industry (leading to two separate movements). In wolf governance the protective paradigm dominates though overly harsh economic damages and even more so against potential threats to human health shall also be avoided. As more diverse actors are participating in the governance system even other priorities might have to be considered. Governance systems have to find way to deal

with contradictory goals and often this remains a major challenge. Examples for this we found in all commons cases that often manifest itself through the tension between more rational, technical and benefit oriented goals and more normative value-loaded objectives.

While main issue(s) that the governance system attempts to address in specific domain are often easy to articulate, they are often accompanied by a range of second order problems that are connected to the particular context, in which the governance system is embedded in. Issues of uncertainty, difficult monitoring and enforcement, coordination issues and attacks from the outside (e.g. proprietary appropriation of OSS software) are a few of them and the applied solutions might attempt to address those. As we were able to show, the number and kinds of issues are not only dependent on the scale of the governance system, but are also created over time through the interplay between implemented solutions to regulate or manage a governance issue, which in turn creates new issues that the governance systems tries so solve and so forth. Kooiman and Jentoft (2009:822) speak in this regard of "Second-order governance" that addresses the institutions, in which the first-order governance (the solving of the key problems) takes place. Those can involve motivation, coordination and interaction issues.

8.3.2 Conceptualization and model of the situation

Governance systems are based on model(s) of the social arrangements, the natural or technological system and the interactions between them. Examples include the anthropogenic nature of the fish stock decline, the conceptualization of wolves as something that needs to be protected, the strong support for positivistic science and rationality, the superiority of open source software etc. These might or might not be true but they enable the actors to align their actions along a common framework. This homogeneity is an important reason why community-based governance (e.g. "hacker culture") works as conflicts were are likely to occur and more likely to be resolved within the range of "informal" rules of the community shared through a common frame of values and internalized through continuous interactions (e.g. Bergquist and Ljungberg 2001, Ostrom 1990).

As natural and digital commons systems become more complex and more diverse actors enter the governance system the diversity within the cognitive-normative framework increases not only in terms of goals and values (interests) but also in terms of the conceptualizations about "what is going on", which contributes to the complexity of the system. Such underlying models of reality are usually not as obvious more difficult to address due to their subtleness. This has not only been experienced in natural resource management; large OSS projects experience struggles with "too many opinions" in an open access structure (Mateos-Garcia and Steinmueller 2003).

8.3.3 Solutions

Lastly, the different governance systems apply a variety of solutions that considered as appropriate are often very specific to the particular system. In fisheries and wolf governance, the central solution is the limitation of resource extraction by quota regulations to keep the resource population (fish, wolves) on a sustainable size. Acts of overuse / illegal hunting are criminalized and both governance systems take efforts to legitimize decisions and educate the

actors in the system. As it is illustrated in the cases, the sustainable size of the resource population is to be defined by the system and the authority to make this definition is given to science (but nevertheless contested in both cases). In OSS governance the most important solutions include the use of an advanced technical infrastructure and modularization to reduce complexity and coordination efforts and the open license as the central institutional mechanism enabling incremental innovation and protecting contributions from proprietary appropriation. Unlike in fisheries and wolf governance, it appears that the legal system to enforce the licenses (or violations of it) are rarely enforced.

8.4 Practical issues of participation

In sum, the discussion shows that many challenges of governance systems are created through the differences in different aspects of the cognitive normative configuration of different agents. Through the lens of the framework, governance systems can therefore try to improve their functioning by aligning the cognitive-normative framework of all actors and the social organisation in place. This manages the complexity in terms of coordination, monitoring and enforcement costs for the governance system. In the last part of the discussion, I will discuss different attempts how governance systems try to achieve this. This also includes more practical considerations about participatory arrangements that play an important role in this regard.

One common response of governance systems to achieve better alignments of the cognitive-normative framework is associated with attempts of powerful actors to explain and convince others of their own world view. In wolf governance, information is distributed among stakeholders trying to counter fears and prejudices with regard to wolves. In OSS governance, leaders tend to explain and rationalize their decisions towards the community and most larger projects provide guidelines about vision and values of the project, the most important procedures and what – from the projects perspective – the best ways to do things. Fisheries governance looks at a long tradition of a governance paradigm, where scientists explained to fishermen how the eco-system looks like and what the best solutions for sustainable fishing are the information instruments applied in all of the governance cases are in the forms of, project and vision statements, roadmaps, guidelines etc. as well as informational talks and campaigns. The underlying deficit model as one-way flow of information has been criticized for its assumptions and effectiveness (Irwin and Wynne 1996; Pidgeon et al. 2005). In Article II about the BS RAC we saw that this one way flow of information to change cognitive-normative frameworks alone is not suited to overcome the existing struggles and might even amplify existing conflicts, perceptions of non-legitimacy and distrust. Our information about wolf governance and OSS governance is not sufficient to support a similar statement. One could hypothesize that both governance cases might experience similar struggles, but particularly in the field of digital commons I am not aware of any research that has examined this question as has been done in other areas of environmental governance.

Calls for learning oriented participation can be seen as a way to overcome this deficit model. This research promotes more dialogical approaches in which the focus is less on education and convincing, and more towards contexts in which objectives can be co-constructed, joined learning and shared understanding is achieved. As outlined above, however, establishing

effective participation is an ongoing challenge. Issues that were found in the cases and other literature (see also Ansell and Gash 2008, Faysse 2006, McClosky 1999) include:

- Power relationships and resources imbalances
- The incentives for stakeholders to participate
- Leadership
- Stakeholder representation and up- and down-scaling
- The capacity to participate meaningfully in the debates and to relate to research
- Prior history of conflict or cooperation, distrust
- Decision-making power and mechanisms
- Platform composition and institutional design

The analysis of the BS RAC (Article II) identified similar issues for participatory governance, which was the base for the Polish fisheries roundtable (Article III) project as an attempt to overcome those challenges. The experiences from this project can be summarized in the following lessons and guidelines:

Leadership is key: Transparent and active leadership is essential to motivate participants, organise the start and move forward in the process, especially in the beginning. The skill facilitator/moderator also has a key role not only in keeping the discussion productive, but also to counteract imbalances due to the existing power relations between participants (an emancipatory role)

A focus on the process of communication, trust building and learning in the beginning. Participation often struggles to find the balance between functionalistic aspects (joined knowledge creation) and deliberate aspects. Consensus should not be the goal under all circumstances (as in the BS RAC) since it can be a significant barrier to the legitimacy and learning effects of the participatory process (see also Van den Hove 2006, Schusler et al. 2003). Instead, improving the pre-conditions, especially the capacity of disadvantaged groups to participate more effectively, has been demonstrated to be of major relevance.

Small steps and early small successes: are relevant to get momentum and support the trust building process and commitment (se also Ansell et al. for a similar observation)

Continuous integration of scientific and experience-based knowledge: through a dialogic relation to scientific expertise including the open discussion of uncertainties and diverging position within the scientific context. Methods like Joint Fact Finding (e.g. McCreary et al. 2001) can support this process.

Ensuring funding for dialogues appears to be a trivial point but is a problem for many participatory projects.

The guidelines derived from the context of the Polish fisheries roundtable are consistent with guidelines derived from meta-analyses of the existing literature (Reed 2008, Ansell and Gash 2008). Interestingly, very recent study in the context of OSS projects (Schweik and English 2013) also concludes that leadership, fine-scaled task granularity and financial backing and a benevolent dictator model are among the key factors distinguishing successful from abandoned projects.

8.5 Conceptualizing commons governance

The second research question of this thesis asked if governance of complex natural and digital commons systems with diverse actors, objectives and knowledge systems usefully conceptualized by applying a universal governance framework. This question was based on the insight that while there are a number of different attempts to conceptualize governance, most of these efforts are very specific to the empirical domain in which they are applied. There is a need for conceptual work that enables interdisciplinary cross case comparisons over a wide range of governance arrangements (Ostrom 2009). The process of conducting case studies on governance in diverse sectors and on multiple levels and assembling them, and using them as an empirical base for theoretical development is essential to cumulative science and to strengthening the inter-disciplinarity of an institutional approach.

In the thesis I suggested a governance framework as an answer to RQ 2. The frameworks conceptualizes governance systems as distinguishable categories of socio-organisational and cognitive-normative governance features. As a conceptual lens for governance analysis it facilitates the description of commons governance systems. Applied to multiple cases, it supports the identification and analysis of similarities and differences among governance systems serving the accumulation of systematic knowledge about very different governance contexts.

Through the three articles (I, IV and V) the framework was used as tool analyse the different commons governance systems including the identification of governance challenges and the responses to it. Thus the framework was applied to answer significant parts of RQ 1. The analyses resulted in rich accounts of the different governance systems that on its own provide relevant empirical records of governance. The benefit of applying this particular framework was thereby in consideration of the interlinks between socio-organisational and cognitive-normative aspects of governance, that result in a better explanation of the ongoing governance mechanisms than any of this category alone. In OSS governance, the area which is probably most distinct from the original applications of the framework when it was developed, the framework provided a conceptual lens that not only made it possible to re-interpret existing research on OSS governance, but also to identify new areas of research that appear relevant as digital commons become highly diverse and complex. Further, the framework was informing the comparative discussion part the thesis. Some scholars might argue that natural and digital commons are not comparable. I think the framework has helped to show that there are important overlaps that can inspire research in both fields of governance and that the framework helped to become visible.

The application of the framework in the different empirical settings is also a good way to learn about aspects that need further development. One underrepresented link is technological aspects and ecological aspects in the conceptualization. Governance systems consist of multiple regulatory structures and processes. That includes not only mechanisms of social regulation and control but also natural and technical control mechanisms (Burns and Hall 2013). The concern could even be put further reflecting the socio-materiality discussion in Information Systems research (see e.g. Leonardi et al. 2012). There it is argued that "*the social and the material are considered to be inextricably related — there is no social that is not also material, and no material that is not also social*." (Orlikowski 2007:1437). Other system-oriented approaches like the Social-Ecological Systems (SES) framework (Ostrom, 2007, 2009) do in fact have material dimensions and for a full fledged system-based analysis framework, I would agree that such a dimension needs still to be developed. Another part requiring some development might be the issue of scale that though representable is not systematically considered.

9 Conclusions

This thesis examined the challenges and governance responses in complex commons systems as increasing complexity of the socio-technical or socio-ecological conditions, such governance systems are increasingly struggling to achieve the desired action outcomes. To achieve this, different empirical cases of commons governance were analysed with the help of a universal governance framework that distinguishes different categories of social-organisational and cognitive-normative features of governance.

Empirically, the thesis contributes to the record of governance cases of natural and digital commons by providing analyses of the governance of Baltic Sea fisheries, wolf governance in Sweden, Germany, Portugal and Galicia as well as a meta-synthesis of governance literature about Open Source Software projects. The key findings and characteristics in relation to the case-related research questions are presented in the following:

RQ 1.1: Baltic Sea fisheries is characterized by contradictory goals of economic gains, damage prevention and nature conservation that compete for priority. It is case of multi-level governance, where the centralized mode of the EU governance institutions dominates. Participatory arrangements exist but are rather weak as their role is mainly advisory. Natural science expertise dominates the knowledge gathering process to a great extent. It involves specialized units of scientific expertise on all levels and is based on a modern and rationalistic understanding of knowledge. The current social-organizational structure does not support an integration of diverse knowledge-systems. The cognitive normative configurations of the groups involved are highly diverse.

RQ 1.2 Wolf governance in the four cases is dominated by the goal of wolf preservation, while preventing damage (human and economic). It is a case of multi-level governance, where the EU assumes a steering function and large amounts of decision-making power remain on the national level. In the cases of Sweden, Germany and Galicia, this is further delegated to the regional level to a large extent, while Portugal is highly centralized. Sweden and Germany also provide strong opportunities for stakeholder participation. Natural science expertise dominates the knowledge gathering process to a great extent based on a modern and rationalistic understanding of knowledge. Special units of scientific expertise feed the governance process mainly national and local level. Although there is agreement that alternative sources of knowledge would help the governance process, no such mechanism is in place. Despite actual numbers of wolf and the amount of damage is opposition to wolves most apparent in Sweden and Germany, despite (or maybe because of) strong participatory mechanisms.

RQ 1.3: OSS governance serves a multitude of goals in form of form of intrinsic and extrinsic motivations of participants. Ideological objectives can nevertheless compete with technical goals and in modern large-scale and hybrid projects the diversity of actors and their goals increases significantly. Despite the assumed network-mode of governance of OSS projects, successful projects often apply (informal) hierarchical structures in form of benevolent dictators. With increasing complexity, OSS projects tend to become more formalized and

bureaucratic(RQ1.3). Knowledge creation is widely distributed among agents and supported by technical infrastructure, transparency and massive user involvement for debugging. The emerging need to integrate diverse systems of knowledge creates an increasing challenge to the established mode of knowledge integration that has not been researched. Large scale and especially hybrid OSS projects cannot rely on a homogeneity of the cognitive and normative frames that characterized classic OSS projects resulting in efforts to apply more formalized measures of organization. Whether a new shared cognitive-normative framework is developing over time has not been addressed so far.

RQ.1.4: The functionalistic-deliberative consensus-finding approach of participation in Baltic fisheries was not successful in overcoming the conflict and distrust between the different rationalities of stakeholders. Science, by many still perceived by as the only and absolute provider of "truths" by policy-makers and NGOs, rather amplified conflicts between scientists, environmentalists and fisheries stakeholders. That as well as, for example, missing feedback loops to other levels of governance, also prevents or slows down collaborative learning.

RQ 1.5: The participatory arrangement set up in Polish fisheries focused strongly on the communication, learning and the co-construction of objectives among the stakeholders. It was successful with regard to trust building and joint learning and creating collaborative capacity. Critical factors in this study involved:

1. Leadership
2. A focus on the process of communication, trust building and learning in the beginning
3. Gain momentum through small steps and early small successes
4. The continuous integration of scientific and experience-based knowledge systems in the decision-making process
5. Ensuring funding

The comparative discussion of the different cases allows to draw some general conclusion with regard to RQ 1:

1. Commons systems with a high actor diversity and high detail and dynamic complexity are struggling to achieve the plurality of desired outcomes. Hierarchical as well as pure-self governance can, however, be effective in commons governance.
2. Co-management forms of organization appear most suited for complex commons governance – digital and natural large complex commons systems. They combine the need of some degree of centralization with public and stakeholders engagement in the decision-making process.
3. Differences in the cognitive-normative configurations of the agents in the governance system are a key challenge of complex governance systems. They are typical for environmental but are increasingly apparent for digital commons as well. Many challenges to the social-organization of governance systems are a result of this increasing diversity.

4. A technocratic approach to governance is unlikely to be able to deal with the challenges of complex governance systems. Science then becomes part of the problem rather than the solution.
5. Strategies of persuasion (one way flow of information) to align cognitive-normative frameworks are unlikely to be able to deal with the challenges of complex governance systems. Approaches that foster collaborative learning and the co-construction of knowledge and objectives appear better suited.
6. Participation in governance is not a solution to the challenges of commons governance per se; they must involve: well-designed communication processes on various levels fostering trust building, learning and capacity building. Participatory processes are highly context dependent and have to be seen in the existing institutional and cultural landscape and power relations. Nevertheless, the guiding principles (see above) appear to be valid in other contexts as well, including OSS governance.

The results of the thesis help to better understand the issues resulting from complexity in commons governance and improve the existing practices of participation. They also create new opportunities for scientific collaboration.

As theoretical contribution, the thesis enhances the conceptual and methodological approaches to commons governance analysis. As a contribution to the new instiutionalism, the thesis enhanced the development of a universal governance framework as a conceptual tool for the analysis of different governance systems (RQ 2). Although the approach can be further developed (see discussion section), the thesis has demonstrated that a full-fledged institutional approach can address different kinds and levels of governance. but that has rarely (if at all) been applied to OSS governance. Utilizing this institutional approach, we have investigated dimensions of power, knowledge, and conflict in governance systems.

10 Limitations of the thesis

As all theoretical and empirical research in science this thesis contains limitations based on compromises that had to be made during the research process.

First, in the articles and this cover paper, I suggested a universal governance framework that also served as tool for the empirical analysis. This approach contains a number of risks as shortcomings in the framework directly affect parts of the empirical analysis. The main risk that I perceive thereby is that the conceptualization leaves out important components as discussed earlier. This can be corrected as through efforts like in this thesis, as further discussion and learning through the application of the framework in different context enables researchers to identify what components are missing, or might be missing.

Second, another necessary limitation regards the generalizability of conclusions. While I accept that that the specific challenges and solutions to commons governance issues are often highly context dependent, we also argued for the need of cross case study analysis over various empirical cases and academic disciplines. With our framework, we attempted to provide a tool that is general enough to be applied in various fields but that is also specific in pinpointing at some of the essential elements of every governance system. While a certain level of detail is necessarily lost, I feel that the comparative analyses still revealed some of the challenges and solutions that reappear in all of the studied cases. Nevertheless, in order to generalize from the three key case studies to governance systems, more empirical research is needed, especially since the case selection by done by purpose (rather than for statistical reasons). The issue of generalizability is even more apparent in the very detailed case and action research studies though both of these studies point at the context dependence of their results. This general problem of case study analysis and action research was addressed by providing detailed information about the context from which the conclusions were drawn.

Finally, one could criticise the lack of general methodological rigor in some of the studies as methods and details of the research design and data collection processes are sometimes insufficiently reported. Thus, it could be argued that it is difficult to understand where the results of the different studies actually come from? In Article II and III we were able to support our findings with quotes and other specific sources of information, whereas particularly Article I and IV are fairly vague in this regard due to the extensive case analyses and the space limitations of journal publications. I tried to counteract such an impression by providing more detailed information about the different research designs in the method section of this thesis.

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