Governance Across the Land-Sea Interface

by

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions (page iii). This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

In the School of Environment, Resources and Sustainability, two forms of presentation of the doctoral dissertation are permitted: (1) a standard dissertation monograph, and (2) a manuscript option centred on three or four published or publishable learned journal-type manuscripts on related matters, packaged with introductory and concluding chapters that integrate the purposes/research agenda and findings/implications, with the required result forming a conceptual whole. This thesis used the manuscript option. Specific requirements relating to the manuscript option, which have been met, are as follows:

- The manuscript-based dissertation must reflect a consistent overall conceptual foundation and research agenda and the parts must be integrated to form a coherent package. The whole must be related to the overall purposes of the School of Environment, Resources and Sustainability (SERS) doctoral program, and the individual components of the dissertation must originate from the doctoral research.
- The manuscripts must be dominated by the intellectual effort of the student. While members of the advisory committee and others involved in the research may, as appropriate, be listed as secondary authors on individual manuscripts, the manuscripts must be written by the student, and the student must be the first author on each manuscript.
- Where multiple authorship occurs, there must be a preface statement in the thesis outlining the roles of the respective authors, and clarifying the extent and nature of the contribution of the student. Co-authors must sign the statement to indicate that they are in agreement with the evaluation of the roles and contributions of the various authors.

- In no case can a co-author serve as an external examiner for the thesis.

Findings from this dissertation are reported in three single- or co-authored manuscripts (Chapters 4, 5 and 6). Chapter 4 was accepted for publication in Environmental Science and Policy (Pittman and Armitage, 2016); Chapter 5 is currently in review; and Chapter 6 will soon be submitted for publication.

I testify that I am the primary author of the manuscripts in my dissertation, and that the work was dominated by my intellectual efforts.

Jeremy Baron Pittman

Co-authorship for D. Armitage (Advisor) on Chapters 4, 5 and 6 was determined based on meeting the following criteria:

- Contributions to the conception and design of the work and/or to interpretation of data;
- Contributing to editing and revising the work critically for important intellectual content;
- Final approval of the versions of the chapters that will be published as refereed journal articles;
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

I testify that [student] is the primary author of the manuscripts in this dissertation, that the work was dominated by her/his intellectual efforts, and that I have met the four tests outlined above.

Derek Armitage (Advisor)

University of Waterloo

Abstract

Effective governance is urgently needed to reduce the existing pressures on coastal-marine resources due to human activities on both the land and sea. Yet effective governance across the land-sea interface remains elusive in theory and practice. The purpose of my doctoral work is to illuminate the elements of effective governance necessary to address sustainability challenges and ensure the wellbeing of communities situated at the margins of the land and sea. Specifically, I examined (1) the current state of knowledge regarding effective land-sea governance, (2) the contributions of network governance to improving capacities to address social and ecological processes across the land-sea interface, and (3) the conditions that foster transformations towards network governance in land-sea systems.

My research was guided by an overall transdisciplinary framing, which allowed for the application of multiple strategies of inquiry – including systematic review and case studies – and a concurrent mixed methods approach to both qualitative and quantitative analysis. Data were collected through a systematic literature search and semi-structured interviews. The case studies were drawn from the Lesser Antilles – a region currently facing multiple sustainability challenges across the land-sea interface due to rapid land-use change, uncontrolled coastal development, and the cross-cutting threats associated with climate change.

Systematic review of land-sea governance scholarship found that the main governance challenges associated with addressing land-sea interactions include determining boundaries, addressing cross-scale effects, and accessing appropriate scientific and local knowledge. Science-policy integration and functional fit are the two most referenced ingredients of governance effectiveness across the land-sea interface. However, supportive networks and both

social and temporal fit were also cited relatively frequently as factors contributing to governance effectiveness. Despite the presence of a firm knowledge base, the review highlighted the need for improved conceptual richness and theory-building regarding governance across the land-sea interface.

In comparative case studies from the southeast coast of Saint Lucia and the southwest coast of Dominica, I examined how network governance contributes to social-ecological fit, or the ability to address social-ecological processes in land-sea systems. I found that network governance has contributed to coordinating management of shared resources and interconnected ecological entities. However, its potential role in promoting co-governance and land-sea integration is yet to be fully realized due to the inertia of existing arrangements. The analysis demonstrates that a more thorough understanding of how network governance emerges in largely hierarchical governance systems is needed in order to improve governance capacities for addressing land-sea interactions in the region.

I then examined the processes contributing to the emergence of network governance in four embedded case studies: Saint Vincent and the Grenadines (focus on Saint Vincent), Antigua and Barbuda (focus on Antigua), Grenada, and Saint Kitts and Nevis (focus on Saint Kitts). Drawing on network governance theory and the concept of governance transformations, I investigated the conditions that foster transformations towards network governance in land-sea systems. I found that participation on collaborative projects has been an essential ingredient in initiating transitions towards network governance. The case studies revealed that project participation was both necessary and sufficient for initiating a transition towards land-sea integration. However, project participation was necessary but insufficient to promote transitions towards co-governance, or state and non-state collaboration in network governance. Other important

conditions for initiating transitions include the ratification of multilateral agreements, the presence of boundary-spanning organizations, and experience with extreme events (e.g., tropical storms). The leadership of central actors and core teams can help ensure that ongoing transitions proceed towards network governance. Also, it will be important to find innovative governance strategies or arrangements that can leverage and build the latent capacities found within communities to improve the emergence of co-governance. These strategies will likely challenge current conceptions of network governance in the region.

A synthesis across these analyses yields three broader contributions. First, my research supports the proposition that network governance can be beneficial to address land-sea interactions. Network governance as a concept helps bridge the theory and knowledge garnered over the years in attempting to apply integrated and ecosystem-based management. It allows for an examination of how different patterns of collaboration and coordination can help match functional interactions in ecosystems and promote inclusive participation in governance. In practice, such an approach can help match governance simultaneously to both the social and ecological properties of land-sea systems – a challenge that has been pervasive. Second, my research identifies the limitations of network governance specifically in relation to preparing for, and responding to extreme events. The governance networks useful to address land-sea interactions may simply be too cumbersome or inefficient in the face of hurricanes and other storms. Improved integration between land-sea governance networks and the institutional arrangements in place to manage disasters could compensate for these limitations of network governance. Third, my research shows the need to consider multiple modes of governance – specifically, both hierarchical and networked modes – as coexisting, rather than in isolation. Governance networks and the hierarchical mode can be synergistic or antagonistic – either serving to support or

undermine one another. My research challenges a view that network governance necessarily implies a hollowing of the state. Rather, I demonstrate how effective network governance is contingent upon appropriate guidance from the state. The state, in such instances, requires a clear mandate to participate in governance networks and ensure sustainable regulation. These contributions – although grounded in the Lesser Antilles context – are relevant for coastal areas and island nations throughout the globe.

Acknowledgements

I extend my sincerest thanks to all the people who took the time to participate in my study. Additionally, I thank those who helped me situate myself in Saint Lucia, Saint Vincent and the Grenadines, Grenada, Antigua and Barbuda, Dominica, and Saint Kitts and Nevis. In particular, I thank Norman Norris, Andrew Magloire, Riviere Sebastien, Jullan Defoe, Sylvia Butcher, Craig Henry, Jeg Clark, Lavina Alexander, Crispin d'Auvergne, Yves Renard, Gordon Paterson, Ayodele Andrew, Idelia Ferdinand, Paul Lloyd, Linroy Christian, Joyelle Clark, and Laveta Mead. I want to give a special thanks to Donovan Campbell for his assistance, support and friendship throughout my doctoral studies.

I want to acknowledge the unparalleled mentorship I have received from my supervisor, Derek Armitage, and the exceptional guidance from my committee members, Tony Charles, Robert Gibson, and Scott Slocombe. I also want to acknowledge the unwavering support from colleagues at the Environmental Change and Governance Group and University of Waterloo.

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Lastly, I want to thank my wife, children, parents and grandparents for setting me on, and supporting me throughout the path towards completing this dissertation.

Dedication

I dedicate this dissertation to the many friends I made in the Lesser Antilles who are working at the frontlines of sustainability issues on these islands. I found my inspiration in your efforts. I also dedicate this dissertation to Monica, Ariela, and Oliver. I could not have completed it without your encouragement.

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List of Abbreviations

CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARIFITA	Caribbean Free Trade Association
CARPHA	Caribbean Public Health Agency
CCCCC	Caribbean Community Climate Change Centre
CDEMA	Caribbean Disaster and Emergency Management Agency
ESDU	Environment and Sustainable Development Unit (of the OECS)
ERGM	Exponential Random Graph Model
DEM	Digital Elevation Model
GIS	Geographic Information System
LBS Protocol	Land-base Sources of Pollution Protocol
LS-SES	Land-Sea Social-Ecological System
IWCAM	Integrated Watershed and Coastal Areas Management
OECS	Organization of Eastern Caribbean States
MERGM	Multilevel Exponential Random Graph Model
SES	Social-Ecological System
SIDS	Small Island Developing States

Chapter 1. Introduction

The land-sea interface represents a transition between marine and terrestrial space that is shaped by multiple social and ecological processes. Schaefer (1972) offers a useful characterization of the land-sea interface as the area "where terrestrial activities importantly impinge on the marine environment, marine resources and marine activities, and where marine activities importantly impinge on the environment, resources, and activities of the land." Schaefer's (1972) definition highlights the interconnectedness between the land and sea, and brings attention to the importance of human use of both spaces. In fact, the land-sea interface is one of the most highly human-used and occupied environments throughout the globe (Hugo, 2011; Neumann et al., 2015; Small and Nicolls, 2003). Approximately 44% of the global human population lives within 150 km of the land-sea interface (UN-Oceans, 2011), and this area provides a disproportionately high level of benefit (e.g., nutrient cycles, food) to humans in relation to its size (Costanza et al., 1997). As is apparent, the land-sea interface is one of the most essential environments for humans in the world. However, its significance has led to a high level of human impact on both sides of the land-sea interface.

Section 1.1. Research focus and objectives

Many land-sea systems have been significantly modified due to anthropogenic pressures (Álvarez-Romero et al., 2011; Halpern et al., 2012, 2009; Ramesh et al., 2016). Direct pressures include coastal developments, land-use changes throughout coastal watersheds, excessive resource extraction (e.g., overfishing), and pollution from point (e.g., sewage, garbage) and non-point (e.g., agrochemicals) sources (Gladstone, 2009; Halpern et al., 2009; Lamb et al., 2016; Ramesh et al., 2016). Cross-cutting pressures are also problematic and include climate change

(e.g., sea level rise, ocean acidification, changing precipitation and storm regimes), global population increase, and increased demand for food and other resources (Álvarez-Romero et al., 2011; Glavovic et al., 2015). These pressures have both social (e.g., loss of livelihoods, distribution of impacts) and ecological (e.g., loss of species or habitats) consequences, and they result in multiple sustainability problems.

Two main management approaches have emerged in response (Chapter 4). First, integrated management – which is meant here to capture a plethora of related terms (e.g., integrated coastal zone management, integrated watershed and coastal areas management) – emerged largely from the social sciences (Aswani et al., 2012). Integrated management aims to reduce the constraints placed on management by sectoral and jurisdictional fragmentation (Aswani et al., 2012; Born, 2012; Charles et al., 2010; Cheong, 2008; Kearney et al., 2007). It promotes collaboration and coordination among diverse actors from both within and outside the state (Charles et al., 2010; Hovik and Stokke, 2007). Second, ecosystem-based management emerged largely from the natural sciences and refers to "management of a particular ecosystem's structure and function to sustain and foster ecosystem services for human society" (Aswani et al., 2012:1). Ecosystem-based management typically recognizes the dynamic complexity of systems interactions (Waltner-Toews et al., 2008). It also maintains a focus on reduced management fragmentation and improved collaboration (Bodin et al., 2016b; Carollo and Reed, 2010; Sandström et al., 2015; Slocombe, 1998); yet it differs from integrated management due to its inherent focus on ecosystems, recognition of system complexity and associated emphasis on exercising precautionary and adaptive approaches to management (Boesch, 2006; Long et al., 2015). To some, ecosystem-based management was viewed as a progression from integrated management

(Christie et al., 2009a), and the two have inherent compatibilities (Arkema et al., 2015; Aswani et al., 2012).

These forms of management – whether integrated or ecosystem-based – have been plagued with implementation challenges (Buono et al., 2015; Perez-Cayeiro and Chica-Ruiz, 2015; Tallis et al., 2010). Although there are promising examples, neither approach generally deals well with the challenge of contextualizing their principles and prescriptions in the diversity of coastal places in which implementation occurs (Charles et al., 2010; Christie et al., 2009a, 2009b; Christie and White, 2007; Kearney et al., 2007). Of the many implementation issues listed in the literature, governance is often highlighted either as (1) a contextual factor that limits and constrains integrated and ecosystem-based management (Adams et al., 2014; Tallis et al., 2010) or (2) a process that can be leveraged to bring together the diversity of actors necessary for implementation (Christie and White, 2007; Hovik and Stokke, 2007; Sievanen et al., 2013). The attention to governance shifts focus from the hands-on management of social and ecological processes to the underlying ways people interpret problems, make decisions, craft rules, and set priorities (Kooiman et al., 2008). Due to this foundational role in defining management, governance is a critical component of addressing sustainability problems at the land-sea interface (Glavovic et al., 2015; Ramesh et al., 2016).

Despite the importance of governance, a clear image of effective governance across the land-sea interface remains elusive in the literature. Governability – or "the overall capacity for governance of any societal entity or system" (Kooiman et al., 2008:3) – is an important lens for understanding and framing governance effectiveness in this context (Section 2.5.1). The governability of land-sea systems hinges on social-ecological fit, or the ability to account for the social and ecological processes that traverse the land-sea interface (Section 2.5.2; Epstein et al.,

2015; Kooiman, 2013). Network governance – or a decentralized mode of governance involving collaboration between diverse actors – has been proposed as a means of improving social-ecological fit (Section 2.5.3; Guerrero et al., 2015a; Hovik and Stokke, 2007; Roldán et al., 2015). However, few empirical studies have examined the role of network governance in achieving social-ecological fit across the land-sea interface. Additionally, the processes of governance transformation (Section 2.5.4) – or fundamental changes in governance (Armitage et al., in press) – that foster the emergence of network governance are not well understood. These knowledge gaps provide the impetus for my doctoral research, which is guided by the following question and objectives:

How can we effectively govern across the land-sea interface?

Objective 1. To synthesize extant theory regarding governance across the land-sea interface.

Objective 2. To investigate the network governance processes contributing to social-ecological fit across the land-sea interface.

Objective 3. To examine the strategies and conditions that foster transformations towards network governance to address land-sea interactions.

I examined a number of embedded and comparative case studies from the Lesser Antilles – a region facing pervasive sustainability problems at the land-sea interface (Section 1.2) – to meet these objectives. I found that governance faces many unique challenges across the land-sea interface, including the determination of boundaries, dealing with cross-scale effects, and accessing knowledge. These challenges can be confronted with timely science-policy integration, supportive networks, and social-ecological fit (i.e., temporal, functional and social fit). Network governance has built social-ecological fit by coordinating management of shared or

interconnected ecological entities, although improved network governance is required to bridge diverse knowledge and match biogeochemical interactions across the land-sea interface. Participation in collaborative projects has helped foster the emergence of network governance. The ratification of multilateral agreements (e.g., the Land-based Source of Pollution [LBS] Protocol), the presence of boundary-spanning organizations and experience with extreme events (e.g., tropical storms) have also contributed to network governance emergence. However, the leadership of central actors and core teams and the latent capacities of communities will be crucial for improving network governance in the region. Governance across the land-sea interface in the Lesser Antilles is currently in transition towards a more networked mode, which will (1) foster capacities to address the negative implications for coastal environments of human use of the land and sea and (2) improve the livelihoods and wellbeing of coastal communities.

Section 1.2. Empirical context

The Lesser Antilles are a group of islands on the eastern fringe of the Caribbean Sea (Figure 1). I chose the Lesser Antilles for empirical focus due to (1) the nature and extent of challenges with land-sea interactions in the region; (2) the magnitude of change expected due to climate and other drivers with relevance to land-sea interactions; and (3) the emergence of multilevel governance arrangements in the region to address land-sea interactions. These three criteria make the Lesser Antilles a useful context for examining governance across the land-sea interface.

The Lesser Antilles face a number of acute challenges related to land-sea interactions. The rugged terrain and catchment areas of these islands coupled with dependence on tourism, fisheries, agriculture and forestry provide a context where ongoing changes in land use or land conversion can have significant influence over nutrient cycles and sedimentation processes,

which lead to detrimental impacts to coastal-marine systems (Bégin et al., 2016; Sweeney and Corbin, 2011). Additionally, the limited land area and freshwater supplies of small islands make coastal inundation and saltwater intrusion particularly concerning. However, the existing institutional context within the region typically precludes or inhibits an integrated approach to management and governance (Sweeney and Corbin, 2011). The pervasive governance fragmentation provides a precursor for a suite of problems – climate change vulnerability, unsustainable development, livelihood insecurity – and limits capacity to address adequately these problems (Pittman et al., 2015; Saffache and Angelelli, 2010; Sweeney and Corbin, 2011).

There are several initiatives to address emerging problems associated with land-sea interactions in the region. For example, the Land-based Sources of Pollution (LBS) Protocol has been developed as part of the Cartagena Convention for Protection and Development of the Marine Environment in the Wider Caribbean. The LBS Protocol is a multilateral agreement that aims to reduce land-based stressors to the marine environment. Additionally, there are a number of multilevel governance arrangements of relevance at two nested levels. The Caribbean Community Secretariat (CARICOM) was created in 1973 to promote free trade and policy coordination within the Caribbean region. CARICOM extends well beyond the mission of its predecessor, the Caribbean Free Trade Association (CARIFITA), and has resulted in the creation of numerous regional agencies that advance cross-cutting and integrated approaches to common problems. Of particular interest in the context of land-sea connections are the Caribbean Public Health Agency (CARPHA), Caribbean Community Climate Change Centre (CCCCC), the Caribbean Disaster and Emergency Management Agency (CDEMA), and the Caribbean Agricultural Research and Development Institute (CARDI). These agencies have advanced or partnered on a number of projects relevant to addressing land-sea connections.

Additionally, independent island nations within the Lesser Antilles also coordinate through the Organization of Eastern Caribbean States (OECS). The OECS was established in 1981 and aims to support sustainable development in the region by creating a collaborative platform from which member states can integrate into the global economy. The OECS is organized into multiple working units to advance its objectives. Most relevant to the context of land-sea interactions is the Environment and Sustainable Development Unit (ESDU), which aims to support sustainable livelihoods and resource use within Member States. Part of this mandate has involved implementing or facilitating various integrated development projects and promoting policy coherence through an island management approach. The island management approach – sometimes referred to as 'ridge-to-reef' – is foundational for an integrated approach to land-sea interactions (McConney et al., 2003; Nichols and Chase, 1995).

I drew on six OECS nations as case studies for my research. Chapter 5 draws on a comparative case analysis of Saint Lucia and Dominica. These two islands share many common social and ecological features (Table 1). However, Saint Lucia is populated somewhat more densely than Dominica. My interviews (Section 3.3) revealed that the two islands had a similar number of actors relevant for land-sea governance. Chapter 6 draws on four embedded cases: Antigua and Barbuda (with a focus on Antigua); Grenada (with a focus on island of Grenada); Saint Kitts and Nevis (with a focus on Saint Kitts); and Saint Vincent and the Grenadines (with a focus on Saint Vincent). Again, these island nations share many key social and ecological features (Table 1); however, Saint Kitts and Antigua have a somewhat higher Gross Domestic Product (GDP) per capita than the other islands. There are a range of actors relevant for land-sea governance in each island context. Based on my interviews, Antigua (18) had the fewest number of relevant actors of these four cases, and Grenada (36) had the most. In all six cases, the governance landscape was

comprised of a mix of local state and non-state actors with varying degrees of interest in the land, sea or both. These actors – in some cases – had collaborated with the regional-level actors noted above on projects or initiatives aiming to address land-sea interactions (e.g., CARPHA, OECS). Three have ratified the LBS Protocol (Antigua, Saint Lucia and Grenada), and three have not (Saint Kitts, Saint Vincent and Dominica). The similarities between cases improve the validity of comparison, while the differences allow for a richer examination of diverse contextual features. For more information on the cases, please see Section 5.3.1, Section 6.4, and Appendix A.

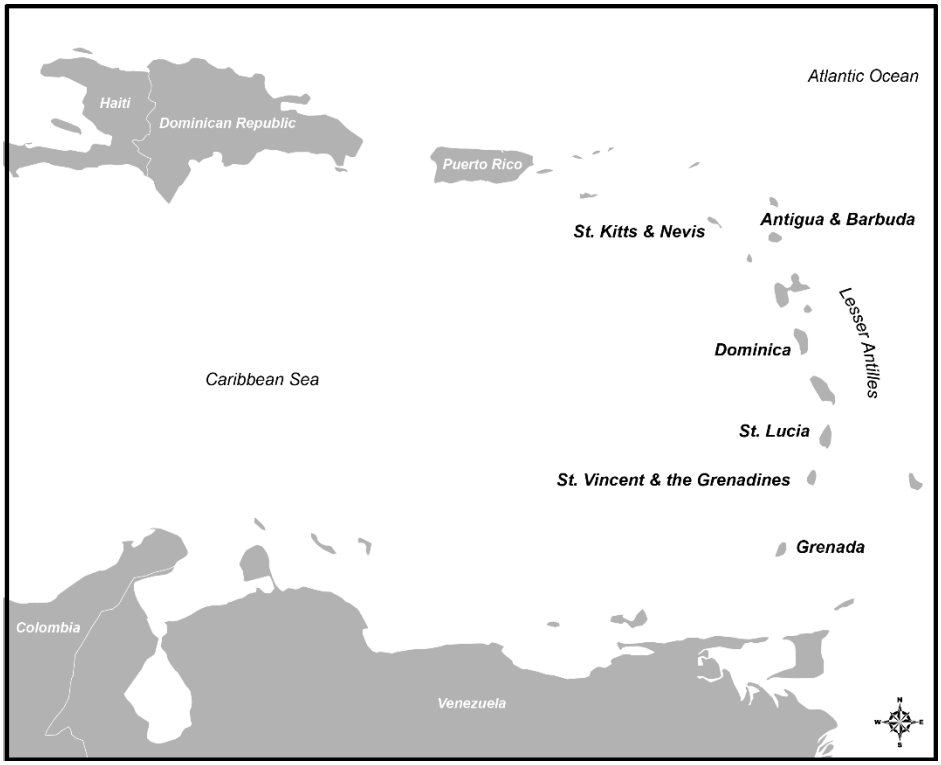


Figure 1. Map of Lesser Antilles.

Table 1. Selected characteristics of the embedded case studies.

	Antigua	Grenada	St. Kitts	St. Vincent	St. Lucia	Dominica
Governance actors (N)	18	36	23	24	35	47
LBS Protocol	Yes	Yes	No	No	Yes	No
Land area (km^2)	443	347	360	345	617	724
Forest area, 2013 (%)	22	50	42	69	33.5	58.5
Area < 5 m elevation (%)	32	22	19	22	8.0	9.4
Coast line (km)	260	121	135	84	163	149
Pop., 2014 (N)	90,900	106,349	54,944	109,360	183,600	72,340
Pop. density, 2014 (N/km^2)	207	313	211	280	301	96
GDP per capita, 2014 (US $)	13,961.70	8,295.50	15,167.00	6,663.30	7,647.50	7,244.50

Source: Interviews, World Bank, FAO Country Profiles

Section 1.3. Thesis organization

This thesis is manuscript-based, but in addition to the manuscript chapters it includes other chapters designed to discuss and develop key concepts and methodological elements. Chapter 2 presents the conceptual framework and discusses a number of key concepts – governability, social-ecological fit, network governance and governance transformation. Chapter 3 describes my multifaceted and transdisciplinary research design, which included systematic review and case studies.

Chapter 4, the first manuscript chapter, characterizes the current knowledge base regarding governance across the land-sea interface (Objective 1) and contains a manuscript entitled "Governance across the land-sea interface: A systematic review". This manuscript delves into the current state of knowledge regarding governance across the land-sea interface. It finds that the main governance challenges associated with addressing land-sea interactions include determining boundaries, addressing cross-scale effects, and accessing knowledge. Science-policy integration and functional fit are the two most often recognized factors that contribute to governance effectiveness across the land-sea interface. However, supportive networks and both

social and temporal fit were also cited relatively frequently as contributing to governance effectiveness. Despite the presence of a firm knowledge base, the review found that improved conceptual richness and theory-building were required regarding governance across the land-sea interface. This manuscript is currently published in *Environmental Science and Policy* (Pittman and Armitage, 2016).

Chapter 5 builds on the findings of Chapter 4 to empirically examine the social-ecological processes contributing to certain aspects of governance effectiveness across the land-sea interface (Objective 2). It contains a manuscript, entitled "How does network governance affect social-ecological fit across the land-sea interface? An empirical assessment from the Lesser Antilles". The manuscript applies the concept of social-ecological fit – which encompasses aspects of functional, social and temporal fit – to examine how network governance can help (or not) address the governance challenges noted above. The paper is focused on the Lesser Antilles, but draws on a structured and focused comparison of case studies from Saint Lucia and Dominica. The paper finds that network governance has contributed to coordinating management of shared resources and interconnected ecological entities. However, its potential role in promoting co-governance and land-sea integration is yet to be fully realized. The paper highlights the need for a more thorough understanding of how network governance emerges in largely hierarchical governance systems in order to improve governance capacities to address land-sea interactions in the region. This manuscript is currently under review.

Chapter 6 examines the gap in understanding identified in Chapter 5 and contains a manuscript entitled "Transforming governance to address land-sea interactions in the Lesser Antilles." Drawing on network governance theory and the concept of governance transformations, this manuscript investigates the conditions that foster the emergence of governance networks and

more effective land-sea governance in the Lesser Antilles (Objective 3). The paper finds that participation in collaborative projects has been an essential ingredient in initiating transitions towards more effective governance. Project participation was found to be both necessary and sufficient for initiating a potential governance transformation towards land-sea integration. However, project participation was necessary but insufficient to promote transitions towards co-governance. Other important conditions for initiating transitions include the ratification of multilateral agreements (e.g., the LBS Protocol), the presence of boundary-spanning organizations, and experience with extreme events (e.g., tropical storms). The leadership of central actors and core teams can help ensure that ongoing transitions proceed towards network governance. Also, it will be important to find innovative governance strategies or arrangements that can leverage and build the latent capacities found within communities to improve the emergence of co-governance. These strategies will likely challenge current conceptions of network governance in the region. This manuscript will be submitted.

Chapter 7 presents a concluding synthesis of the three manuscripts to identify the broader contributions to both theory and practice resulting from my doctoral research. In addition, Chapter 7 contains reflections regarding the limitations of the research and on the process of conducting transdisciplinary research on sustainability at the land-sea interface.

Chapter 2. Governance for sustainability in land-sea social-ecological systems

My doctoral research is guided by a multifaceted conceptual framework that draws on a rich foundation in scholarship on coastal management, social-ecological systems, sustainability, and governance. First, the roots of existing land-sea governance scholarship are grounded in the literature on integrated and ecosystem-based management (Section 2.1). Next, I use the concept of a social-ecological system to articulate and explore the inherent interconnectedness of the social and ecological domains across the land-sea interface (Section 2.2), and I highlight the concepts of adaptability and transformability as particularly important for my research (Section 2.3). Drawing on these concepts, the general goals of sustainability underpin my lens on the challenges that we must address and the expectations of effective governance across the land-sea interface (Section 2.4). Finally, I use governance as a set of theories and related concepts (Section 2.5) to understand what constitutes effective decision making and collective action across the land-sea interface. The development of the conceptual framework presented in this chapter has been an iterative process, which involved drawing on the available literature on governance across the land-sea interface (Chapter 4), but also critically assessing the gaps in this literature and augmenting with additional literature where necessary (Section 2.5).

Section 2.1. Conceptual foundations for sustainability across the land-sea interface

There is a rich history of relevant research for sustainability in land-sea social-ecological systems (LS-SES). This body of research provides the theoretical and conceptual roots for current scholarship on sustainability across the land-sea interface. Much initial attention in this regard was placed on integrated coastal zone management and its derivatives (e.g., integrated coastal and oceans management). Integrated coastal zone management emerged in the 1980s as a

management paradigm closely tied with the idea of sustainable development (Kenchington and Crawford, 1993; van der Weide, 1993). Conceptually, integrated coastal zone management developed from many related approaches (e.g., cross-sectoral coastal planning, coastal area management) originating in the 1960s, which were rooted in the identified need to improve coastal zone management (Meltzer, 1998). This need was a response to increasing concerns regarding the (1) overexploitation and unsustainable use of coastal resources and (2) the failure of predominantly sector-based and fragmented institutions to mitigate undesirable practices and effects (Huggett, 1998). These concerns foreshadow many of the contemporary sustainability challenges noted above (see Chapter 1).

Various definitions are found in the early literature (Table 2), but integrated coastal zone management typically refers to an approach that seeks to explicitly overcome sectoral and jurisdictional divides in coastal management to promote sustainability (Aswani et al., 2012; Cicin-Sain, 1993). 'Integrated' is meant to describe attempts to reduce fragmentation by promoting collaboration and coordination (1) horizontally, across government departments and agencies and (2) vertically, across nested jurisdictions (Clark, 1997). By the mid-1990s, integrated coastal zone management also became tied quite closely with community-based management or the desire to engage local members of the public in coastal zone management (Clark, 1997; Hildebrand, 1994; Kearney et al., 2007). The linkages with community-based management were created to improve the implementability of integrated coastal zone management, but they also provided a more explicit focus on place and context. However, establishing and using these linkages have been problematic in some cases (Charles et al., 2010).

Integrated coastal zone management essentially reflects a systems view of the coastal zone and, arguably but not explicitly, the beginnings of a social-ecological systems approach to coastal

management (Charles et al., 2010; van der Weide, 1993). The focus on human users of coastal resources, social and physical infrastructure, and biotic and abiotic components resonates with a social-ecological systems approach (van der Weide, 1993). However, one particular criticism or limitation of integrated coastal zone management was its underuse of natural sciences, and perceived overuse of societal values in setting management goals related to resource use (Christie et al., 2009a). Integrated coastal zone management thus focuses on social systems in an ecological context.

Table 2. Selected definitions of integrated coastal zone management.

Definition	Source
"…a system for resource management operated by governments at the local/regional level with central government assistance. ICZM focuses on sustaining coastal resources, conserving biodiversity, protecting the littoral environment, and countering natural hazards."	(Clark, 1997)
''…a process by which rational decisions are made concerning the conservation and sustainable use of coastal and ocean resources and space. The process is designed to overcome the fragmentation inherent in single-sector management approaches…in the splits in jurisdiction among different levels of government, and in the land-water interface.''	(Cicin-Sain and Knecht, 1998)
"…a dynamic process in which a co-ordinated strategy is developed and implemented for the allocation of environmental, socio-cultural and institutional resources to achieve the conservation and sustain- able multiple use of the coastal zone."	(Sorensen and McCreary, 1990)
"…the effective integration across sectors, disciplines, agencies and stakeholders for the sustainable use of coastal areas and resources."	(Poitras et al., 2003)
"…a process that seeks to join up the different policies that have an effect on the coast whilst bringing together stakeholders to inform, support and implement these policies."	(Atkins, 2004)

Partially in response, ecosystem-based management emerged in the 1990s as a means of improving ecological considerations in management (Aswani et al., 2012; Christie et al., 2009a).

Ecosystem-based management also has a focus on integration, coordination, and sustainability; however, greater attention is placed on ecosystem properties (e.g., structure and function), and how these can be mirrored or accounted for in management (Charles, 2014; Charles et al., 2014; Long et al., 2015). Ecosystem-based management especially acknowledges the complex, dynamic nature of ecosystems (Waltner-Toews et al., 2008). Similarly to integrated coastal zone management, multiple definitions for ecosystem-based management are found within the literature (Table 3). However, in general ecosystem-based management refers to a management system rooted in place with an inherent focus on a specific ecosystem and the humans who are part of, or use that ecosystem (Aswani et al., 2012; Eisma-Osorio et al., 2009; Long et al., 2015). As McLeod and Leslie (2009:5) point out, "it is important to note that the concept of ecosystem-based management is grounded in the idea that ultimately we are managing people's influences on ecosystems, not ecosystems themselves." Ecosystem-based management, as such, also exhibits some elements of a social-ecological systems approach. Although its focus is on the ecosystem, some ecosystem-based based management frameworks explicitly take the human dimensions into account; however, the human dimensions or "people" side are sometimes difficult to address adequately in an ecosystem-based management framework (Castrejon and Charles, 2013; Charles, 2014; De Young et al., 2008; McLeod and Leslie, 2009). Arguably, the predominant approach to ecosystem-based management focuses on an ecological system in a certain context of human use.

These conceptual foundations in integrated and ecosystem-based management demonstrate the need to holistically manage the land-sea interface and account for both social and ecological dimensions. The aforementioned management paradigms exhibit various attempts at joint land-

sea and social-ecological management, which draw to varying degrees on systems thinking. They establish the need for a social-ecological systems approach to the land-sea interface.

Table 3. Selected definitions of ecosystem-based management.

Definition	Source
"…a place-based approach that considers the entire ecosystem and the connections between its various components. These connections include a strong link between social and natural systems that focuses on the maintenance of a healthy, productive and resilient ecosystem that is able to provide the services required by humankind."	(Cárcamo et al., 2013)
"…an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors."	(McLeod et al., 2005)
"…an integrated, place-based approach that focuses on a specific ecosystem and on the range of activities affecting it, recognizing the existing connectivity amongst all of its elements, including humans."	(Frazão Santos et al., 2014)
"…looks at all the links among living and nonliving resources, rather than considering single issues in isolation. This system of management considers human activities, their benefits, and their potential impacts within the context of the broader biological and physical environment. Instead of developing a management plan for one issue (such as a commercial fishery or an individual source of pollution), ecosystem-based management focuses on the multiple activities occurring within specific areas that are defined by ecosystem, rather than political, boundaries."	(U.S. Commission on Ocean Policy, 2004)

Section 2.2. What is a land-sea social-ecological system?

Land-sea social-ecological system: An inherently linked and interdependent set of social and ecological actors, elements and entities that are found across the land-sea interface, or occupy both the land and sea domains.

The definition of a land-sea social-ecological system (LS-SES) above reflects decades of learning regarding the interconnected nature of social-ecological systems (SESs) across the land-sea interface. Berkes and Folke (1998) popularized the SES concept, and highlighted SESs as inherently linked, co-dependent and co-evolutionary systems of social and ecological subsystems (Figure 2). These subsystems are nested across scales and connected via multiple feedbacks (Berkes et al., 2003), which represent interactions as diverse as material flows, interplay between ecosystems and management regimes, human impacts, and many others. Drawing on this line of thinking, a LS-SES can be conceived quite broadly, but typically includes human communities, nested within different levels of institutions and social processes, and the nested, interacting ecosystems – marine, freshwater and terrestrial - they rely on (Glavovic et al., 2015). There are many terms related to LS-SES found in the literature, and a few are captured in Table 4. These terms all reflect an inherent disposition towards defining the land-sea interface based on geographic or biophysical features. However, both the Margin (Table 4; Glavovic et al., 2015) and more recent definitions of the coastal zone (EU, 2009) begin to acknowledge the social-ecological nature of land-sea systems.

Contemporary views on SESs emerged during the late 1990s. *Linking Social and Ecological Systems*, edited by Berkes and Folke (1998), was an initial attempt at clearly articulating and synthesizing many ideas on the nature of connections between ecosystems and society that had

been developing over the previous century (and possibly longer). The main assumption put forth by Berkes and Folke (1998), which is supported by the work of C.S. Holling and his colleagues (see Holling and Meffe, 1996), is that many current environmental challenges and their related socioeconomic consequences are the result of utilitarian, exploitative and dominative human interactions with nature, in which the environment is viewed as separate from society and parsed into a number of discrete, discontinuous commodities. As Berkes and Folke (1998) observe, the ethos that bore these negative human-nature interactions had been institutionalized and indoctrinated within many resource management regimes and governance systems, as well as within scientific and academic investigation. The former resulted in human society moving towards overexploitation of environmental resources, and the latter in a system of human inquiry where humans and their environments are separated by disciplinary boundaries.

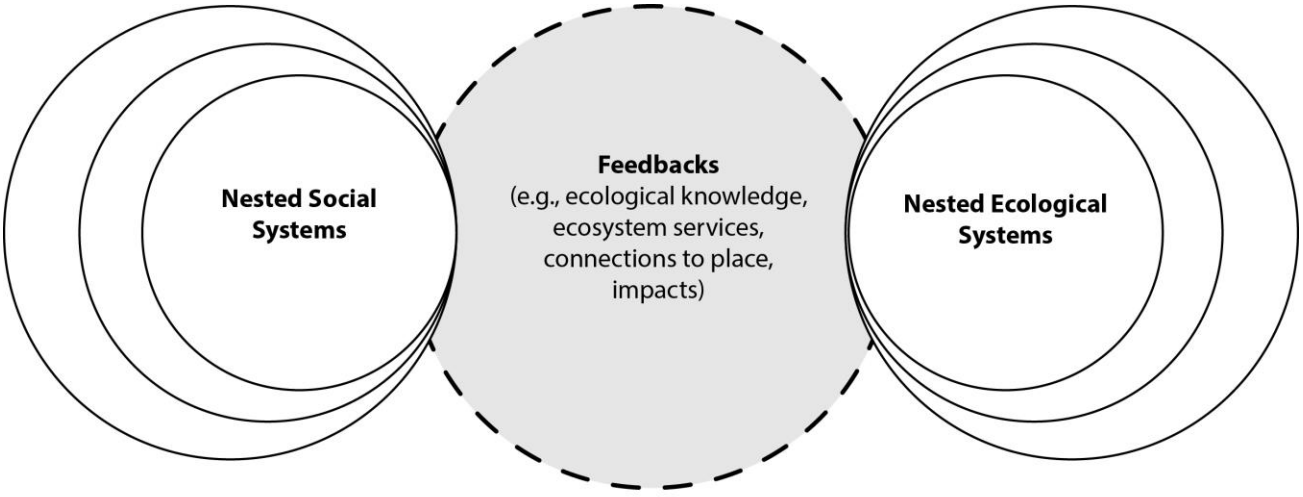


Figure 2. Social-ecological system framework.
Modified from (Berkes et al., 2003)

Table 4. Selected terms related to LS-SES.

Term	Definition
The Margin	"…coastal lands inward from the seashore that influence and are influenced by the sea and extending outward to the continental shelf and slope. It is thus a relatively narrow band within which humans live, work, recreate and exploit coastal and marine resources." (Glavovic et al., 2015:1)
Coastalshed	"…the geographic area which is subject to drainage of water and/or the transference of impacts, from the land, through the estuaries into the inshore waters and beyond into the marine domain, and vice versa." (Boudreau et al., 2013:66)
Coastal zone	"…the interface where the land meets the ocean, encompassing shoreline environments as well as adjacent coastal waters. Its components can include river deltas, coastal plains, wetlands, beaches and dunes, reefs, mangrove forests, lagoons, other coastal features." (Post and Lundin, 1996)
	"…the geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities." (EU, 2009)

Aldo Leopold (1949:xix) described this apparent lack of coherence between human worldviews and ecosystem function as a "sickness" that threatened humanity's future (as cited in Berkes et al., 2012). Building on Leopold's metaphor, Holling and Meffe (1996:328) describe the "pathology of natural resource management" and extend the problem beyond ethics to human institutions, norms and behaviours that seem to be constructed for a single purpose: to reduce variability in natural systems. To Holling and Meffe (1996), the assumptions underlying this purpose – that natural systems exist in a single state near equilibrium and that reducing variability will maintain the system near its ideal, equilibrium state – are fundamentally flawed. Holling (1994, 1973) proposes a very different view of ecological dynamics, where natural systems can exist in multiple stable states, away from equilibrium, and any system instabilities, resulting from internal or external disturbances, can cause a system to flip between states. Under

these assumptions, the concept of ecosystem resilience takes form, as “the magnitude of disturbance that can be absorbed or accommodated before the system changes its structure by changing the variables and processes that control system behavior” (Holling and Meffe, 1996:330). The problem with reducing natural variability (or diversity), which seemed to be the goal of most resource management regimes, is that it also reduces resilience, and the system becomes more vulnerable to shocks and less likely to exist in its current state (Holling and Meffe, 1996). This theoretical framing provides direct linkages between human actions, as partially influenced by institutions and norms, and ecosystem resilience, which provides an entry point for new understandings of nature-society relations.

The main contribution of Berkes and Folke (1998) was to advance these new understandings and frame nature-society relations more explicitly within the theoretical domain of Holling’s resilience and ecological dynamics. They accomplish this by using, as a starting point, the assumption that social and ecological systems are inherently linked and only arbitrarily differentiated in human thought and academic disciplines (Box 1) (Berkes and Folke, 1998). As such, the SES became their focus, as a system of human institutions, norms, governance and ethics in constant two-way feedback with the natural world (Berkes and Folke, 1998). These systems behave similarly to Holling's (1994, 1973) account of ecological systems, insofar as they can exist in multiple stable states far from equilibrium and have an emergent characteristic of resilience; however, there are added human dimensions related to the individual and collective intentionality and agency that influence system behaviour (Walker et al., 2006). The existing state and trajectory of either component (i.e., the social or the ecological sub-system) has implications for the state and trajectory of the other, and of the SES as a whole. This framing exhibits a view of SESs that has been pervasive in much scholarship since 2000 (Berkes et al.,

2003), and my work on LS-SESs is consistent with this framing. A number of key features of SESs with direct application in my research are highlighted below.

Box 1. Transdisciplinarity in SES research.

The assumption that social and ecological systems are inherently linked opens the door for interdisciplinarity in SES research, which means research ultimately intends to cross predetermined disciplinary boundaries to provide novel insights and contributions to theory (Castán Broto et al., 2009). Much recent SES research has even transcended interdisciplinarity to become explicitly transdisciplinary (Becker, 2012). Lang et al. (2012) define transdisciplinary research as an approach aimed at addressing both the practical and academic dimensions of socially important issues, by integrating across diverse bodies of knowledge and explicitly involving stakeholders throughout the research process. This distinction between inter- and transdisciplinarity is important because it highlights the dual focus on theoretical and applied outcomes from SES research.

Feature 1. Moving beyond command-and-control.

The SES approach provides a framework and rationale for replacing management regimes oriented towards the rigid and mechanistic command-and-control of natural resources with those more capable to cope with natural variability, change and uncertainty (Holling and Meffe, 1996). Traditional command-and-control regimes are characterized by an interventionist ideology (Chandler, 2012) that seeks to reduce uncertainty and unpredictability in stocks and flows of ecosystem services through seemingly strategic interventions. These interventions typically ignore the complex, adaptive nature of ecosystems and largely assume that ecosystems can exist in an ideal, equilibrium state and that they will respond to managerial interventions in a simple linear way. As such, interventions can have many unintended consequences and may actually increase uncertainty and unpredictability by eroding ecosystem resilience (Holling and Meffe, 1996).

In SES scholarship, the management paradigm beyond command-and-control is referred to as adaptive management. Adaptive management is an iterative approach, involving learning from the successes and failures of management activities (Walters, 1986). Under the adaptive management paradigm, management is explicitly linked with the scientific method. Management interventions or strategies are framed as hypotheses, which are tested through implementation and the assessment of outcomes. Management is then adjusted based on what is learned from the outcomes. As noted earlier, ecosystem-based management typically embraces an adaptive management approach (Slocombe, 1998).

There is, however, doubt in the literature about how frequently the potential value of adaptive management is actually realized in practice. The contribution of the SES approach has been to conceive of management regimes beyond command-and-control, but implementing them has

proven a greater challenge (Westgate et al., 2013). This challenge is grounded in difficulties with adequately framing management interventions as experiments (Theberge et al., 2006), conflating adaptive management with reactive and *ad hoc* forms of management (Sutherland, 2006), and logistical feasibility, especially in relation to long-term monitoring programs (Lindenmayer and Likens, 2010). In addition, some scholars highlight the need to more effectively and explicitly consider the social and governance contexts in which adaptive management regimes are embedded (Armitage et al., 2015a), since these have significant influence over the actual adaptability following interventions (e.g., the flexibility of institutions to adjust to lessons) and the selection of interventions in the first place (e.g., political salience or support for various options fitting within adaptive management).

Feature 2. Linking the social and the ecological.

A second contribution of the SES approach has been to conceive of the social and ecological as truly linked. This ultimately has implications for the framing, scope and potential consequences of management interventions, and it broadens the information and variables that are necessary to consider for sound management decisions. Pollnac et al. (2010), summarized in (Walker and Salt, 2012), recently conducted an international assessment of marine reserves to understand the variables contributing to their success or failure. They found that social variables were more influential in determining reserve success than ecological variables, with the level of poaching playing a particularly important role (Pollnac et al., 2010). Compliance with reserve rules (i.e., limiting poaching) required more than enforcement; reserves established in ways that built capacity for cooperation and voluntary compliance (e.g., by undergoing formal consultations and ongoing outreach) were able to better conserve marine habitat (Pollnac et al., 2010). This

example demonstrates how considering social variables when establishing marine reserves can influence their success.

Feature 3. Conceptualizing change and complexity.

Another contribution of the SES approach is its conceptualization of change. These conceptualizations extend beyond complex systems thinking to complex *adaptive* systems thinking, largely based on resilience scholarship (Duit and Galaz, 2008). Embracing complex systems thinking requires acknowledging the inherent uncertainty, unpredictability and nonlinearity in systems resulting from the interactions of multiple components (Duit and Galaz, 2008). Complex adaptive systems thinking includes these features of complex systems thinking, but also encompasses the potential for threshold behaviour, surprises and cascading effects (Walker et al., 2004a). Governance informed by complex adaptive systems thinking must acknowledge that SESs can exist in states that are far from equilibrium and that transformation towards alternative states is possible.

Governance can improve its capacity to deal with complexity by using integrative science in decision making, which explicitly seeks to engage knowledge across disciplinary and other boundaries (e.g., scientific and local/traditional knowledge; Miller et al., 2010). This approach could help co-create and mobilize the knowledge necessary to deal with climate change and other issues by challenging and eroding the *illusion of certainty* (Charles, 2007), the *fallacy of controllability* (Charles, 2007, 2001), and the *trap of the expert* (Gunderson and Holling, 2002). Thus, integrative science is one way to embrace complexity in governance.

Feature 4. Questioning the maintenance of resilience.

Drawing on complex adaptive systems theory, the SES approach has made an additional contribution to governance and management: the realization that a resilient system is not always a desirable system (Walker et al., 2004b). Walker et al. (2010) recently demonstrated how, in some developing nations, strategies that erode, rather than build, the resilience of the existing system state could be required to move beyond poverty traps and foster more desirable conditions. This realization has an important implication for the goals of governance. It highlights how governance may not necessarily need to be focused on building resilience, as some scholarship implies, but could also aim to enact deliberate transformations. Deliberate transformations are those intentionally initiated (O'Brien, 2012a). They are strategic approaches to challenging the status quo and fostering fundamental changes in the structure, function, identity and feedbacks of SESs (Chapin et al., 2010). However, they also pose additional challenges, since navigating transformations is undertaken in the context of deep uncertainty (Olsson et al., 2006).

Feature 5. Functioning as a boundary object.

In discussing the efficacy of the SES as a boundary object, I draw on two main assumptions that are apparent in some SES research. First, SESs are inseparable and irreducible. Although typically conceptualized as interacting social and ecological sub-systems or domains, it is important to emphasize that this distinction is only analytical and is not intended to reflect any true separation in the real-world (Berkes and Folke, 1998). Second, SESs are abstractions meant to represent real-world phenomena in an idealized way. In this regard, SESs are socially constructed and represent knowledge systems about the real-world. These assumptions draw on Becker's (2012) constructivist realism for SES research.

In transdisciplinary research, the SES itself is a boundary object to engage diverse knowledge systems (Becker, 2012). The SES functions by using the analytical distinction of the 'social' and 'ecological' as a starting point to guide inquiry towards their interactions. In this way, it allows researchers to draw on the strengths of their existing, narrowly-defined systems of disciplinary knowledge (e.g., in various of the social and natural sciences). But, as noted earlier, the analytical distinction between 'social' and 'ecological' does not reflect an assumption that they are separable or inherently distinct. As such, the SES also makes crossing boundaries the explicit pursuit of research and provides sufficient space to explore how the 'social' and 'ecological' interact.

As a boundary object for transdisciplinarity, the SES is fairly successful but not perfect. Typically, SES research is undertaken from a particular transdisciplinary perspective that integrates disciplines, but does so in a way that still excludes certain beneficial entry points into complex problems. Becker (2012) has proposed that transdisciplinary perspectives in SES research can be organized into three categories. The first situates "natural entities in a social context" (e.g., resilience research); the second, "social entities in an ecological context" (e.g., ecological economics); and the third explores "hybrid entities", or those that are simultaneously social and ecological (e.g., food and water supply systems or webs; Becker, 2012:49).

Each transdisciplinary perspective comes with its own benefits and limitations. For example, most early advancements (e.g., Holling and Meffe, 1996) fit under "natural entities in a social context" (Becker, 2012:49). This work led to many contributions to SES theory, but has been criticised for over-applying ecological thinking in the social domain (Adger, 2000; MacKinnon and Derickson, 2012). Ecosystem-based management somewhat aligns with this framing. Similarly, research fitting under "social entities in an ecological context" (Becker, 2012:49),

such as Ostrom's (2009) SES framework and other "third wave" (Duit et al., 2010:364) complex social science thinking, often fail to adequately incorporate ecological thought and theory (Epstein et al., 2013; Rissman and Gillon, 2016). Integrated coastal zone management can be classed under this form of research. The final category, "hybrid entities" (Becker, 2012:49), which typically focuses on networks consisting of social and ecological components – or social-ecological networks – is an emerging stream of SES research (Bodin et al., 2016a; Bodin and Tengö, 2012; Guerrero et al., 2015a; Janssen et al., 2006; Steins, 2001). It provides a frontier for exploring SESs as truly and inherently linked.

Section 2.3. Adaptability and transformability in LS-SESs

Core concepts within the SES approach, drawn largely from its original application in ecology, are based on the assumption that the world is self-organized into nested complex adaptive systems that can exist far away from equilibrium in multiple stable states (Levin, 1998). Within the thresholds of each stable state, these systems respond to multiple endogenous and exogenous pressures by absorbing, reorganizing and adapting to stressors in ways that do change the systems, but not in ways that modify their fundamental structures, functions, feedbacks or identities (Table 5) (Folke et al., 2010). However, sometimes pressures push systems to their limits, causing key systemic variables to cross thresholds and systems' current states to become unstable. In these cases, fundamental and often irreversible change in the systems is initiated and they transform towards alternative states (Walker and Salt, 2012).

The discussion above illustrates two core concepts – adaptability and transformability – and their relationship to resilience. Adaptability is "the capacity of actors in the system to influence resilience" (Walker et al., 2004b). Transformability is "the capacity to create a fundamentally

new system when…structures make the existing system untenable" (Walker et al., 2004b). In SESs, these concepts have been used to understand social-ecological resilience as "the capacity of social-ecological systems to absorb recurrent disturbances...so as to retain essential structures, processes and feedbacks" (Adger et al., 2005:1036). It centres on "…how to persist through continuous development in the face of change and how to innovate and transform into new more desirable configurations" (Folke, 2006:260), and is dependent on the magnitude of disturbance a system can adapt to, its capacity for self-organization, and its ability to learn and innovate (Carpenter et al., 2001). Adaptability, transformability and resilience are SES properties that emerge from the interaction of the social and the ecological domains across multiple scales.

Adaptability and transformability are central to understanding sustainability in LS-SES and the implications of failing to address current sustainability challenges. According to Glavovic et al. (2015), the land-sea interface is currently under a human-induced 'quadruple squeeze' from (1) population growth, (2) ecosystem degradation, (3) climate change (e.g., sea level rise), and (4) the threat of nonlinear change. Population and population growth place increased pressures on the land-sea interface. Coastal areas are highly and relatively densely populated, and trends towards urbanization are likely to add population pressures to coastal areas (Hugo, 2011; Neumann et al., 2015). In the context of high and increasing population, historic and expected resource demands in coastal areas and watersheds have led to, and will likely exacerbate, ecosystem degradation (Agardy et al., 2005). Climate change places additional pressures on already stressed systems. The pressures from climate change are diverse, but include sea-level rise, coastal erosion, storm surge, ocean acidification, and changing precipitation regimes (Nicholls et al., 2007; Settele et al., 2014; Wong and Losado, 2014). The culmination of these

pressures increase the threat of abrupt and unanticipated nonlinear change in LS-SES. The quadruple squeeze makes sustainability a top priority, but extremely challenging.

Table 5. Characteristics of each SES state.

Characteristic	Definition
Structure	The nature and predominant patterns of interaction between the system components.
Function	The emergent outcomes associated with the processes that result from the interaction of system components.
Feedback	The interactions between system components that instantiate and organize the system.
Identity	The emergent characteristics that constitute a normative, interpretive understanding of system boundaries, components, relationships, goals, directions and focus (i.e., understanding questions like "of what?", "to what?", and "for whom?" in relation to resilience of the SES).

Sources: (Andrachuk and Armitage, 2015; Scheffer et al., 2002; Walker et al., 2006, 2004b)

Section 2.4. What is effective governance for sustainability in LS-SESs?

Sustainability in LS-SESs requires addressing the negative consequences of land-sea interactions in ways that promote environmental stewardship, human wellbeing, and social justice (Aswani et al., 2012; Barker, 2005; Becker et al., 1997; Gibson et al., 2005). Sustainability, broadly defined, refers to "use of the environment and resources to meet the needs of the present without compromising the ability of future generations to meet their needs" (Chapin et al., 2010:241, citing WCED, 1987). Environmental stewardship is "a strategy to respond to and shape social–ecological systems under conditions of uncertainty and change to sustain the supply and opportunities for use of ecosystem services to support human wellbeing" (Chapin et al., 2010:241). Human wellbeing refers to "quality of life in terms of material needs, freedom and choice, good social relations and personal security" (Chapin et al., 2010:241). Social justice adds a focus on equity and fairness (Berbés-Blázquez et al., 2016; Dearing et al., 2014; Moore et al.,

2014a). These three interrelated concepts form the basis for sustainability in LS-SES in the face of multiple challenges or pressures.

Effective governance – broadly conceived – is hoped to deliver or contribute to sustainability in LS-SESs (Aswani et al., 2012). Effective governance advances environmental stewardship in a proactive, as opposed to reactive manner by supporting decision- and rule-making systems geared towards dealing with current issues, while preparing for the unexpected (Armitage et al., 2009; Chapin et al., 2010) – which is analogous to improving governability (Section 2.5.1). Improving governability requires that the structures of governance (e.g., rules, networks) are aligned or fit with the properties of social-ecological systems (Section 2.5.2). In this context, governance also provides a lens for examining the distributional elements of sustainability (e.g., social justice) and how these translate into different patterns of human wellbeing as actors navigate SES change and uncertainty (Armitage et al., 2012a). Network governance is useful in this regard, since it explicitly deals with issues of participation and inclusiveness within existing arrangements (Section 2.5.3). These components of effective governance provide capacity to address a range of sustainability challenges across the land-sea interface (Armitage and Plummer, 2010; Engle and Lemos, 2010), and do so while maintaining socially just and ecologically safe conditions in LS-SESs (Dearing et al., 2014). However, effective governance also necessitates the capacity to transform if such safe conditions are threatened or not being maintained (Section 2.5.4).

Governance, in general, consists of three main components: (1) processes related to goal-setting, decision- and rule-making, and monitoring; (2) structures of formal and informal rules, norms and practices; and (3) actors from a range of backgrounds (e.g., state and non-state) and with a range of roles (Table 6) (Jentoft and Chuenpagdee, 2009; Stoker, 1998). Governance is typically

associated with the hollowing of the state, where changing roles and distributions of authority, accountability, legitimacy and capacity have provided space for the emergence of new hybrid forms of governance involving both state and non-state actors (Table 7; Armitage et al., 2012b; Lemos and Agrawal, 2006; Stoker, 1998). However, there is some debate in the literature as to whether or not the term governance can include traditional forms of top-down decision-making (Lynn et al., 2001), where an idealized 'state' exhibits control of many publically-relevant decisions and resources, or whether the term should be reserved exclusively for settings where civil society or actors beyond the state have been explicitly engaged in decision-making (Stoker, 2004). My use of the term essentially encompasses both top-down and collaborative decision making.

Environmental governance is a subset of the governance literature that exhibits – although sometimes implicitly – a normative concern with social-ecological sustainability and deals with sustainability-related decisions, actions and outcomes. As with the term governance, environmental governance takes on a variety of meanings (Table 8). For the purposes of this paper, environmental governance is defined as multilevel systems of formal and informal institutions, decision-making processes, and actors intended to help societies plot a course through environmental change (Armitage et al., 2012b; Biermann et al., 2009; Lemos and Agrawal, 2006). Institutions in this context also take on a number of meanings (Table 9), but can generally be conceived as the rules that structure social and governance processes, help define the roles of different actors, and both enable and constrain action (Giddens, 1986; Young et al., 2008). Institutions underpin governance interactions, contribute to defining behaviours, and influence governance performance (Klijn and Koppenjan, 2012). These definitions and concepts form the basis from which I later depart in order to introduce four additional concepts of

particular importance to my examination of governance across the land-sea interface: governability, social-ecological fit, network governance, and governance transformation (see Section 2.5).

Table 6. Selected definitions of governance.

Definition	Source
‘‘…regimes of laws, rules, judicial decisions, and administrative practices that constrain, prescribe, and enable the provision of publicly supported goods and services.’’	(Lynn et al., 2001:7)
“…the rules and forms that guide collective decision-making. That the focus is on decision-making in the collective implies that governance is not about one individual making a decision but rather about groups of individuals or organisations or systems of organisations making decisions.”	(Stoker, 2004:3)
“…the conditions for ordered rule and collective action or institutions of social coordination. Governance is the structures and processes by which people in societies make decisions and share power.”	(Folke et al., 2005:444)
“…government is not the only governor, and governance occurs not only nationally and internationally, but also at the local level or within a particular industry. Governance is the shared, collective effort of government, private business, civic organisations, communities, political parties, universities, the media and the general public…goals are not external to the process, but their formulation is part of governance itself.”	(Jentoft and Chuenpagdee, 2009:554)

Table 7. Hybridized forms of governance in practice.

Form of governance	Description
Co-management	Decentralized approach to environmental governance, where authority to make and implement decisions is shared between state and non-state actors (e.g., communities). These arrangements typically cross different jurisdictional levels (e.g., local, regional, national).
Public-private partnerships	Formal coordination and collaboration between public governance organizations and market actors in the private sector to pursue shared or synergistic goals.
Social-private partnerships	Formal coordination and collaboration between civil society organizations (i.e., Non-governmental and Community-based Organizations) and market actors in the private sector to pursue shared or synergistic goals.

Source: (Lemos and Agrawal, 2006)

Table 8. Selected definitions of environmental governance.

Definition	Source
"The set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes."	(Lemos and Agrawal, 2006:298)
"The interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies toward preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development."	(Biermann et al., 2009:3)

Table 9.Selected definitions of institutions.

Definitions	Source
"…the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction."	(North, 1990:3)
"…sets of working rules…. Working rules are those actually used, monitored, and enforced when individuals make decisions..."	(Ostrom, 1990:50)
"[clusters] of rights, rules and decision-making procedures that [give] rise to social practices, assign roles to participants in these practices, and [guide] interactions among occupants of these roles."	(Young et al., 2008:xxii)

Section 2.5. Advancing effective governance in LS-SESs

Governance contains many rich concepts, which can help foster an understanding of effective governance and how governance can become more effective. For my purpose, I employ two concepts directly related to effectiveness – governability (Section 2.5.1) and social-ecological fit (Section 2.5.2) – to guide my analysis and synthesis throughout the dissertation. I use governability in my overarching framing to denote the capacity for effective governance (Chapter 4); while social-ecological fit is examined explicitly as an analogue for effectiveness (Chapter 5). Additionally, I examine how network governance assists or not in achieving effectiveness (Chapter 5). Networks have been tied to notions of effectiveness in the literature (Chapter 4), and network governance has been proposed as a means to tackle sustainability problems across the land-sea interface (Bodin et al., 2016b; Hovik and Stokke, 2007; Sandström et al., 2015). Finally, I use the concept of governance transformations to examine the processes underpinning the emergence of network governance across the land-sea interface (Section 2.5.4). These concepts are further discussed in turn below.

Section 2.5.1. Governability

The concept of governability underpins my examination of Objective 1 (see Chapter 4). Governability is defined as "the overall capacity for governance of any societal entity or system" (Kooiman et al., 2008:3). The concept is grounded in ideas of interactive governance, or a view of governance that highlights the interactions and interdependencies between and among different societal actors – state and non-state – as they negotiate change, address problems, pursue opportunities, and craft institutions (Kooiman et al., 2005). Governability and interactive governance have an inherent focus not only on governance systems themselves but additionally

on systems-to-be-governed (e.g., a coastal watershed) and systems of governance interactions. Systems-to-be-governed are people, their livelihood activities, and the environments on which they depend (Jentoft, 2007; Kooiman et al., 2008, 2005). Systems of governance interactions are feedbacks between systems-to-be-governed and the governance systems, which include things like management interventions and lobbying pressures (Kooiman, 2008). Governability cannot be understood without considering simultaneously the characteristics of governance systems, systems-to-be-governed, and systems of governance interactions. As such, governability is a composite property of a broader societal system, and it reflects both the capacity of the governance system to govern and the potential for effective governance in light of the characteristics of the system-to-be-governed (Kooiman et al., 2008).

Another component of governability important for my research is its treatment of governance modes. Assessments of governability recognize that multiple modes of governance coexist simultaneously within any given societal system (Kooiman, 2008). Three commonly employed modes within governability scholarship include hierarchical governance, self-governance, and co-governance. Hierarchical governance represents top-down approaches to governance, where most decisions are made and implemented by the state or another asymmetrically empowered group of actors (e.g., transnational corporations in a global market; religious organizations) (Kooiman, 2008; Kooiman et al., 2008). Self-governance is at the opposite end of the spectrum, and refers to situations where governance occurs in the absence of the state and other authoritative, external actors (Charles et al., 2010; Kooiman et al., 2008). Co-governance is in the middle, and represents a collaborative mode where multiple actors – usually representing the state and non-state organizations – share authority, responsibility, and pursue shared goals (Charles et al., 2010; Kooiman et al., 2008). Co-management is a common form of co-

governance (Kooiman, 2008). Although not applied directly, this conceptualization of multimodal governance underpins both Chapter 4 and Chapter 5. Additionally, I apply the concept of co-governance as it relates to power sharing and collaboration in networks.

Section 2.5.2. Social-ecological fit

Social-ecological fit is a relatively new articulation of an established concept, which builds on a rich foundation in the institutional fit literature (Guerrero et al., 2015a; McDermott and Ituarte-lima, 2016; Robards and Lovecraft, 2010). Fit, as it was originally conceived, refers to the degree of coherence or congruence between institutions and the cross-scalar dynamics of social-ecological systems (Table 10; Cash et al., 2006; Folke et al., 2007; Young, 2002). Institutions, here, are "[clusters] of rights, rules and decision-making procedures that [give] rise to social practices, assign roles to participants in these practices, and guide interactions among occupants of these roles" (Young et al., 2008:xxii). Fit scholarship centres on the proposition that "effectiveness and the robustness of social institutions are functions of the fit between the institutions themselves and the biophysical and social domains in which they operate" (Young and Underdal, 1997). As such, institutions must exhibit some degree of fit with biophysical and social systems to be effective in achieving positive outcomes. In this regard, fit is often associated with issues of scale or scale mismatch between institutions and social-ecological systems (Cash et al., 2006; Haller et al., 2013).

Table 10. Original types of misfit found in the literature.

Type	Description
Spatial	Institutional jurisdictions do not match areal extent of a resource, its users, or the impacts associated with resource use.
Temporal	Institutional creation is either too soon or too late in relation to a certain problem or ecosystem process. Decision-making processes, as structured by institutions, are not able to produce timely decisions in relation to a problem.
Functional	Institutional scope does not adequately account for functional diversity and variety in a social-ecological.
Cascading effects	Institutions unable to adequately buffer negative effects and feedbacks to prevent their propagation throughout an SES.
Threshold behaviour	Institutions unable to recognize and avoid abrupt ecological shifts. Institutions unable to effectively manage extremes and variability in the system.

Sources: Young 2002; Folke et al. 2007; Galaz et al. 2008

Drawing on the original conceptualization of fit, Galaz et al. (2008) expanded the concept to extend beyond institutions to entire governance systems. According to Galaz et al. (2008), the problem of fit is more than institutional and is also apparent in patterns of interactions among governance actors (e.g., individuals and organizations), conflicting interests among these actors, and the diversity of instruments actors use to promote different environmental outcomes. In a similar vein, Scholtens and Bavinck (2013), drawing on a governability lens, propose fit has two components: architectural compatibility and attunement. Architectural compatibility refers to how well the structural properties of the governance system (e.g., institutions, regimes) are matched to the structural characteristics of the system-to-be-governed. This conception is similar to the spatial, temporal and functional fit referred to by Galaz et al. (2008), although Scholtens and Bavinck (2013) apply it strictly to the spatial scale. Attunement refers to the capacity for responsiveness of a governance system to problems or issues that arise in the system that is being governed (Scholtens and Bavinck, 2013). Attunement acknowledges the processes and instruments beyond institutions that can contribute to (mis)fit, which aligns with Galaz et al.'s (2008) conception of governance fit.

Scholtens and Bavinck (2013) also broaden fit beyond a relationship between dualistic social and ecological components. Kooiman (2013), citing Scholtens and Bavinck (2013), proposes that fit can also be a characteristic of the relationship between hybrid sub-systems, where a sub-system may be comprised of both social and ecological components (i.e., a social-ecological system). Drawing on their previous work on governability and interactive governance, Kooiman (2013) says this new conceptualization of fit highlights relationships between the governance system and the system-to-be-governed (Bavinck and Kooiman, 2013; Mahon and McConney, 2013).

These ideas underpin my use of social-ecological fit, which I treat as an analogue to explore governance effectiveness in social-ecological systems. Social-ecological fit helps address multiple governance challenges that lead to the underlying problems of fit (Bodin et al., 2014; Guerrero et al., 2015a) and align the values and goals inherent in governance with those of resource users (Scholtens and Bavinck, 2013). Social-ecological fit emerges when the structures of governance (e.g., rules, networks) are matched to the properties of social-ecological systems. However, social-ecological fit is not a panacea, and achieving it does not imply the challenges of governance will be addressed. Rather, it provides an indication of the capacity for governance, which takes into account both the characteristics of the system-to-be-governed (e.g., patterns of interactions between components) and the properties of governance (e.g., networked interactions between governance actors). I explicitly apply the concept of social-ecological fit in Chapter 5.

Section 2.5.3. Network governance

Network governance refers to a form or mode of governance where multiple actors participate, establish relationships with one another, and work collectively (or not) towards shared goals (Carlsson and Sandström, 2008). Network governance operates through both the agency and

intent of participating actors – who can be organizations or individuals – but also through institutional arrangements and norms (Carlsson and Sandström, 2008; Klijn and Koppenjan, 2012). Network governance is thought to support social learning (Armitage et al., 2009), enhance collaborative policy innovation (Klijn and Koppenjan, 2012), and improve capacity to deal with sustainability problems (Dedeurwaerdere, 2005).

Network governance is often used synonymously with collaborative governance (Guerrero et al., 2015), and tied to ideas of polycentricity (Galaz et al., 2012; Koontz et al., 2015) and multilevel governance (Armitage, 2007; Duit and Galaz, 2008). It is a form of co-governance (Kooiman and Bavinck, 2013), and co-management can be conceived as a realization of network governance (Carlsson and Sandström, 2008). Collaborative governance "brings public and private stakeholders together in collective forums with public agencies to engage in consensus-oriented decision making" (Ansell and Gash, 2008:543). The network perspective on collaborative governance highlights the relational foundations and underpinnings of collaboration and allows for collaborative governance systems to be abstracted as networks of interacting and interdependent actors (Bodin et al., 2016b; Guerrero et al., 2015a). Multilevel governance highlights the nested, multi-layered nature of certain governance systems (Armitage, 2007). It implies an existing organization of nested jurisdictions and institutional arrangements (e.g., municipal to provincial to federal), where actors at each level are somewhat autonomous and empowered to pursue collaborative, networked interactions with other actors within and across levels (Koontz et al., 2015). Polycentricity depicts similar, multi-tiered arrangements with multiple centres of authority; yet it typically connotes more flexibility in the boundaries between levels or jurisdictions and the ability to create boundaries and jurisdictions with relevance to specific problems or challenges (Koontz et al., 2015). Networks are thought to form the

structural basis of polycentric order, and different network structures provide insights into the degree of polycentricity within a given system of governance (Galaz et al., 2012).

The concept of power is central to examining collaborative and network governance (Brisbois and de Loë, 2015). Governance networks are formed in power-laden contexts and they represent a particular realization of how power relations have played out in terms of network formation. Although a plethora of conceptualizations exist, power in the context of network governance is essentially relative and relational, which means different actors are empowered in different ways and have differing abilities to influence other actors, agendas or discourses (Boonstra, 2016; Brisbois and de Loë, 2015; May, 2015). Power, in this context, is "mobilized through networks of interaction; the flows of which are often assumed to penetrate conventional territories and reach extensively across them" (Allen, 2009:198). Territories, in this sense, refer to geographic spaces; however, it is conceivable that the idea can refer to jurisdictional spaces (e.g., fisheries) or thematic areas of authority (e.g., integrated management) in addition to tangible space (e.g., Ernoul and Wardell-Johnson, 2013). The result is a conception of power where networks facilitate or constrain patterns of influence and participation in decision-making that can transcend or reinforce traditional boundaries, such as those defining governance fragmentation across the land-sea interface.

Network-based power also brings attention to position. Powerful positions are created due in part to relational topologies. Actors occupying powerful positions have the ability to asymmetrically exert dominance over other actors in the network (Brisbois and de Loë, 2015; Hearn, 2008). Dominance, in this sense, is derived from three interrelated factors (Hearn, 2008): (1) strategic control, where actors deliberatively maintain a dominant position to exploit the dominated; (2) advantage, where certain actors are more or less influential based on their predefined superiority;

and (3) negligence, or the intentional inaction of empowered actors to foster the wellbeing or avoid harm to other actors. Patterns of dominance can become institutionalized within network interactions; and actors either challenge or reinforce these patterns through their actions and participation within the network (Giddens, 1986). In LS-SES, powerful positions can create biases within network governance that favour certain domains (e.g., the land or sea) or limit the opportunities for participation in network governance (e.g., state versus non-state actors).

Network governance is a recurring theme throughout my dissertation. Chapter 4 identifies networks as an important element of effective governance in land-sea systems. However, the systematic review yielded very little empirical evidence regarding the role of networks in land-sea governance. Specifically, there has been, to date, limited exploration of network governance across the land-sea interface, save a few exceptions (e.g., Hovik and Stokke, 2007; Ernoul and Wardell-Johnson, 2013). Chapter 5 and Chapter 6 attempt to fill this gap by explicitly applying network governance theory to land-sea systems. Chapter 5 uses network governance theory and the concept of social-ecological fit to examine the effectiveness of various arrangements for addressing land-sea challenges in the comparative case studies from Saint Lucia and Dominica. Chapter 6 combines network governance theory with the concept of governance transformations to examine the emergence of network governance in the Lesser Antilles. Governance transformations are discussed below.

Section 2.5.4. Governance transformations

Governance transformations are "fundamental shifts to the processes and institutions through which societies make decisions about coastal commons" (Armitage et al., in press). Due to their focus on fundamental change, governance transformations usually involve a shift in social power

(Moore and Tjornbo, 2012). Transformations can (1) be deliberate or unintended (O'Brien, 2012a), (2) result from cumulative incremental changes (Park et al., 2012), (3) be initiated from the margins of society (Moore and Tjornbo, 2012), and (4) be contingent upon the development of windows of opportunity or critical junctures that make fundamental change more likely (Folke et al., 2005; Gelcich et al., 2010).

The concept of governance transformations essentially treats the governance system as a complex adaptive system, which means governance is dynamic, behaves nonlinearly, and can undergo changes in system state (Duit et al., 2010; Duit and Galaz, 2008; Lubell, 2015). Governance transformations are thought to often occur through three stages: (1) a preparatory stage; (2) a transitional stage; and (3) a final stage focused on building resilience of a new state of the system (Chapin et al., 2010; Gelcich et al., 2010; Olsson et al., 2004). Transformations are characterized by high degrees of uncertainty, and they are likely to be irreversible (but not final). I use the concept of governance transformations to examine the conditions that foster major changes to achieve effective governance for addressing land-sea interactions (Chapter 6).

Section 2.6. Synthesis for governing land-sea interactions

Governance – as a set of processes, intuitions and actors – is the foundation for decisions and actions to address land-sea interactions. The governability of LS-SESs is inherently linked to the structure and function of governance systems (Kooiman et al., 2008). Social-ecological fit suggests that the structure and function of governance systems must be matched to the social and ecological processes found in land-sea systems for governance to be effective (Epstein et al., 2015; Guerrero et al., 2015a). Network governance is hypothesized to improve social-ecological fit – and thus governability – within land-sea systems (Bodin et al., 2016b; Hovik and Stokke,

2007; Sandström et al., 2015). The concept of governance transformation is useful for examining how network governance emerges, and it can help characterize the current state of governance in relation to the emergence of network governance (i.e., preparatory, in transition, or transformed). These concepts provide the basis for my subsequent examination of governance across the land-sea interface in the Lesser Antilles, and I have designed my research to apply these concepts in multiple ways (e.g., systematic literature review, community-based research) and in multiple case studies.

Chapter 3. Research design

My research design was chosen to provide opportunities for the types of reflection and exploration characteristic of transdisciplinary research. Wickson et al. (2006) propose that a key element of transdisciplinary research is the ability to draw on approaches from different disciplines and critically place them aside one another to interpret deeper meaning from results. A transdisciplinary research design is intended to expose different knowledge systems to one another and to continually and iteratively combine and reconstruct knowledge in the pursuit of theoretical and applied contributions (Wickson et al., 2006). I have endeavoured to employ such a design by explicitly (1) drawing on multiple paradigms when making knowledge claims, (2) using both primary data gathering and synthetic strategies of inquiry, (3) employing a combination of qualitative and quantitative data collection and analysis methods, and (4) applying analytical techniques from both natural (e.g., ecology, hydrology) and the social sciences (e.g., sociology, human geography). These methods are briefly described below and discussed in more detail in Chapter 4, Chapter 5, and Chapter 6 as part of their respective manuscripts.

Section 3.1. Knowledge claims

Knowledge claims refer to the philosophical underpinnings of all research (Creswell, 2003). According to Creswell (2003), knowledge claims are apparent in how researchers define knowledge, determine contributions to knowledge, inject values into knowledge, disseminate knowledge, and seek to build knowledge. There exists an impressive number of traditions or paradigms that provide the foundations for knowledge claims. There are two with particular relevance to my research: postpositivism and constructivism.

First, postpositivism reflects a deterministic view of the world, where the probability that hypothesized causes have led to focal outcomes is tested or determined through objective, empirical observation (Creswell, 2003). Postpositivism – somewhat synonymous with the scientific method – departs from the more traditional positivism in that the goal is not to seek absolute truths, but rather to place bounds on the extent to which relationships between cause and effect can essentially be known (Creswell, 2003). Postpositivism is reflected in my use of quantitative methods and, to some extent, in the way I assess the relationships between network governance, social-ecological fit, and the conditions fostering transformations towards network governance. Second, constructivism – in contrast with postpositivism – is aimed at examining the subjective meanings of the world developed as people experience and seek to understand their surroundings (Creswell, 2003). Constructivism posits these meanings are diverse and essentially constitute reality, and the goal of research is to consider – as much as possible – the breadth of meaning found in a human population regarding a particular phenomenon (Creswell, 2003). In contrast, postpositivism acknowledges subjective meanings of reality but seeks to reduce these through empirical observation (i.e., assuming that reality exists outside of peoples' perceptions and experience). My research exhibits a constructivist bent, which is apparent in my use of qualitative methods and inductive reasoning to examine peoples' experience with governance across the land-sea interface.

Although I've placed postpositivism and constructivism in contrast with one another for the purposes of explanation, my goal was really to find synergies between the two paradigms. I am not alone in these attempts. Critical realism – for example – attempts to draw postpositivism and constructivism together to examine a 'real' world, but do so in a way that recognizes that our knowledge of that world is highly incomplete, flawed, value-laden, and – in some ways –

constructed (Alvesson and Sköldberg, 2009). Also of relevance are two related paradigms – constructivist realism and realist constructivism.

Constructivist realism aims to examine experience and subjective meaning in a 'real' world; whereas realist constructivism aims to identify a consistent set of arguments based on a diverse set of constructed meanings (Jackson and Nexon, 2004). Based on these definitions, I would consider my research most aligned with the latter: realist constructivism. My research used experience and subjective meaning as a starting point for examining network governance, social-ecological fit, and governance transformations; in other words, it is essentially founded in constructivism. However, I sought to develop – based on different types of evidence – consistent arguments regarding these relationships, which is aligned with a realist pursuit. The knowledge claims found within this thesis are all underpinned by this integrated paradigm of realist constructivism, which informed both my selected strategies of inquiry and choice of methods for data collection and analysis.

Section 3.2. Strategies of inquiry

Strategies of inquiry provide general direction for the applied procedures of gathering and analyzing data (Creswell, 2003). They are inseparable from the paradigms underpinning knowledge claims; yet they are less abstract and determine how the assumptions apparent in different paradigms manifest in the act of conducting research. I used two strategies of inquiry. First, systematic literature review was employed as a synthetic approach to distill and generate knowledge regarding governance across the land-sea interface. Second, a case-oriented approach was used to gather and analyze empirical data regarding the role of network governance in

achieving social-ecological fit and the conditions that foster transformations towards network governance. These two strategies of inquiry are discussed in greater detail below.

Section 3.2.1. Systematic literature review

I used systematic review methods to address Objective 1: *to synthesize extant theory regarding governance across the land-sea interface.* Systematic review is a structured and focused method for synthesizing existing research on a given subject (Berrang-Ford et al., 2015). It is usually used to scale out from single studies or publications to identify the broader theoretical relevance and policy implications from a body of knowledge (Bilotta et al., 2014). It is appropriate when attempting to ascertain a knowledge baseline within a particular field or regarding a particular phenomenon. I examined the body of knowledge regarding management and governance to address land-sea interactions to determine how different management paradigms: (1) frame and conceptualize governance; (2) characterize the challenges that governance must address; and (3) view the attributes of effective governance. This strategy of inquiry also served to frame the relevant concepts used in subsequent analyses.

Section 3.2.2. Case studies

I used comparative case studies to address Objective 2: *to investigate the network governance processes contributing to social-ecological fit across the land-sea interface*. Cross-case comparison is used to explore multiple cases in depth, but improve the ability to answer causal questions through comparisons across cases (George and Bennett, 2005). I used cross-case comparison to examine how network governance has contributed or not to social-ecological fit in the case studies from Saint Lucia and Dominica.

I used embedded case studies to address Objective 3: t*o examine the strategies and conditions that foster transformations towards network governance to address land-sea interactions.* Embedded case studies allow for an examination of an overarching, holistic case through comparison of multiple, sub-units of analysis (Yin, 2009). I used embedded case studies to examine the conditions that foster transformations towards network governance across the land-sea interface. I treated the Lesser Antilles as the overarching case and used experience from Saint Vincent, Saint Kitts, Grenada and Antigua to shed light on important conditions at the overarching case level. Both case-oriented strategies of inquiry required the collection and analysis of qualitative and quantitative data.

Section 3.3. Data collection

I collected both qualitative and quantitative data in relation to the strategies of inquiry noted above: systematic literature review and case studies. My approach essentially employs concurrent mixed methods, where I gathered both types of data at the same time (Creswell, 2003).

Section 3.3.1. Systematic literature search

I searched two well-known and appropriate databases – Scopus and Web of Science – using a variety of key words intended to capture papers relevant to my purposes (Table 11). The resulting list of papers were screened according to the following criteria: (1) papers must be peer-reviewed; (2) papers must be written in English; (3) papers must be published during or after 1999; and (4) papers must be relevant to governance across the land-sea interface. After screening, 151 papers remained in the sample.

Table 11. Search terms used to identify papers and their occurrences in each database.

Search terms	**Scopus (N of hits)**	**Web of Science (N of hits)**
governance AND ("ecosystem-based management" OR "integrated coastal zone management") AND (coastal OR marine)	148	184
governance AND integrated AND watershed AND coastal	14	12
governance AND (“integrated coastal and oceans management" OR “integrated land-sea”)	3	0
TOTAL	165	196

Note: The searches were completed in August 2014.

Section 3.3.2. Semi-structured interviews

I gathered data primarily through interviews conducted between July and December 2014. The interview participants were purposively sampled from governance organizations relevant for addressing land-sea connections (e.g., government agencies, resource user groups, environmental NGOs) (Hay, 2000). I developed an initial list of target organizations in each case study by examining their documented participation in relevant meetings and initiatives (e.g., workshops on land-based sources of pollution in the wider Caribbean, Integrated Watershed and Coastal Zone Management project). My lists were refined based on feedback from partners in each case study location. I used the refined contact list as the starting point, and added organizations that were mentioned by two or more respondents for their role in land-sea governance or related issues. I interviewed 65 participants in Saint Lucia and 60 in Dominica for the comparative case studies (Table 12). In the embedded case studies, I interviewed between 16 (Antigua) and 28 (Saint Kitts) participants. The number of participants varied according to the number of relevant actors in relation to land-sea governance.

Table 12. Overview of sample.

	St. Lucia	Dominica	Antigua	St. Kitts	St. Vincent	Grenada
Interviews (n)	55	56	13	27	24	22
Participants (n)	65	60	16	28	24	27
Actors (n)	35	47	18	23	24	36
Full info. (n)	28	36	11	15	15	16
Partial info. (n)	7	11	7	8	9	20

My research instrument captured both quantitative governance network data and qualitative data (Appendix B). Network data were gathered using a free-recall name generator technique by asking respondents with which organizations they regularly collaborate or coordinate on issues related to land-sea governance (Marsden, 2011). Qualitative data were gathered by asking open-ended questions on key themes within the research instrument. The key themes were as follows: (1) the evolution of the governance network; (2) important processes driving this evolution; (3) the existence and nature of relevant regulations and rules (e.g., development control, agricultural input control); (4) critical roles and mandates within the governance network; (5) the main challenges related to addressing land-sea interactions; (6) past strategies used to address land-sea interactions; and (7) the effectiveness of these strategies. Additionally, the qualitative interviews were used to gather perceptions regarding biogeochemical and ecological interactions among and between landscape and seascape features. For more detailed methods see Chapter 5 and Chapter 6.

Section 3.4. Data analysis

As noted earlier, I undertook a concurrent mixed methods approach, which involves collecting qualitative and quantitative data simultaneously (Creswell, 2003). With respect to data analysis,

a similar concurrent mixed methods approach was taken to provide a comprehensive analysis of the data. I drew on different forms of qualitative and quantitative analysis – both descriptive and inferential – to address my research objectives. Such an approach is aligned with both transdisciplinarity and the realist constructivism underpinning my knowledge claims.

Section 3.4.1. Qualitative analysis

Papers included in the systematic review sample and transcribed interviews were both coded using NVivo 10.0 software. Systematic review papers were first inductively coded to identify emergent themes regarding governance conceptualizations, challenges and effectiveness. Subsequently, the papers were coded in a more reductionist manner to quantify the degree to which the emergent themes were apparent in the literature sample. The second round of coding allowed for the generation of descriptive statistics and minor statistical inferences using Fisher's Exact Test regarding the predominance of different governance challenges and notions of effectiveness in different subsets of the literature.

The semi-structured interviews were coded using qualitative content analysis in relation to the following themes: (1) governance challenges stemming from land-sea interactions; (2) what has worked or not in the past to help address these challenges; (3) the current state of affairs regarding governance across the land-sea interface; and (4) governance changes required to better address land-sea connection. Qualitative content analysis is both a deductive and inductive approach to analysis, which allows for a predetermined analytical framework to be contextualized or grounded with information relevant to a particular set of case studies (Pietri et al., 2015; Pittman et al., 2015; Schipper and Spekkink, 2015). I first coded deductively based on

the themes note above, which was followed by inductive coding to refine the themes and identify sub-themes.

Section 3.4.2. Network Analysis

Network analysis refers to a group of techniques for both abstracting and analyzing complex systems. The starting point for any network analysis is abstracting a particular system as a set of nodes (e.g., people, species) and edges representing interactions or interdependencies between these nodes (e.g., friendship, trophic flows). I used network analysis in three main ways. First, I used network analysis to examine patterns of co-authorship in the systematic review papers (Chapter 4). Papers were abstracted as nodes and co-authorship as relationships between the papers. Second, I used network analysis to construct social-ecological networks (Chapter 5). Following Bodin and Tengö (2012), I identified social-ecological networks by abstracting land-sea systems as sets of interacting governance actors (e.g., government agencies, cooperatives), interconnected ecological entities (e.g., coral reefs, mangroves), and the relationships between governance actors and ecological entities (e.g., management interests). Third, I used network analysis to construct governance networks (Chapter 6). Governance networks are essentially one level of a social-ecological network, and they consist of interacting governance actors. For more detailed methods see the respective chapters.

Section 3.4.3. Stochastic Network Modelling

Stochastic network modelling refers to a broad set of analytical tools designed to make inferences from network data by comparing observed networks to a set of randomly generated networks. I used two forms of stochastic network modeling in Chapter 5 and Chapter 6, respectively: Exponential Random Graph Models (ERGM) and Multilevel Exponential Random

Graph Models (MERGM). ERGM is a statistical technique for determining the social processes underpinning the formation of an observed or empirical network. MERGM is essentially very similar, but focuses on multilevel networks (i.e., those with multiple sets of actors and ties) as opposed to single level networks. These techniques – building on earlier modelling approaches (e.g., Bernouli and Markov random graphs) – use network building blocks consisting of only a few nodes and edges to examine theoretically-informed hypotheses about how the observed networks emerged and evolved. The particular strengths of the ERGM and MERGM techniques are the ability to consider the influence of multiple building blocks simultaneously and the ability to distinguish between nested building blocks, or those that can form parts within more complicated wholes. The influence of multiple building blocks is tested using techniques similar to multivariate or logistic regression with the observed network being the dependent variable and the building blocks being the independent variables; however, ERGMs and MERGMs do not assume that the ties in an observed network are independent, which makes them better aligned with social theory (Lusher et al., 2013a; Wang et al., 2016, 2013). The main premise of ERGMs and MERGMs dictates that building blocks representing various social processes will be more (less) prevalent in observed networks than in a set of random networks if the corresponding social processes are (not) playing a significant role in producing the observed network. These processes are deemed significant if their corresponding parameter estimates are twice their standard errors, as determined by comparing the observed network to the distribution of random networks (Lusher et al., 2013a). The parameter estimates are found using Markov chain Monte Carlo Maximum Likelihood Estimation, which essentially involves systematically searching for values that produce a model where the observed network statistics are central and not extreme in the distribution of graphs produced by the model (Lusher et al., 2013a). I used MPNet software

for all stochastic network modelling (Wang et al., 2014). For more specific details on methods see Chapter 5 and Chapter 6.

Section 3.5. Research ethics

This research adhered to the University of Waterloo's ethical guidelines and the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans. The research was reviewed by the University of Waterloo's Office of Research Ethics and approved on June 6, 2014 (Appendix C. Ethics Approval). Table 13 provides an overview of the main ethical considerations and how they were addressed.

Table 13. Ethical considerations and strategies to address them.

Ethical consideration	How it was addressed
Informed and prior consent to participate	Research participants were made aware of the nature and objectives of the research as well as their rights to remain anonymous and to end their participation at any time.
Anonymity and confidentiality of respondents	All data were encrypted and stored in a secure location. Datasets were de-identified as much as possible and as soon as possible following data collection.
Research reporting and community benefits	Research results have been communicated iteratively with key participants and partners in the study sites. Research briefs will be prepared and distributed following successful defense of this thesis.

Chapter 4. Governance across the land-sea interface: A systematic review

Section 4.1. Chapter summary

Governance across the land-sea interface is an emerging challenge. The propensity for, and intensity of social-ecological interactions across this interface (e.g., eutrophication, sedimentation) are being exacerbated by cross-system threats (e.g., climate change). We draw on a systematic review of 151 peer-reviewed papers on governance and land-sea connections to (1) outline the current state of the literature, (2) examine the predominance of different approaches for addressing land-sea interactions, (3) characterize how governance is conceptualized within these approaches, (4) investigate governance challenges, and (5) provide insights into effective governance. The review finds that the number of relevant papers published per year has generally been increasing, and most of these papers are found in interdisciplinary journals. Ecosystem-based management is the most predominant approach found in the literature as a means to address land-sea interactions. Papers referring to ecosystem-based management are more likely than those referring to alternative management approaches (e.g., integrated management) to highlight science-policy integration and the need to account for interactions between ecosystem components as elements of effective governance. The main governance challenges include determining boundaries, addressing cross-scale effects, and accessing knowledge. However, few empirical studies of governance across the land-sea interface have been completed. A richer conceptual framework of governance is required to improve our ability to navigate the rapid social and environmental change occurring across the land-sea interface.

Section 4.2. Introduction

The land and sea are inherently connected via multiple, complex social-ecological interactions (Álvarez-Romero et al., 2011; Makino et al., 2013; Stoms et al., 2005). These interactions are an important component of local ecologies and major factors influencing people's livelihoods and wellbeing. Álvarez-Romero et al. (2011) have developed a typology of land-sea connections consisting of three categories. First, there are natural material and physical flows occurring within land-sea ecological processes (Álvarez-Romero et al., 2011) – for example, the input of freshwater, sediments and nutrients by rivers into coastal areas, or the freshwater spawning migration of diadromous species, represent land-sea processes (Beger et al., 2010). Second, there are cross-system threats, which usually arise due to biophysical or environmental change – human-induced or otherwise – in one sub-system (i.e., the land or the sea) but have implications for another (Álvarez-Romero et al., 2011). For example, cross-system threats may be point and non-point source pollution in coastal-marine areas resulting from human activity on land (e.g., agriculture, solid waste management), or changing coastlines associated with erosion, storm-surge and sea level rise (Boesch, 2006; Tallis et al., 2008). Third, there is an overarching influence of management and policy decisions on both land-sea processes and cross-system threats (Álvarez-Romero et al., 2011). These decisions include things like conservation area designation or enacting land-use restrictions (Carollo and Reed, 2010; Cicin-Sain and Belfiore, 2005; Lebel, 2012), which can have significant effects on human influences and vice versa.

It is the latter category – the influence of policy and management decisions and the social processes and values that drive those decisions – which brings us into the realm of governance. We define environmental governance here as the processes and institutions (e.g., cultural norms, rules) through which societies make decisions that affect the environment (i.e., land and sea;

Oakerson, 1992). As such, governance is distinct from, but not exclusive of, management. Kooiman et al.'s (2005) interactive governance framework, which consists of governance, systems-to-be-governed and interactions between the two, is useful for unpacking the relationship between management and governance. Within this framework, governance represents the structures (e.g., rules, networks), decision making processes, actors, and ideas that shape what management strategies, if any, are chosen and implemented in light of land-sea processes and cross-system threats (Kooiman et al., 2008) (Figure 3). In other words, one function of governance is to make decisions regarding management. The management strategies themselves represent an interaction between governance and the systems-to-be-governed. In the case of land-sea systems, the systems-to-be-governed are the different land-sea ecosystems, cross-system threats, and the socioeconomic activities or systems that influence them. Additionally, land-sea systems pose significant social and biophysical challenges for governance, which represent a signal from the systems-to-be-governed to governance.

Figure 3. Relationship between governance and land-sea systems.

While there have been recent syntheses focused on land-sea ecological processes, cross-system threats and possible management options (Álvarez-Romero et al., 2011; Halpern et al., 2009; Lebel, 2012; Stoms et al., 2005), there has not been a comprehensive literature review and

synthesis focused on governance across the land-sea interface, a gap we aim to address with this paper. Specifically, we apply a systematic review methodology with five objectives: (1) to outline the state of the literature on governance across the land-sea interface; (2) to examine the predominance of different approaches for addressing land-sea interactions; (3) to characterize the current conceptualization of governance within the literature; (4) to investigate the challenges of governance, and (5) to provide insights into what is considered effective governance. The paper begins with an overview of the methods, followed by the results and discussion, and, finally, presents the main conclusions that can be drawn from the research.

Section 4.3. Methods

We employ a systematic review of literature related to governance and land-sea connections to meet the objectives. Systematic review is a structured, purposive approach to sampling, analyzing and synthesizing literature to answer targeted research questions (Berrang-Ford et al., 2015). It is appropriate for identifying broad theoretical implications or policy relevance from an existing body of scholarship (Bilotta et al., 2014). Systematic reviews differ from other reviews in many ways, but most importantly by being explicit and transparent regarding literature sampling, selection, and approaches to analysis and synthesis (Berrang-Ford et al., 2015).

The systematic review employed here follows a four step process that has been adopted and tested in similar studies (Moore et al., 2014b; Petticrew and Roberts, 2006; Plummer et al., 2012). Petticrew and Roberts (2006) identify the steps as follows: (1) determine research questions to guide the review; (2) develop a search protocol (i.e., targeted databases and search terms) to explore literature databases; (3) screen the results of the literature search based on a

predetermined set of criteria; and (4) conduct an analysis and synthesis of the remaining literature.

The questions guiding our research relate directly to the objectives (Table 14). We chose SCOPUS and Web of Science (WoS) as the targeted databases because they contain a broad range of journals related to environmental management and governance. These databases are appropriate since (1) the relevant literature spans multiple disciplines (e.g., ecology, geography, sociology, planning) and (2) there are no journals or databases focused specifically on land-sea connections or governance. These two conditions necessitate drawing from a range of journals and databases to capture an adequate scope of relevant papers.

The targeted databases were queried using three sets of keywords (Appendix D, Table D1). The keywords were chosen to sample literature that covered the major management approaches to address land-sea connections (e.g., integrated coastal zone management, ecosystem-based management, land-sea conservation planning) and also explicitly contained, referenced or made linkages to the concept of governance. We acknowledge that these search terms would omit publications relevant to governance in relation to land-sea connections that do not explicitly use the term 'governance'. However, we assume that explicit use of the term 'governance' is important, since we aim to explore governance conceptualizations, challenges and effectiveness. As such, inclusion of the omitted papers should not significantly alter our findings.

The search protocol returned 165 papers from SCOPUS and 196 papers from WoS. After removing duplicates, there were a total of 207 papers. These 207 papers were then screened by reviewing their titles, citation information and abstracts, and employing the following criteria: (1) papers must be peer-reviewed; (2) papers must be written in English; (3) papers must be published during or after 1999, since our focus is on contemporary literature; and (4) papers must

be relevant to governance in relation to land-sea connections. Relevance was interpreted based on review of the papers' abstracts. These criteria were chosen to capture salient scholarship and cover early and later appearances of governance in the literature. Additionally, the choice to only include peer-reviewed literature published in English was made to restrict the list of publications to a feasible number for review (Petticrew and Roberts, 2006). However, we acknowledge that valuable literature exists in other languages and outside of peer-review. One hundred and fifty-one papers remained after screening.

The remaining papers (n=151) were analyzed in three phases, which loosely followed a sequential exploratory design (Pluye and Hong, 2014). The first phase focused on qualitative analysis following a Grounded Theory approach (Plummer et al., 2012). This phase involved iterative rounds of open coding (i.e., capturing all possible themes found in the data), axial coding (i.e., identifying patterns and relationships within and between themes), and selective coding (i.e., refinement of theoretical constructs through compilation of evidence; Glaser and Strauss 1967; Corbin and Strauss 2008). The analysis aimed to answer the research questions and resulted in numerous themes and conceptual constructs relating to governance, challenges, and effectiveness. Additionally, it helped provide rich, detailed analysis of management approaches.

The second phase employed a more reductionist approach to coding, which involved categorizing papers or counting them. This phase mostly involved producing descriptive statistics on the number of papers referencing different management approaches, governance constructs, challenges, or notions of effectiveness. However, it also involved testing hypotheses regarding the relationships between challenges, notions of effectiveness, and the management approaches. These hypotheses were tested using Fisher's Exact Test for two-by-two contingency tables. Each challenge and factor leading to effectiveness was tested individually to see if it was

more or less likely to be mentioned in relation to two predominant management approaches: ecosystem-based management and integrated management.

Table 14. Objectives and related research questions.

Objective	Research question(s)
To outline the state of the literature on governance across the land-sea interface	How has the number of relevant publications changed over the study period?
	What are the main characteristics of these publications (e.g., geographic focus)?
	In what journals are the papers published?
To examine the predominance of different management approaches in relation to governance	What management approaches are predominant?
	What patterns of co-authorship are apparent in the literature on different management approaches?
To characterize the current conceptualization of governance within the literature	Is governance defined? If so, what definitions of governance are used?
	If not, how is governance being constructed?
To investigate the challenges of governance	What governance challenges emerge from, or are apparent in the literature?
	How predominant are these challenges?
	Are the challenges identified related to management approaches?
To provide insights into what is considered effective governance	What characteristics and factors emerging from the literature are thought to constitute effective governance?
	How predominant are these notions of effectiveness?
	Do the notions of effectiveness differ by management frame?

The third phase involved a network analysis of the papers. Each paper corresponded to a unique node in the network. Edges or relationships between nodes were drawn based on co-authorship, which means that two papers sharing at least one author were related to one another. Homophily – or the tendency for similar nodes to be related (McPherson et al., 2001) – was qualitatively assessed based on management approach using a radial visualization algorithm in Gephi. The

network analysis allowed us to examine patterns of co-authorship in literature examining the management approaches.

Section 4.4. Results and Discussion

This section covers the main findings of the review and discusses their implications (see a summary in Table 15). The section is organized according to the objectives (see Table 14).

Section 4.4.1. The State of the Literature

The majority of papers included in the sample were published since 2007 (Appendix D, Figure D1). There were three years – 2009, 2012 and 2013 – during which more than 20 papers were published. The literature is also found in a diverse set of journals. There were seven individual journals that each contained more than two papers within the sample (Appendix D, Figure D2). These seven journals collectively contained 64% of the sample. Of these seven journals, *Marine Policy* by far published the greatest number of papers (n=38), which represents approximately 25% of the sample. The journals' foci range from coastal or marine issues specifically to environment or conservation issues broadly. In addition to these seven journals there were 13 journals that each published two papers in the sample and 29 papers that each published one. These additional journals had similar foci to the seven noted above.

Approximately 53% (n=80) of papers were review papers. However, 34% (n=51) were review papers that drew on case studies to demonstrate their findings (i.e., they included case studies but did not report on specific methods for gathering data and examining the case studies). Approximately 36% (n=54) were empirical papers, 7% (n=11) were conceptual, 3% (n=5) were synthesis papers, and 1% (n=1) was an opinion piece. The geographic range for empirical and

review papers using case studies was varied (Figure 4). However, there were considerably more papers focused on the United States (n=18) than other countries.

Section 4.4.2. The Predominance of Management Approaches

There were three management approaches explored that have relevance to governance for addressing land-sea interactions. The first was integrated management. Integrated management encompasses a broad range of associated approaches (e.g., integrated coastal zone management, integrated watershed management, integrated oceans management). It refers to purposive attempts to induce a coherent approach to land-sea management in the face of jurisdictional and sectoral fragmentation and competing interests (Aswani et al., 2012; Born, 2012; Cheong, 2008). Integrated management and its associated approaches emerged largely from planning and other social science disciplines (Aswani et al., 2012).

Ecosystem-based management – the second management approach – emerged largely from the natural sciences (Aswani et al., 2012; Long et al., 2015). Ecosystem-based management generally refers to "management of a particular ecosystem's structure and function to sustain and foster ecosystem services for human society" (Aswani et al., 2012:1). Similarly to integrated management, ecosystem-based management usually requires integration across jurisdictions, sectors and system components; however, it additionally implies a focus on sustainability, exercising precaution, and adaptively improving management effectiveness (Boesch, 2006). Christie et al. (2009a:380) note that "[the] replacement by [ecosystem-based management] of previously influential frameworks and approaches, such as community-based planning and integrated coastal management, might be perceived as a natural progression or necessary displacement of outdated frameworks".

Figure 4. Geographic distribution of case-based studies.
Note: papers employing regional case studies (e.g., Large Marine Ecosystems) are not shown.

The third management frame was land-sea conservation planning. This frame is related to both integrated and ecosystem-based management, but it is still distinct. According to (Álvarez-Romero et al. (2011:382) the distinction lies in the focus on systematic conservation planning:

> *"These approaches [integrated and ecosystem-based management] often address aspects of land-sea planning such as ecological connections between land and sea, cumulative impacts, multiple objectives, diverse stakeholders, and jurisdictional fragmentation. However, neither addresses the fundamental concepts of systematic conservation planning, namely, complementarity between selected areas, least-cost solutions to achieving objectives, and transparent and repeatable methods for designing configurations of conservation areas."*

There is an added emphasis on robust and economically feasible strategies under land-sea conservation planning. Additionally, land-sea conservation planning explicitly contains conservation objectives related to land-sea connections and cross-system threats (Adams et al., 2014; Álvarez-Romero et al., 2011; Stoms et al., 2005).

Table 15. Main findings in relation to the research objectives.

Objective	Main finding(s)
The State of the Literature	The number of relevant articles has generally been increasing over time.
	The articles are mainly review papers with a smaller subset of empirical papers. There is more empirical work or case studies from the United States than other countries.
	The majority of articles are published in interdisciplinary journals, such as *Marine Policy*.
The Predominance of Management Approaches	Ecosystem-based management was the most predominant of the three management approaches investigated in relation to governance.
	Each management paradigm appears related to different communities of scholars who rarely work together on papers.
The Conceptualization of Governance	There is not one unifying conception of governance within the literature. Additionally, the majority of articles do not define governance, despite using the term.
	There are two main governance constructs apparent in the literature: governance as context and governance as praxis. Governance as praxis is the most common. Very few papers treat governance as a theory or lens.
The Challenges of Governance	There were seven main challenges apparent in the literature: boundaries, scale, knowledge, bridging, uncertainty, trade-offs, and incentives.
	The most predominant challenges relate to boundaries, scale and knowledge.
	Challenges are not related to different management approaches.
The Effectiveness of Governance	There were six main elements of governance effectiveness to address land-sea interactions found in the literature: science-policy integration, leadership, networks, social fit, functional fit, and temporal fit. Power, fairness, and adequate planning horizons were only mentioned in a small subset of the literature.
	The most predominant elements were functional fit and science-policy integration.
	Both functional fit and science-policy integration are more likely to be found in the ecosystem-based management literature than the integrated management literature.

Within the literature, ecosystem-based management was the most predominant approach, and it was apparent in approximately 52% of the papers (n=78). Integrated management was apparent in 35% of papers (n=53), and land-sea conservation planning in 5% (n=8). The remainder of the papers (8%; n=12) either did not provide enough information to make a clear classification or they referred to multiple management approaches.

Another interesting finding is that research using the different management approaches correspond to different communities of researchers (Figure 5). In Figure 5, the nodes (circles) represent each paper and the relationships (lines) represent sharing of one or more authors between the papers. The nodes are colored according to the respective management approach apparent in the paper, and their size indicates their degree or number of connections they have with other nodes. While there are some instances of co-authorship across papers employing multiple management approaches, the majority of co-authorship ties are between papers covering the same management approach. From a governance perspective, improved collaboration between these different communities of researchers could be beneficial to facilitate learning, especially given the possible synergies between approaches (e.g., ways of dealing with governance fragmentation).

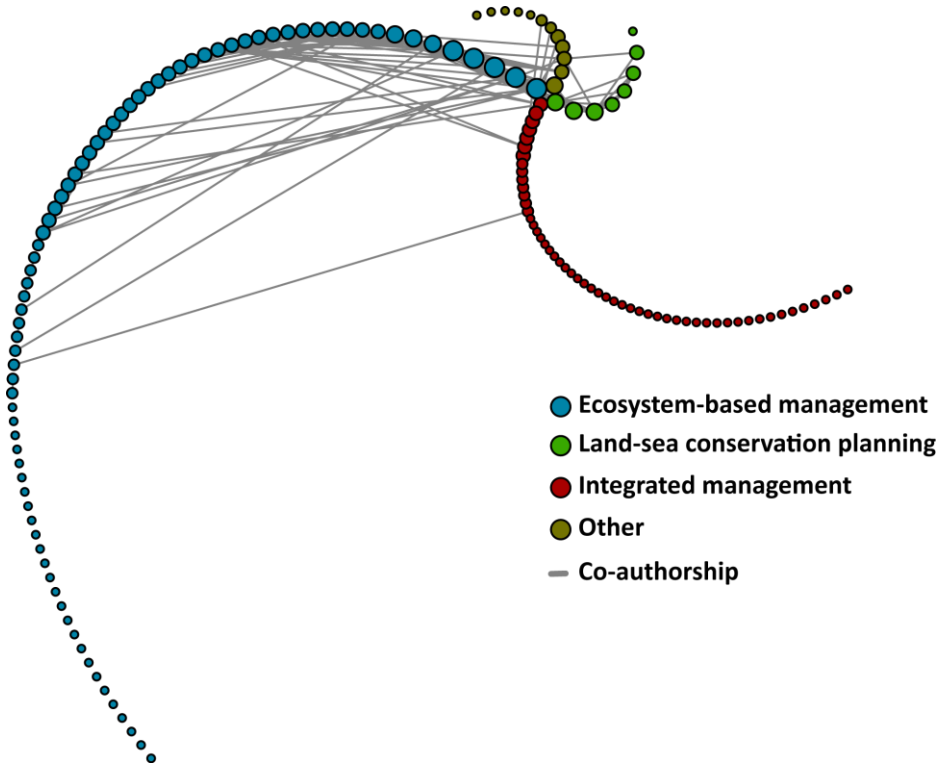


Figure 5. Co-authorship between papers and management approaches.

Section 4.4.3. The Conceptualization of Governance

Governance definitions varied within the literature (Table 16). However, some common themes emerged. Governance, as defined in the sampled literature, is about making decisions and formulating rules (Alves et al., 2013; Falaleeva et al., 2011). To some, governance is explicitly about sharing power across societal levels or among different types of actors (e.g., government, civil society, private sector) (Alves et al. 2013). To others, power sharing is not explicitly part of the definition (Christie et al. 2009a). Governance can be a means of giving voice and building relationships across different segments of society (Alves et al., 2013; Cicin-Sain and Belfiore, 2005; Falaleeva et al., 2011), or it can be related to ways in which the dominant forms of organizing are spread or implemented throughout a society (Juda 1991). Some definitions tie

governance directly to resource use (Christie et al., 2009b), and others make explicit reference to addressing environmental change (Biermann et al., 2009). It is important to note that none of the literature sampled provided a definition of governance specifically in relation to land-sea interactions. Rather, definitions of governance are drawn from the broader literature and applied to land-sea interactions as a particular problem situation or context.

Table 16. Selected definitions of governance found in the literature sample.

Definition	Source
"…the process by which long-term social goals and the rules and procedures to achieve them are defined. This definition assumes governments, civil society, and markets as the principle (sic) source of power by which the processes of governance are expressed."	Alves et al. (2013) citing Olsen et al. (2011)
"…the formal and informal arrangements, institutions, and mores which determine how resources or an environment are utilized; how problems and opportunities are evaluated and analyzed, what behavior is deemed acceptable or forbidden, and what rules and sanctions are applied to affect the pattern of resource and environmental use."	Christie et al. (2009b) quoting Juda (1999)
"…the interactions among structures, processes and traditions that determine how power is exercised, how decisions are taken, and how citizens or other stakeholders have their say."	Cicin-Sain and Belfiore (2005) quoting Graham et al. (2003)
''…an interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development.''	Falaleeva et al. (2011) quoting Biermann et al. (2009)

Approximately 84% of the sampled papers offered no explicit definition of governance despite using the term. These papers, rather, exhibit two main implicit conceptualizations or concepts of governance: (1) governance as context; and (2) governance as praxis. Each has different implications for how land-sea interactions can be addressed.

With regard to ‘context’, governance is considered part of the setting in which the management of land-sea interactions takes place (e.g., Flannery and Ó Cinnéide, 2012; Juda and Hennessey, 2001; Ruckelshaus et al., 2008). Thus, governance is seen largely as a structural phenomenon, consisting of rules, regulations and the institutional arrangements that enable and constrain management (Cárcamo et al., 2013; Ekstrom and Young, 2009). There are clear lines drawn between governance and management in this perspective, and sometimes the two are cast as having an antagonistic relationship. For example, this literature often asserts that effective management of land-sea connections requires breaking down governance structures that keep land and sea management separate (Adams et al., 2014). Questioning the reasoning behind this assertion is not our focus here. However, using a ‘governance as context’ perspective may limit needed attention to the processes required to mainstream or contextualize different management approaches to address land-sea interactions.

Governance as praxis moves beyond a contextual focus to include attention to process (Day and Dobbs, 2013; Knol, 2013; Sievanen et al., 2013). Governance, under this construct, still contains structural components (e.g., rules, regulations, arrangements); however, it is also active and reflexive with a greater attention to the people or actors who are involved in governing (Kearney et al., 2007). The lines between governance and management are somewhat blurred, and the two are considered to contribute synergistically to desired outcomes. For example, the ability to address land-sea connections is viewed as contingent upon determining effective management strategies through appropriate governance processes (e.g., inclusive planning) (Hovik and Björn Stokke, 2007).

Governance as praxis was the most common construct with 52% of papers (n=79) invoking it. Governance as context was apparent in 37% of papers (n=56). The remainder of the papers

(11%; n=16) either did not invoke either construct (i.e., governance as praxis or context) or did not provide enough information to make an adequate judgement.

Of particular note is a possible third governance construct apparent within the remaining papers: governance as theory. This construct treats governance as different sets of propositions, ideas and hypotheses to be tested, explored and updated. It was apparent in only 4% of papers (n=6), which indicates that treating governance as a theory is a gap in the literature on land-sea connections. Governance as theory or lens has been highlighted as an important application within the scholarship on environmental governance (Armitage et al., 2012b).

Section 4.4.4. The Challenges of Governance

Governance in relation to land-sea connections faces multiple challenges. These challenges originate in the system-to-be-governed; however, addressing these challenges is inevitably a problem of governance. There were three main challenges identified through the systematic review: (1) the determination of boundaries; (2) finding suitable scales for governance; and (3) accessing adequate knowledge. These three challenges were each found in approximately 80% of papers (Appendix D, Figure D3). There were four other challenges identified: (1) bridging disparate forms and sources (e.g., scientific, policy, local) of knowledge, as opposed to just accessing knowledge; (2) dealing with uncertainty about future environmental or social conditions; (3) negotiating trade-offs among different sectors or resource users; and (4) providing appropriate incentives to encourage sustainable resource use. These challenges were less predominant in the literature and were only found in between 30%-60% of papers. The most predominant challenges are discussed further below.

Boundary determination

The first challenge that emerged from the systematic review deals with the determination of boundaries for management and governance when addressing land-sea interactions. The nature of ecological processes (e.g., nutrient flows, trophic interactions) and social processes (e.g., cohesion, solidarity, resource distribution and use, livelihood generation) that create feedbacks between the land and sea make boundary determination extremely difficult (Adams et al., 2014; Álvarez-Romero et al., 2011; Sreeja et al., 2016). For example, the oxygen-deprived 'dead zones' in the Gulf of Mexico are caused, in part, by agricultural intensification and subsequent nutrient runoff occurring far inland (Boesch, 2006; Mitsch et al., 2001). These areas – in addition to being separated by space – are separated by jurisdictional boundaries (e.g., counties, states), sectoral and livelihood boundaries (e.g., between agriculture and fisheries), and possibly social boundaries (i.e., different communities or social networks, different connections to place and identity), to name a few. Similarly, Cárcamo and Gaymer (2013:1355) have shown how management of the Islas Choros-Damas Marine Reserve in northern Chile "must recognize interferences from outside conditions and consider some of them…as cross-cutting actions for the entire social–ecological system". The challenge of governance becomes finding appropriate boundaries for addressing land-sea connections across a range of pre-existing boundaries (Cheong, 2008) and at spatial extents that encompass social and ecological systems relevant for land-sea interactions (Armada et al., 2009; Charles et al., 2010; Christie et al., 2009a). Climate change adds urgency to the need to determine appropriate boundaries, but also an extra dimension to the challenge. As climate change modifies important land-sea social-ecological processes, the potential need for transboundary or transnational initiatives becomes greater (Craig and Ruhl, 2010; Lester et al., 2010; Rosen and Olsson, 2012).

Governance scale

In addition to dealing with boundaries, governance must also – according to the sampled literature – determine the appropriate social and ecological scales for action (Bruckmeirer 2012). Scale is defined here as the various dimensions (e.g., spatial, temporal, functional) that can be applied to understand, measure or conceptualize different phenomena within social-ecological systems (Cash et al., 2006; Crowder et al., 2006; Gibson et al., 2000). Social-ecological interactions between the land and sea operate at many different scales, and governance must be able to match these scales (Cinner et al., 2012). For example, Aswani et al. (2012:4) note how "[ecosystem-based management] in the Philippines (and much of the tropics) must balance the imperative to scale-up management to encompass ocean patterns and biological connections with the expectation for participatory planning". The challenge becomes scaling up to address system-level problems, while simultaneously scaling down to empower social actors (e.g., fishers or farmers organizations) at scales relevant to them (Armada et al., 2009; Bruckmeier, 2012; Charles, 2012; Christie, 2011; Coleman, 2009).

Access to knowledge

An additional governance challenge identified within the sampled literature is accessing the appropriate knowledge. As McFadden (2007:429) points out, "[s]uccessful integration in coastal management must…be underpinned by knowledge of the integrated behavior of the system." Understanding integrated behavior inevitably involves engaging knowledge from diverse sources (Henocque, 2013; Lebel, 2012; Miller et al., 2010; Ommer et al., 2012). However, some governance systems have been focused entirely on certain forms of knowledge (e.g., scientific knowledge) of only parts of the system-to-be-governed (e.g., ecosystems) (Christie, 2011). These pre-existing foci create barriers to accessing and inclusion of other forms of knowledge within

governance on different parts of a system. The challenge of governance becomes developing suitable processes for engaging with diverse sources and types of knowledge.

Section 4.4.5. The Effectiveness of Governance

Governance effectiveness in the literature was broadly defined in relation to "environmental sustainability, social equity, and institutional endurance (sic)" (Aswani et al., 2012); however, there is an apparent emphasis on environmental sustainability. The literature we reviewed recognized six factors contributing to governance effectiveness in making progress towards addressing the main challenges highlighted above: timely science-policy integration, strong leadership, supportive networks, social fit, functional fit, and temporal fit. These notions of effectiveness were usually seen as cross-cutting in relation to the challenges identified. The most predominant factor was functional fit (see description below), which was apparent in approximately 70% of the papers, followed by science-policy integration, which was apparent in 53% (Appendix D, Figure D4). Leadership was the least predominant, and it was apparent in approximately 35% of papers. The other three factors were all similarly predominant and apparent in approximately 50-52% of papers. Only the two most predominant notions of effectiveness will be discussed in detail below. Many notions of effectiveness could not be verified, and there were many notable gaps (e.g., power, long-term agendas). It is clear that governance effectiveness across the land-sea interface requires further conceptual and theoretical development, as well as empirical verification.

Science-policy integration

Science-policy integration usually refers to the use of scientific knowledge when making policy (Hopkins et al., 2012; Juda, 1999). As Ommer et al. (2012:319) articulate, "[e]ffective

governance implies a process that puts integrative, broadly defined and interdisciplinary science at the heart of policy making". A key ingredient of successful science-policy integration appears to be the focus on interdisciplinary or transdisciplinary science, which facilitates access to diverse forms of knowledge through two-way dialogue between researchers, policy makers, and other stakeholders (Armitage et al., 2015b; Christie, 2011; Miller et al., 2010). Disciplinary science, usually drawing only on ecology, is thought to be largely ineffective by itself (Christie, 2011). Hopkins et al. (2012) demonstrate the application of transdisciplinary science for crossing the science-policy interface, in what they call experiments, regarding the implementation of a framework for advancing complex systems thinking in coastal zone management (the Systems Approach Framework [SAF]). They tested the implementation of their framework in 18 case studies from Europe.

> *"Testing ideas for improving the science–policy interface was a major objective of the SAF development. A key factor was the initial establishment of a working collaboration with managers and stakeholders around the shared goal that formed a truly transdisciplinary research team. The benefits were, e.g., increased familiarity, improved exchange of information, and an erosion of the perceived aloofness of science. Repeated discussions with the stakeholders helped the researchers tune their presentations toward a more balanced sharing of information in a common-space dialog."*
> *(Hopkins et al., 2012:39).*

Another important finding from the systematic review was that papers referring to ecosystem-based management were statistically more likely to contain science-policy integration as an element of effective governance ($p = 0.01$), which possibly relates to the emergence of ecosystem-based management from the natural sciences.

Functional fit

Functional fit refers to the ability of governance to account for the characteristics, processes and dynamics of the ecosystems being influenced by governance (Ekstrom and Young, 2009). Within

the literature, functional fit usually involves governing at land-sea ecosystem scales (Crowder and Norse, 2008) or drawing management boundaries to encompass relevant land-sea ecological processes (Adams et al., 2014). However, the ability of governance to achieve functional fit is often constrained by pre-existing institutional capacity and social conditions, such as existing jurisdictions or sector-based management (Aswani et al., 2012; Charles, 2001; Crowder et al., 2006).

The literature is beginning to acknowledge the effectiveness of functional fit in relation to social fit, or the ability of governance to also match social processes and dynamics (Aswani et al., 2012). However, empirical work is lacking on the relationship between functional and social fit, and how these relate to governance effectiveness under conditions of change (see Epstein et al., 2015; Pittman et al., 2015). Additionally, functional fit is statistically more likely to be found in the ecosystem-based management literature than in the integrated management literature (p = 0.0001), which is logical since ecosystem-based management focuses on making decisions at the ecosystem scale and following ecosystem boundaries.

Section 4.5. Conclusions

The literature on governance across the land-sea interface has undergone extensive development over the last few years. This literature has been found in a number of interdisciplinary journals, although the geographic focus of the literature remains fairly narrow (i.e., most case studies are from the United States). Ecosystem-based management is the most commonly referred to management approach in the context of governance and land-sea interactions. Governance is conceptualized mostly as praxis, but also commonly as context. Determining adequate boundaries for management, appropriate scales for governance, and obtaining access to relevant

knowledge are the most commonly found governance challenges within the literature; while the need for science-policy integration and functional fit are the most commonly cited elements of effective governance. The relevant management approaches (e.g., ecosystem-based management, integrated management) do not influence what is identified as a key challenge for governance; however, what is deemed necessary for governance effectiveness is more likely to be related to science-policy integration and functional fit in the ecosystem-based management literature.

However, there is a need to develop a richer conceptual framework of governance across the land-sea interface. Currently, few papers treat governance across the land-sea interface as theory (i.e., a set of propositions and hypotheses to be empirically tested), and there is no unique or distinct definition of governance in this context. Governance theory in the context of land-sea interactions must account for the direct social and ecological linkages and feedbacks between disparate livelihood activities, bundles of ecosystem services, and multiple environmental realms (e.g., freshwater, terrestrial and marine) (Beger et al., 2010). Emerging techniques from the social-ecological systems literature (e.g., social-ecological network analysis; see Bodin et al., 2016, 2014; Kininmonth et al., 2015) could prove beneficial in this regard. Governance is an important component of our ability to navigate rapid social and environmental change in land-sea systems (Álvarez-Romero et al., 2011), and developing a more in depth and appropriate understanding of governance in this context is crucial to promote sustainability as we negotiate current and future change in these systems.

This systematic review illuminates four broader gaps in the current literature regarding the role of governance in navigating change across the land sea interface:

1. A social-ecological systems approach to governance across the land-sea interface is needed to match both the functional ecological scales of the problems (e.g., eutrophication) and the

social contexts in which problems emerge and solutions are crafted. Matching both ecological scale and social context is necessary to address the multidimensional nature of many sustainability challenges currently facing, and expected to threaten, land-sea systems. Recommendations to draw on social-ecological systems approaches for governance at the land-sea interface reflect similar conceptual developments in related problem contexts, such as marine conservation and protected areas (Ban et al., 2013; Charles, 2012).

2. The ability of governance to match scale and context hinges upon the available capacities to (a) engage diverse actors to access and bridge multiple forms of knowledge; (b) coordinate management of ecological resources across social boundaries; and (c) collaborate across organizational scales or jurisdictions in relation to biogeochemical and ecological interactions (Álvarez-Romero et al., 2015; Lebel, 2012; Mahon et al., 2009).
3. Structural alignment across multiple dimensions – social, temporal and functional – helps to build collaborative capacities, and corresponds to emerging theory regarding social-ecological fit in complex systems-to-be-governed (Epstein et al., 2015; Guerrero et al., 2015a; Kooiman, 2013). Collaborative and network governance across the land-sea interface are emerging as specific modes of governance potentially useful in enhancing social-ecological fit (Ernoul and Wardell-Johnson, 2013; Guerrero et al., 2015a; Hovik and Stokke, 2007; Sandström et al., 2014). Additionally, boundary-spanning organizations – or governance organizations that seek to reduce fragmentation through strategic collaborations – can be particularly useful to improve the capacity of governance to deal with social and ecological problems (Berdej and Armitage, 2016; O'Mahony and Bechky, 2008; Paige Fischer, 2015).

4. Finally, we require a better understanding of how governance systems evolve and change to become better capable of enhancing fit and to address rapid social and environmental change across the land-sea interface. Most existing studies suggest modifications to improve the effectiveness of land-sea governance without giving much attention to the challenges associated with making these modifications. To improve governance across the land-sea interface we must first identify effective strategies (e.g., the development of bridging organizations, participation in collaborative projects) for realizing governance change in land-sea systems. In reconciling this implementation gap, there is also a need to consider the role of legal frameworks that may hinder the types of institutional adaptation needed to respond to new sets of problems and drivers of change at that land-sea interface.

The path forward for governance across the land-sea interface is difficult. However, as we have outlined here, the imperative to catalyze more effective and adaptive forms of governance is increasingly evident. There are few easy solutions to the emergent biophysical and institutional challenges at the land-sea interface. However, ongoing conceptual development in the areas of collaboration, networks, fit and social-ecological systems may be sources of innovation to foster meaningful and beneficial governance across the land-sea interface.

Chapter 5. How does network governance affect social-ecological fit across the land-sea interface? An empirical assessment from the Lesser Antilles.

Section 5.1. Chapter summary

Governance across the land-sea interface presents many challenges related to (1) the engagement of diverse actors and systems of knowledge, (2) the coordinated management of shared ecological resources, and (3) the development of mechanisms to address or account for biogeochemical (e.g., nutrient flows) and ecological (e.g., species movements) between marine and terrestrial systems. If left unaddressed, these challenges can lead to multiple problems of social-ecological fit stemming from governance fragmentation or inattention to various components of land-sea systems. Network governance is hypothesized to address these multiple challenges, yet its specific role in affecting social-ecological fit across the land-sea interface is not well understood. We aim to improve this understanding by examining how network governance affects social-ecological fit across the land-sea interface in two empirical case studies from the Lesser Antilles: one from Dominica and one from Saint Lucia. We find that network governance plays a clear role in coordinating management of shared resources and providing capacity to address interactions between ecological entities; yet its potential role in engaging diverse actors and addressing, specifically, biogeochemical interactions across the land-sea interface has not been fully realized. Our research shows that network governance is beneficial, but not sufficient, to improve social-ecological fit across the land-sea interface. Strategically leveraging the social processes leading to the existing governance networks could prove useful in addressing the current deficiencies in the networks. Additionally, the interplay

between hierarchical and networked modes of governance appears to be a critical issue in determining social-ecological fit across the land-sea interface.

Section 5.2. Introduction

Network governance is thought to enhance our capabilities to address sustainability problems in social-ecological systems (SES) (Ansell and Gash, 2008; Bixler et al., 2016; Klijn and Koppenjan, 2012; Voß et al., 2007). Network governance is characterized by a shift in reliance away from top-down or hierarchical modes of decision making, to more decentralized, self-organized modes of governance (Newig et al., 2010). The networked mode is theorized to improve participation and legitimacy (Ernoul and Wardell-Johnson, 2013; Sandström et al., 2014), increase integration and application of diverse knowledge sources (Armitage et al., 2009; Newig et al., 2010), better leverage the distinct capacities of different actors by supporting collaboration and collective action (Engle and Lemos, 2010), and improve the responsiveness of governance to emerging social and ecological problems (Duit et al., 2010; Duit and Galaz, 2008).

Current research aims to examine how and when governance network structures are beneficial for addressing various governance challenges, such as coordination between multiple actors and the ability to address issues of scale (Bergsten et al., 2014; Bodin et al., 2014; Guerrero et al., 2015a; Kininmonth et al., 2015). The concept of social-ecological fit has emerged as a useful lens in this regard (Bodin et al., 2014; Epstein et al., 2015). Social-ecological fit, drawing on earlier conceptions of institutional fit (Young, 2002), refers to the degree of alignment or match between governance systems and various dimensions of the SES in which governance is embedded (Epstein et al., 2015; Folke et al., 2007). Types of fit are often distinguished by the SES features of interest, and some commonly employed types of fit include spatial, functional

and temporal (Table 17). However, a focus on single or a subset of features can be problematic, especially if the intent is to optimize governance for certain features without considering others (Epstein et al., 2015; Folke et al., 2007). Hence, social-ecological fit typically encompasses multiple types of fit simultaneously, and analyses of social-ecological fit are focused on the specific governance challenges that lead to a plethora of fit problems (Bodin et al., 2014; Guerrero et al., 2015a; Rijke et al., 2013, 2012). Social-ecological fit is a means for characterizing capacities to deal with such governance challenges.

Table 17. Original types of misfit found in the literature.

Type	Description
Spatial	Institutional jurisdictions do not match areal extent of a resource, its users, or the impacts associated with resource use.
Temporal	Institutional creation is either too soon or too late in relation to a certain problem or ecosystem process. Decision-making processes, as structured by institutions, are not able to produce timely decisions in relation to a problem.
Functional	Institutional scope does not adequately account for functional diversity and variety in a social-ecological system.
Cascading effects	Institutions are unable to buffer negative effects and feedbacks sufficiently to prevent their propagation throughout an SES.
Threshold behaviour	Institutions are unable to recognize looming thresholds and avoid abrupt ecological shifts. Institutions unable to effectively manage extremes and variability in the system.

Sources: Young 2002; Folke et al. 2007; Galaz et al. 2008

Governance challenges leading to social-ecological misfit are particularly acute across the land-sea interface. Pittman and Armitage (2016; Chapter 4), in a recent systematic review, highlighted three main governance challenges in this context: (1) engaging diverse actors to access multiple forms of knowledge; (2) coordinating management of ecological resources across social boundaries; and (3) undertaking governance at scales relevant to biogeochemical and ecological interactions. These challenges have the potential to result in multiple problems related to social-ecological fit. They do not represent all issues of potential interest in an examination of social-ecological fit (e.g., social justice), but they represent an adequate subset of issues with particular

importance to governing land-sea interactions. For example, fragmentation between governance systems focused on the land and those on the sea can lead to decisions about land use that ignore potential implications for coastal communities and ecosystems, such as sedimentation, eutrophication and subsequent impacts to the resources on which coastal communities depend. Detrimental land use, aside from producing general issues with sedimentation and eutrophication, can also place coastal communities and ecosystems at greater risk from hurricanes and extreme precipitation events, which amplify the physical processes driving erosion, sedimentation and nutrient transport. These examples highlight how the inability of governance to match the functional (e.g., sedimentation interactions) and temporal (e.g., extreme events) scales increases the potential negative impacts of land-sea processes, and limits governance capacity to address these impacts.

These types of governance challenges are pervasive in the Lesser Antilles islands of the Caribbean (Pittman et al., 2015; Saffache and Angelelli, 2010; Sweeney and Corbin, 2011; Walters, 2016). By drawing on network governance theory and the concept of social-ecological fit, we aim to examine the following research question: *How does network governance affect social-ecological fit across the land-sea interface in the Lesser Antilles?* Our goals are (1) to characterize how current governance networks contribute to capacity for governing across the land-sea interface and (2) to identify strategies for improving governance in this regard. Our research is focused on two comparative case studies from Dominica and Saint Lucia. Each of these cases provides a distinct context for exploring the value of network governance to improve social-ecological fit across the land-sea interface.

Section 5.3. Methods

Section 5.3.1. Case studies and data collection

The southwest coast of Dominica and the southeast coast of Saint Lucia provide useful case studies of governance across the land-sea interface (Figure 6). These case studies were chosen since they have key socioeconomic and ecological similarities (Table 18), yet different approaches to governance. Saint Lucia has implemented a more top-down approach, which has involved ratification of relevant multilateral agreements, whereas Dominica's approach is much more self-organized and not guided as directly by international commitments. Population and population densities are also important distinctions between these two contexts. Saint Lucia has a higher population and is much more densely populated than Dominica, which allows for us to compare across various levels of resource use and intensity. Saint Lucia also experienced twice as many large storms as Dominica from 1950 to 2014, which provides different signals to governance in the case studies. For more information on the cases, please see Section 1.2 and Appendix A.

Table 18. Characteristics of the case studies.

Contextual conditions	**Saint Lucia**	**Dominica**
Population, 2014 (N)	183,600	72,340
Population density, 2014 (N/km2)	301	96
Gross Domestic Product per capita, 2014 (US $)	7,647.5	7,244.5
Income level	Upper middle	Upper middle
Area (km^2)	617	724
Coastal length (km)	163	149
Area below 5 m (%)	8.0	9.4
Forest area, 2013 (%)	33.5	58.5
Maritime area (km^2)	15,417	28,593

Sources: World Bank, FAO Country Profiles

Note: Information at the national level. No data specific to the case study regions were available.

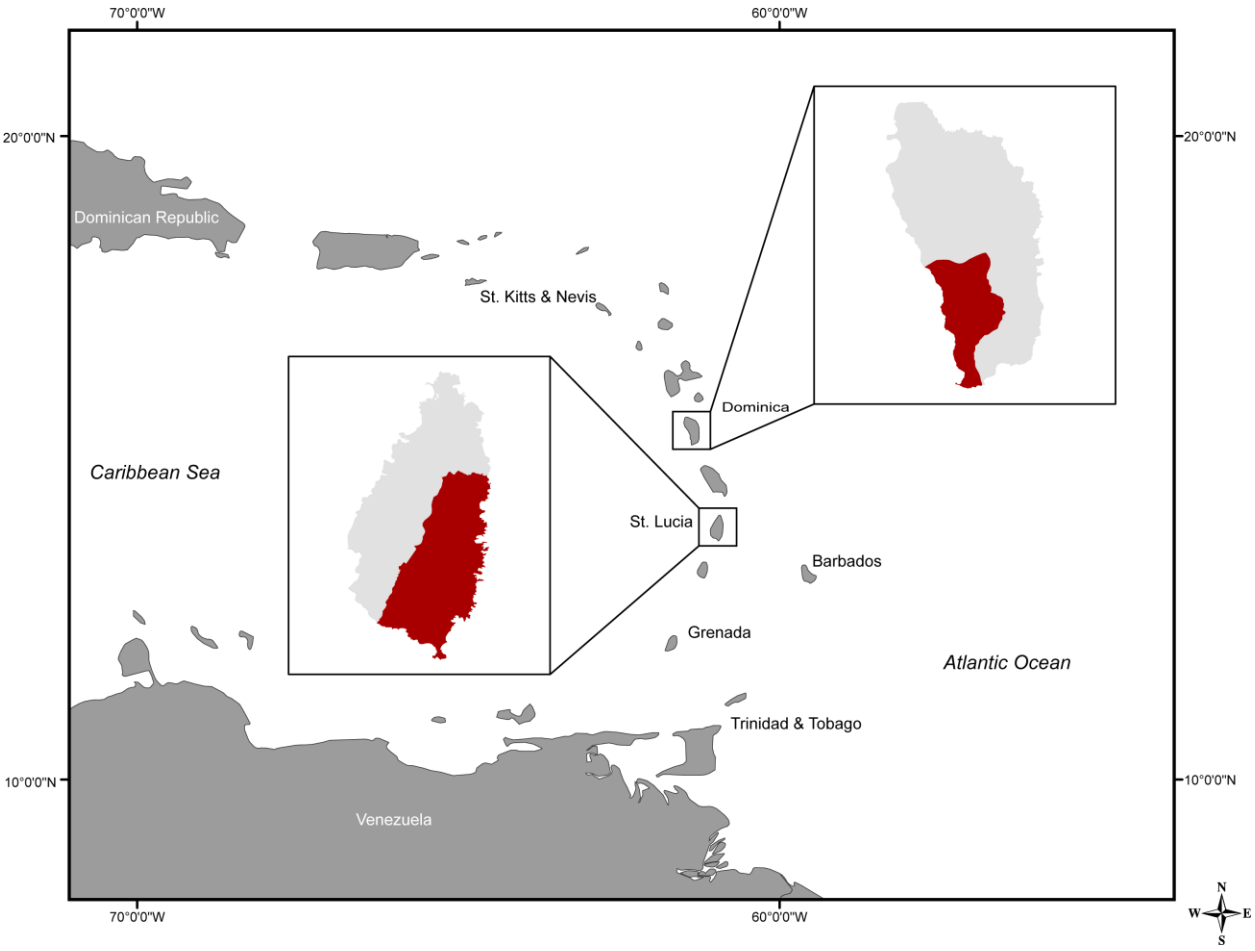


Figure 6. Map of region and focal islands. Note, the red areas represent the case studies.

Qualitative and quantitative data on governance networks and land-sea interactions were gathered using interviews with representatives from relevant governance organizations (e.g., government agencies, non-governmental organizations) (Table 19) (Borrás and Olsen, 2007). An initial contact list of relevant organizations was constructed by examining participation in key regional and international meetings (e.g., Global Programme of Action for the Protection of the Marine Environment from Land-based Activities). Partnerships were then formed with lead organizations in each context, and representatives from these organizations helped develop a complete list of contacts for organizations relevant for governing land-sea interactions.

Additional organizations were added if they were mentioned as relevant by at least two interview participants. The research instrument contained a mix of structured and semi-structured components, which allowed for focused data gathering regarding governance networks and land-sea interactions, but also for the exploration of emergent themes. Quantitative governance network information was gathered by asking participants with whom they most frequently collaborate or coordinate regarding issues arising from land-sea interactions. Qualitative information was gathered by asking respondents about the drivers of challenges arising from land-sea interactions and how governance has typically functioned (or not) to address these challenges. Maps of the study sites at various scales were used to assist in gathering data during interviews, and respondents were able to interact directly with the maps (e.g., draw on areas of problematic land use).

Table 19. Overview of sample.

	Saint Lucia	**Dominica**
Interviews (n)	55	56
Participants (n)	65	60
Actors (n)	35	47
Full information (n)	28	36
Partial information (n)	7	11

Section 5.3.2. Constructing social-ecological networks

We constructed social-ecological networks for each case study following Bodin and Tengö's (2012) three step approach to provide a starting point for our examination of social-ecological fit. First, we defined the relevant social-ecological interdependencies. These consisted of

management authority as defined by existing rules or interests in the respective ecological components (e.g., livelihood dependence). These types of interactions were chosen to capture both the ability to influence particular ecological nodes through management or resource extraction and use. Second, we defined our relevant social actors and ecological nodes. Social actors were defined as key organizations and groups involved with some aspect of land-sea governance. The scope included both formalized organizations (e.g., government agencies, fisheries cooperatives) and informal, yet organized groups (e.g., unincorporated groups of fishers or farmers). Ecological nodes were defined as key types of habitat, land cover, and land use that are found in each respective landscape and seascape. Third, social-social and ecological-ecological linkages were defined. Presence of collaboration and coordination were used to define social-social linkages, since these two forms of interaction are particularly important for governance (Ansell and Gash, 2008). Ecological-ecological links were defined as the potential for either species movements or biogeochemical flows between nodes to capture key land-sea processes (Álvarez-Romero et al., 2011).

Interviews formed the basis for determining whether social-ecological, social-social, and ecological-ecological links were present or absent. However, ecological network construction also involved drawing on secondary sources. Recent land cover and land use maps were gathered and combined in a Geographic Information System (GIS) with Digital Elevation Models (DEM) and key seascape features for both case studies. The GIS overlays were used to qualitatively assess the potential for connectedness among landscape and seascape features, which served to complement interview accounts of potential interactions. Peer-reviewed publications and grey literature were used – when available – to triangulate potential linkages and further improve the validity of our ecological networks (e.g., Nagelkerken 2009). Our approach has limitations since

it is not based on monitored or modelled ecological and biogeochemical connections between ecological nodes; however, a particular strength of our approach is that it engages with, and synthesizes multiple forms of knowledge – both academic and non-academic – regarding land-sea processes in our case studies. Similar approaches have been used elsewhere to answer a range of research questions in data-poor contexts (e.g., Vanwindekens et al. 2013, Daw et al. 2015, Walters and Chinowsky 2016).

Our definition of ecological nodes is not identical to that used in other similar studies (e.g., Guerrero et al., 2015; Kininmonth et al., 2015). We defined ecological nodes to reflect the diversity of key landscape and seascape features, rather than as the particular or specific features themselves (Table 20). For example, we chose seagrass in general to be an ecological node meant to capture all particular patches of seagrass found within our study areas, but the nodes were not defined as each patch of seagrass separately. One limitation of our approach is it removes the spatially-explicit nature of our social-ecological networks. However, we found our approach particularly useful to abstract the focal SESs in a manner relevant for understanding social-ecological fit across the land-sea interface. It is not the connections between particular features that are of interest to us, but rather the connections between types of features and how these can be governed effectively. Similar approaches have been used elsewhere (see Roldán et al. 2015). Additionally, our approach helps match scales, or the ability to influence one another, between the social actors and ecological nodes (Bodin and Tengö, 2012), since governance organizations or key groups of resource users typically have management authority for, or resource use interests in multiple features simultaneously. These authorities and interests are usually defined in the case studies based on type of feature.

Table 20. Ecological nodes and their presence in each case study.

Ecological node	Abbreviation	Saint Lucia	Dominica
Inland Tropical Forest	ITF	X	X
Scrub Forest	SF	X	X
Mangrove	MAN	X	
Nearshore	NS	X	X
Coral Reef	CR	X	X
Beach	B	X	X
Small Offshore Islands	SOI	X	
Seagrass	SG	X	X
Riparian Areas	RA	X	X
Surface Water	R	X	X
Offshore	OS	X	X
Grassland	GL	X	
Agricultural Lands	AL	X	X
Urban/Town	UT	X	X
Quarries	QL		X

Section 5.3.3. Analyzing social-ecological fit across the land-sea interface

We used network analysis to examine how network governance affects social-ecological fit. Network analysis has proven a useful tool to characterize social-ecological fit and assess the role of governance networks in helping to address issues of fit (Bergsten et al., 2014; Bodin et al., 2014; Guerrero et al., 2015a; Kininmonth et al., 2015). Network analysis allows for an SES to be abstracted as a multilevel network of interacting social actors, interconnected ecological entities or resource units, and the interdependencies (e.g., ecosystem services, management authority) between social actors and ecological entities (Bodin and Tengö, 2012). Social-ecological fit is analyzed by determining the tendency for certain network building blocks to be present or dominant in producing the observed network (Bodin et al., 2014; Guerrero et al., 2015b; Kininmonth et al., 2015). These building blocks represent various social-ecological network processes and have a theoretically-informed and empirically-examined relationship with social-

ecological fit (Bodin et al., 2014), or the ability to address various governance challenges (Guerrero et al., 2015b).

We have chosen a number of building blocks to examine social-ecological fit across the land-sea interface (Table 21). This approach follows Guerrero et al. (2015a), Bodin et al. (2016a) and builds off a suite of previous studies (e.g., Bodin et al. 2014, Kininmonth et al. 2015). We use building blocks related to the ability to address the governance challenges underpinning social-ecological misfit in land-sea systems. They capture the capacity of governance to (1) engage knowledge from diverse actors, (2) coordinate the management of shared ecological entities, and (3) account for the biogeochemical (e.g., sedimentation, nutrient flows) and ecological (e.g., species movements) interactions between ecological entities. However, it is important to note that many of the governance capacities captured in the building blocks are hypothesized and their assumptions not fully tested (Bodin et al., 2016a), which is why our analysis also draws on the qualitative interview data to better interpret the meaning of the building blocks. As such, we also contribute to an emerging conversation regarding the role of the building blocks in improving the capacity of network governance arrangements to address specific challenges.

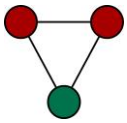
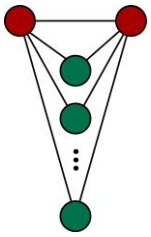
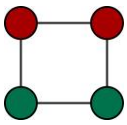
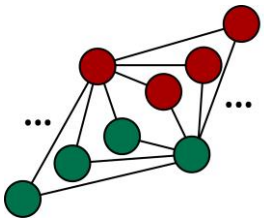
Section 5.3.4. Multilevel Exponential Random Graph Models

We used Multilevel Exponential Random Graph Models (MERGM) to examine social-ecological fit across the land-sea interface in our case studies. Multilevel networks consist of multiple sets of actors, interactions between/among actors in each set, and interactions between/among the actors across each set (Lazega and Snijders, 2016). MERGMs are an approach to modeling multilevel networks that acknowledges the interdependence of network ties both within and across levels (Wang et al., 2013). MERGMs treat the empirical or observed networks as

dependent variables, and tests how various network building blocks can explain the observed network (Lusher et al., 2013a). The starting point for the MERGM analysis is the assumption that network ties are random variables (Robins et al., 2007a). Based on assumptions of stochasticity, the prevalence of observed configurations is compared to their prevalence in a distribution of randomly generated networks. Regression techniques are used to consider simultaneously the effects of multiple, potentially nested building blocks (Lusher et al., 2013a; Wang et al., 2016).

Multilevel networks and MERGMs have recently been extended to construct and model social-ecological networks (Bodin et al., 2014; Bodin and Tengö, 2012; Guerrero et al., 2015a; Kininmonth et al., 2015). Multilevel social-ecological networks are constructed using the procedures described above (i.e., following Bodin and Tengö 2012), where the social network consists of one level, the ecological network another level, and the social-ecological interactions are considered the cross-level linkages. These social-ecological networks can then be analyzed using MERGMs to examine the propensity of multiple social-ecological building blocks for producing the observed network.

Table 21. Focal social-ecological network processes.

Description	Building block	Code
Governance challenge 1: Engaging diverse actors		
Collaboration between state (e.g., government agencies) and non-state (e.g., fishers' cooperatives) actors to draw on their distinct forms of knowledge (Bodin et al., 2016b; Guerrero et al., 2015b).		MA1
Collaboration between actors with knowledge of, and interests in the terrestrial and coastal-marine ecosystems to draw on their distinct forms of knowledge (Álvarez-Romero et al., 2015).		MA2
Governance challenge 2: Coordinating management of ecological resources		
Collaboration and coordination between actors with management authority or interests in a shared ecological entity increases capacities to sustainably manage that entity (Bodin et al., 2016a, 2014; Guerrero et al., 2015b; Kininmonth et al., 2015). Both the simple (CM1) and alternating form (CM2) are used (Wang et al., 2016).		CM1
		CM2
Governance challenge 3: Ability to address biogeochemical and ecological interactions		
Collaboration and coordination between actors who have management authority or interests in interconnected ecological entities increases capacities to sustainably manage these entities (Bodin et al., 2016a, 2014; Guerrero et al., 2015b; Kininmonth et al., 2015). Both the simple (BI1) and alternating form (BI2) are used (Wang et al., 2016)		BI1
		BI2

Legend: Red nodes are governance actors and green nodes are ecological entities. ST = State Actor; NS = Non-state Actor; L = Land-interested Actor; S = Sea-interested Actor.

The building blocks embodying social-ecological fit were focal parameters in our models (Table 21). Additionally, we included a number of control parameters related to general social-ecological network processes (Appendix D, Table D2). These control parameters include process related to popularity and closure in the governance network, but the alignment of actor roles in relation to cross-level interactions. Our approach allows us to account for the effects of the control parameters in our estimates for the building blocks related to social-ecological fit. The building blocks representing social-ecological fit were deemed to be significant if their estimates were twice the standard error (Lusher et al., 2013a). We kept both the ecological network and the interactions between social and ecological networks fixed in the models, since we were more concerned about how governance actors organize their interactions in relation to these other levels and interactions. We used the software MPNet for our analysis (Wang et al., 2014).

Section 5.4. Results

The social-ecological networks in both the coastal case studies from Dominica (Figure 7) and Saint Lucia (Figure 8) demonstrate considerable collaboration and coordination between governance actors as they navigate interactions within their respective land-sea systems. These networks play a distinct role in engaging diverse actors, coordinating management, and addressing biogeochemical and ecological interactions across the land-sea interface. These roles are each discussed below and summarized in Table 22.

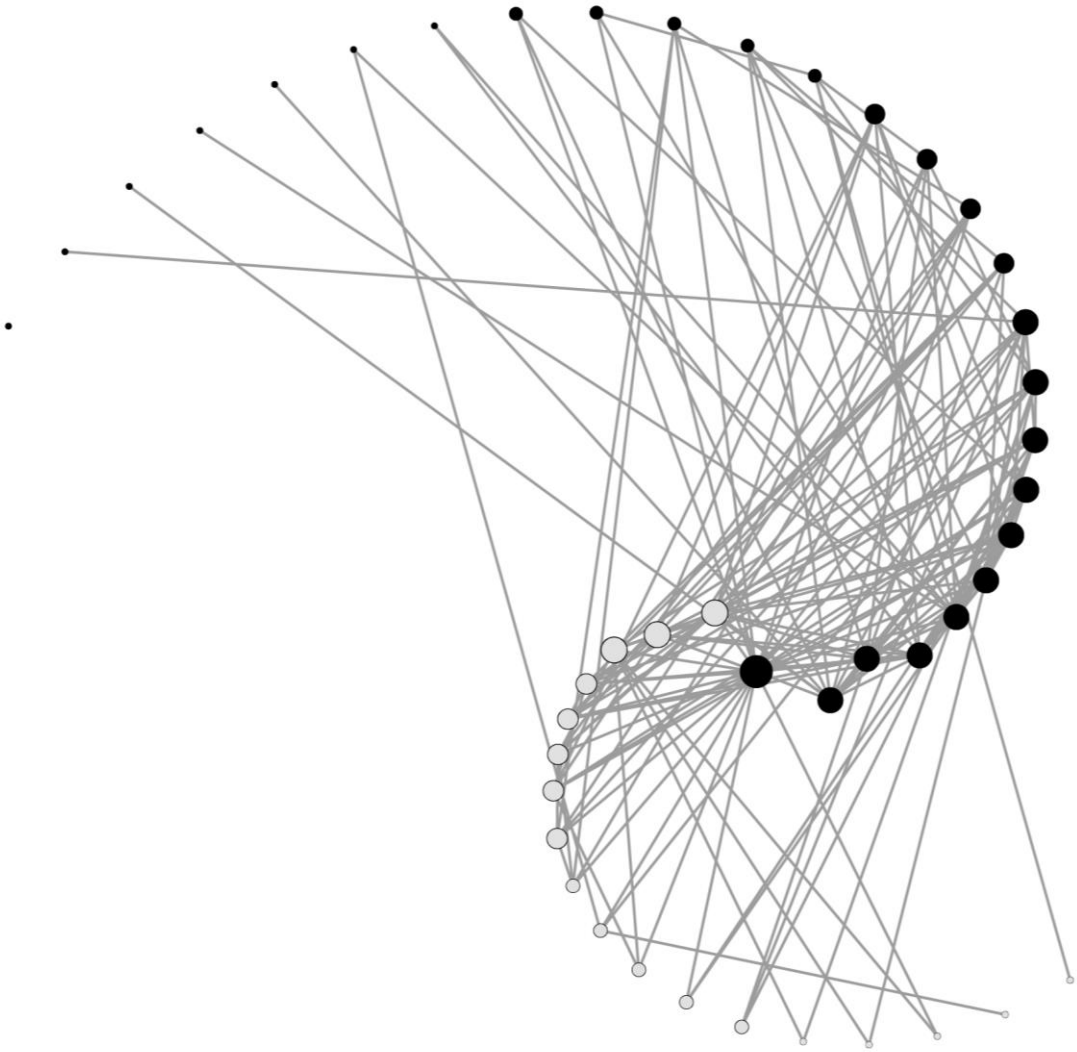


Figure 7. Governance network for the southwest coast of Dominica.
Black nodes represent national-level actors, and grey nodes represent community-level actors.
For full social-ecological network, please see Appendix D, Figure D5.

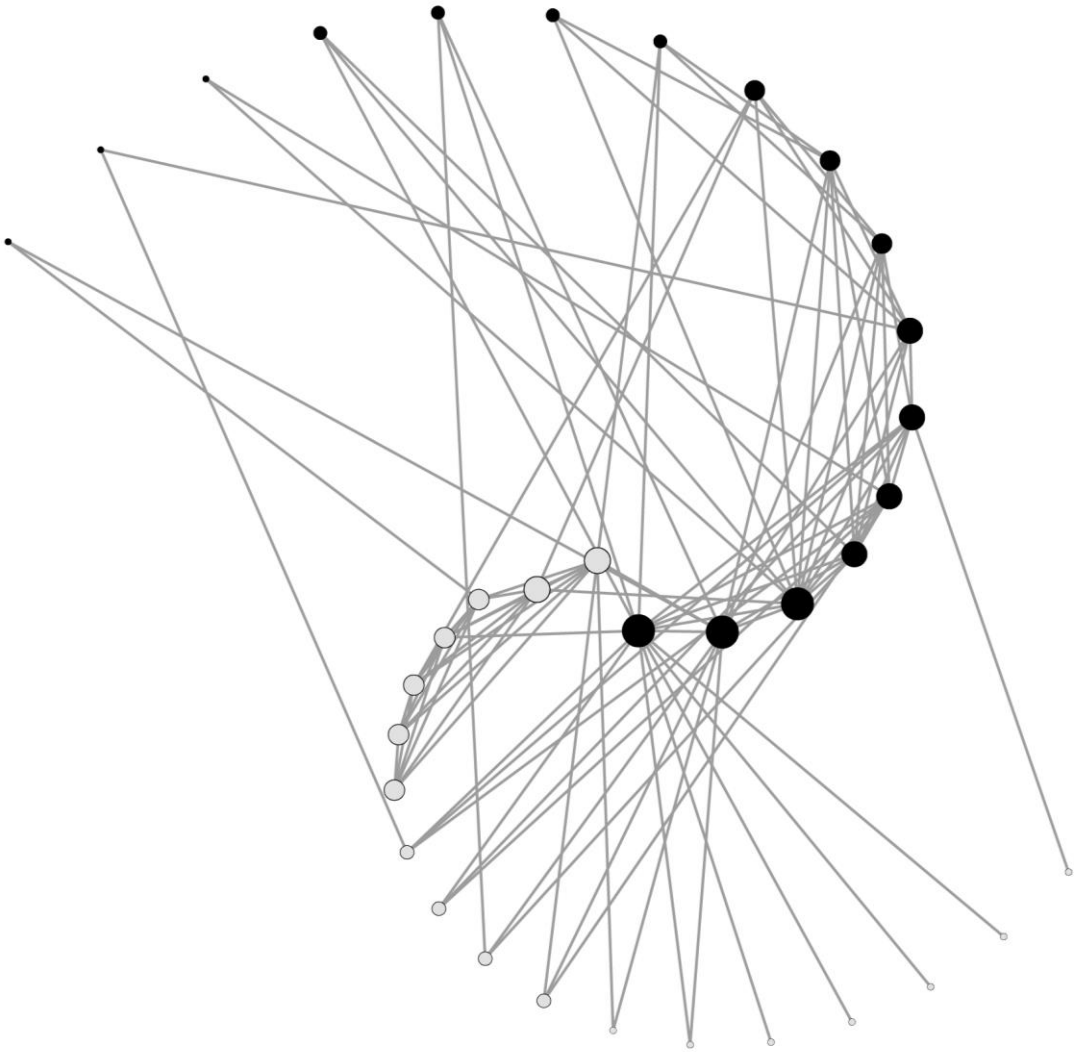


Figure 8. Governance network for the southeast coast of Saint Lucia.
Black nodes represent national-level actors, and grey nodes represent community-level actors.
For full social-ecological network, please see Appendix D, Figure D6.

Table 22. The main findings related to land-sea governance themes.

Theme	Southwest coast, Dominica	Southeast coast, Saint Lucia
Engaging diverse actors	Participatory governance is emerging in the case from Dominica; however, governance is not yet centred around participation.	There are examples of participatory governance; however, state and non-state collaboration is still rare.
Coordinating management	There is a high capacity for coordinated management, which reflects efforts of both state agencies and non-state actors.	Coordinated management is recognized as important, and some capacity exists to undertake it. However, governance has not yet centred around coordinated management and existing capacities could be augmented by developing networks.
Addressing interactions	There are capacities for addressing interactions; however, these are mostly focused within, as opposed to across marine and terrestrial systems. There is evidence of self-organized partnerships as well as hierarchical institutional arrangements to address land-sea interactions.	Similar capacities and hierarchical institutions exist for addressing land-sea interactions. The constraints on network governance imposed by hierarchies are more apparent in the case from Saint Lucia.

Section 5.4.1. Engaging diverse actors

The governance networks in both contexts contain a wide range of different actors extending beyond the state (Figure 7 and Figure 8). For example, the governance network in Dominica includes fishers' cooperatives and community-based groups (e.g., NFC), private dive shops (e.g., AnchDive) and divers' associations (e.g., DWA), and other environmental non-governmental organizations (e.g., DOMSETCO). The governance network in the case from Saint Lucia contains a similar mix of actors; however, there is a greater presence of farmers' organizations (e.g., TFTO) and less presence of the diving industry in Saint Lucian case, which reflects the

socioeconomic differences between the case studies. Non-state actors in both cases are organized both at the community- and national-levels, which means there are community-based organizations or individual businesses who then come together to form national-level umbrella organizations (e.g., NFTO in Saint Lucia) or associations (e.g., DWA in Dominica). Actors typically maintain autonomy at both levels, which means that community-based actors are free to operate independently of their national-level counterparts, and vice versa. The Saint Lucian network also contains a collaborative partnership at the watershed-level – the Trust for the Management of Rivers (TMR) – which was established as part of the regionally-focused Integrated Watershed and Coastal Areas Management (IWCAM) project. The TMR is an experiment with participatory watershed management in the Lesser Antilles, and the organization has been able to persist and stay active beyond the timeframe of the IWCAM project. It provides a collaborative platform for integrating land-sea management by engaging with, or having representation from actors with interests or management authority on both sides of the land-sea interface.

Despite the presence of diverse actors in the governance network, collaboration between state and non-state actors is significantly underrepresented in the Saint Lucian case based on the MERGM results (Table 23; MA1 is significant and negative). The same underrepresentation is not apparent in the case from Dominica, although overrepresentation is also not apparent. Participatory governance, as represented by state and non-state collaboration and coordination, is an ongoing challenge in the Caribbean in general (Scobie, 2016), and these challenges are replicated in both case studies. However, Dominica is typically perceived as having a slightly more participatory system than other Small Island Developing States (SIDS) in the Caribbean – which is supported by the MERGM results as well as interview respondents.

> *"Dominica has, based on our interactions with the islands, probably one of the strongest community engagement frameworks. We have had activities in Dominica where we've had very strong community involvement and community participation." REG0053*

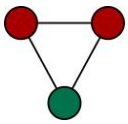
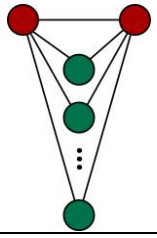
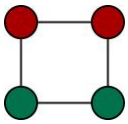
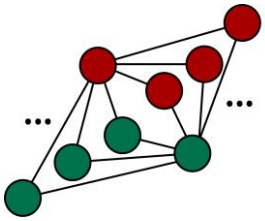
> *"In terms of the governance process, generally we have a top-down governance system. So, the [state agency] assesses the requirements [following] the government's protocol, which establishes the rules and regulations, and asks the communities to comply with those principles and protocols. We [state agency] are seeing that as not very effective, and we [state agency] are trying to change protocols to get stakeholders more involved in the governance activities." DOM0052*

The MERGM results do not show any significant network processes related to collaboration between land- and sea-focused actors in the Saint Lucian case (Table 23; MA2 not significant). In the case from Dominica, collaboration between land- and sea-focused actors is significantly underrepresented (Table 23, MA2 negative). These results suggest that the governance networks do not significantly exhibit land-sea collaboration; although the situation is somewhat better in the Saint Lucian case. There are examples of land-sea collaboration in both cases but not enough to suggest the governance networks are geared for land-sea collaboration. Respondents from Saint Lucia demonstrate how collaboration exists, but is still probably insufficient.

> *"So, you would not only have [at meetings] the marine-based organizations, but also the ones that are responsible for the land aspect. Because what we've recognized is a lot of the impacts on the marine environment result from land-based sources." StLu0041*

> *"[Governance effectiveness] comes under question sometimes, but I mean, in terms of being inclusive and that sort of thing there is at least some capacity there, right? But when it comes to dealing with some of the land-based stuff there's kind of this disconnect between what's happening on land and what's happening in the ocean." StLu0054*

Table 23. Significant relationships based on the MERGMs.

Building block	Southeast coast, Saint Lucia	Southwest coast, Dominica
Engaging diverse actors		
MA1 	Negative	
MA2 		Negative
Coordinating management		
CM1 		Positive
CM2 		
Addressing interactions		
BI1 		
BI2 	Positive	Positive

Note: For complete estimates see Appendix D, Table D3.
Legend: Red nodes are governance actors and green nodes are ecological entities. ST = State Actor; NS = Non-state Actor; L = Land-interested Actor; S = Sea-interested Actor.

Section 5.4.2. Coordinated management of ecological entities

The coordinated management of ecological entities was recognized as extremely important in both case studies, so much so that this importance has even been captured in a common saying in Saint Lucia:

> *"It's again a dual purpose. There is a Kwéyòl saying. Saying it in English never sounds right. It means that when you have a cow and there are various owners, sometimes that cow can die by the end of the day. Because I am expecting you to check it out, and you are expecting my brother to check it out, and nobody does and the cow dies. Sometimes they say, 'A cow with more than one owner can die at the rope'." StLu0053*

This saying was brought up in the context of a discussion around mangrove management in Saint Lucia, and it reflects how mangroves fall under the jurisdiction of multiple state agencies (e.g., Fisheries Department, Forestry Department) and there are multiple groups with interests in mangroves (e.g., fishers, farmers, beekeepers, tour guides). Yet, despite the multiple responsibilities and interests, mangroves have historically been at risk of being destroyed in Saint Lucia (FAO, 2005), and limited coordination has been flagged as an underlying issue (Government of Saint Lucia, 2009).

The recognized importance of coordinated management in the Saint Lucian case, yet the potential limits on network-based capacity to achieve it are also supported by the MERGM results (Table 23). These results do not suggest a significant lack of capacity for coordinated management of ecological entities in Saint Lucia; however, they also do not suggest an abundance of capacity (i.e., CM1 and CM2 are both not significant). The limits to capacity for coordinated (or integrated) management in Saint Lucia could be related to the transaction costs, as demonstrated by the following respondents:

> *"The main costs that are now an obstacle is in a sense, they're personnel – it's human resources. Because integration is largely facilitation, and it's not much hardware – it's not infrastructure, it's not doing new things; it's doing things differently in a coordinated way. So, it's largely people and their ability to convene and to bring people together, so that's the most important. An integrated approach is not costly, except that it is costly when you have a government that doesn't have resources." – StLu0001*

> *"Now us [state agency] being so caught up in our work, what it normally does, is it restricts our influence and our interaction into the whole aspect of land based planning." StLu0030*

The case from Dominica demonstrates an alternative model for coordinated management, where self-organized coordination outside of, but facilitated by the state has played a considerable role in addition to government-led coordination. The MERGM results suggest that coordinated management in the case from Dominica occurs to a significant degree (CM1 significant and positive). These results capture both the coordination of government agencies amongst themselves, but also the coordination of non-state actors with shared interests in particular types of resources. For example, there is a high degree of coordination within the diving industry focused on coastal-marine resource (e.g., coral reefs, seagrass) sustainability. It is common for dive shops to collectively address various problems (e.g., lionfish invasion, marine litter). The Dominica Watersports Association (DWA) provides the formal, collaborative platform for addressing shared risks; although, certain dive shops will also collaborate directly, if the need arises. Additionally, the Local Area Management Authority (LAMA) for the Soufriere-Scott's Head Marine Reserve (SSMR) provides a multi-sectoral platform for coordination of community-based actors. As part of LAMA, the DWA and various dive shops can also coordinate with other organizations, such as the Saint Mark's Fisherfolk and Tourism Cooperative, on issues related to coastal-marine and terrestrial sustainability. These networked arrangements have provided significant capacity for coordinated management in the case from Dominica, and their self-organized nature contrasts slightly with the approach in the Saint Lucian case.

Section 5.4.3. Biogeochemical and ecological interactions

Coordinated management of shared resources is important. Yet in the context of land-sea interactions an additional challenge is governing at scales able to encompass biogeochemical and ecological interactions among resource units. This challenge usually requires extending

governance networks beyond coordinated management of shared resources to coordinated management of interconnected resources (Bodin et al., 2014). The MERGM results suggest that both case studies exhibit capacity to address biogeochemical and ecological interactions (Table 23; BI2 significant and positive). However, when taken in conjunction with the lack of significant land-sea collaboration (MA2) and interview results, the MERGM results suggest that this capacity is likely more focused on addressing interactions within terrestrial and marine systems as opposed to between them.

There are examples where actors have intentionally pursued collaboration across the land-sea interface to deal with biogeochemical and ecological interactions (Figure 7 and Figure 8). In the case from Dominica, a local dive shop has formed a partnership with a local quarry operator to monitor the health and status of the marine environment in areas potentially impacted by the quarry operator's activities. The development of this arrangement was completely self-organized and not based on any form of intervention from higher levels. The partnership was struck when the local dive shop owner became concerned about possible impacts from the quarry. The two actors met and developed a formal partnership, where the quarry funds the divers to participate in Reef Check monitoring in potentially sensitive coastal-marine areas. Additionally, the quarry operator has implemented a number of practices (e.g., settling ponds) to reduce potentially damaging sedimentation and runoff. The success of this initiative has been noted by other dive shops, who have endeavoured to create similar partnerships with other quarry operators. However, additional partnerships have yet to take root, as they are faced with multiple challenges (e.g., lack of political salience). Despite the challenges, these findings suggest that self-organized approaches to land-sea integration can emerge, they just take time to scale-out from their original point of conception.

The interviews also suggest the importance of institutional context, in addition to network governance, for dealing with negative biogeochemical interactions across the land-sea interface in the case study sites. Interview participants in both case studies highlighted the role of hierarchical, nested institutional arrangements – from international to community levels – in reducing agricultural impacts to coastal environments. These arrangements influence the export-oriented, commercial agricultural sectors, which are mostly focused on bananas in both cases and, additionally, citrus in the case from Dominica. Both case studies relied heavily on agricultural exports and suffered significant hardships following changes in international trade policies during the 1990s, which limited their abilities to access export markets. The fair trade system was put in place, and quickly took hold in the Lesser Antilles as a means to provide comparative advantage and maintain market connections, especially with the United Kingdom (UK). The fair trade certification comes with multiple prescriptions for sustainable agricultural practices, many of which reduce the potentially negative impacts of farming on coastal environments (e.g., reduced use of agrochemicals, maintenance of buffer zones). Adherence to these prescriptions is carefully monitored and enforced by authorities, and failure to adhere comes with significant penalty.

> *"Since we are under the fair trade logo, we have to sell fruits that use as little chemicals as possible. Every year, the guys from the market, they come down, and select five of farmers randomly. We have no idea who they will choose. So, if he is not prepared, everybody has to help that farmer, because if that farmer fails, he is not going to sell [bananas] again." StLu0034*
>
> *"The farmer's farm must be at least 10 feet away from rivers or the beach. He must have a buffer zone, and on the farm, he must have a chemical disposal pit." StLu0034*
>
> *"From the point of view of agriculture itself, we are very concerned about the environment for obvious reasons, but more so, there's been a lot of external pressures, which have been introduced by way of standards in production – which in themselves lead to safeguarding the environment. But I think by far and large as a country, our farmers and our people have been very conscious of the impact of things like pesticides and so on, and have resisted them to a large extent." DOM0004*

Although reducing the potential for negative biogeochemical interactions between terrestrial and marine environments, the fair trade policies and standards are still largely enforced from the outside and, to some degree, they disempower farmers and can create hardships.

> *"I believe that the farmers are frustrated. They are not making money and all the time there are different rules over them. [For example] they will say, 'Look, we don't want that, we want this', and the suspension! When you're suspended for things that are out of your control, beyond your control, you are suspended and then you have to sell a product where you make no money. I have been selling bananas, and at times when you recognize that for a suspended farmer, the money that they spend to grow the bananas, they don't get it back. It's very awful!" StLu0018*

Klak et al. (2011) have argued that the current fair trade rule system fosters negative power relationships, which lead to insecure livelihoods for producers and possible issues with legitimacy and compliance. These issues are also reflected in our observed governance networks (Figure 7 and Figure 8). Although present in the Saint Lucian case, the local and national fair trade organizations (FTOs) were not effectively participating in the governance networks. They did not collaborate to a significant degree, especially beyond the agricultural sector. Network governance is possibly constrained in these cases by imposed rules, which have not led to the creation and empowerment of local organizations in the agricultural sector. These rules have definite benefits in reducing negative agricultural impacts to coastal environments (e.g., increased erosion and sedimentation, agrochemical pollution). Yet, similarly, their benefits are possibly constrained due to their purposive design as an external influence on producers' actions.

Section 5.5. Discussion

We examined how network governance influences social-ecological fit in two case studies of land-sea systems: the southwest coast of Dominica and the southeast coast of Saint Lucia. We found that network governance could help engage diverse actors, but existing networks are

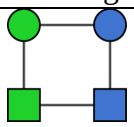
constrained by the general lack of reliance on participatory governance apparent across the Caribbean region (Scobie, 2016). The situation is somewhat better in the case from Dominica where there has been a concerted effort to improve participation and erode the barriers imposed by top-down hierarchies. However, neither case study exhibits a clear shift in their respective governance networks towards participation and the ability to engage diverse actors and knowledge when making decisions regarding land-sea systems.

Network governance also contributed to the coordinated management of shared resources in both case studies. However, this contribution was much clearer in the case from Dominica, where both state and non-state actors have self-organized to coordinate management. In the Saint Lucian case, much of the burden for coordination has been placed on the state, which presents numerous challenges (e.g., lack of funding) for making a clear shift in the governance networks towards coordination. The transaction costs of coordination across the land-sea interface may simply be too high in relation to other priorities for the state. In the case from Dominica, transaction cost issues have been dealt with in a self-organized manner, where non-state actors have come together autonomously to coordinate their interests in coastal-marine resources. These actors are not as inhibited by budgetary and bureaucratic constraints, and they perceive a direct benefit related to coordinated management (e.g., sustainability of the resources they rely on for their livelihoods). These findings are in line with commonly held notions that network governance can reduce transaction costs (Klijn and Koppenjan, 2012); however, our analysis highlights the importance of autonomous networks outside the state for reducing these costs. Transaction costs may impede the over-participation of the state in network governance.

Coordinated management of interconnected resources to address biogeochemical and ecological interactions is a greater challenge than coordinated management of shared resources based on

experience in the case studies. Capacity exists, in both cases, to address such interactions; however, the majority of capacities are focused on interaction within, as opposed to across marine and terrestrial systems. Again, the case from Dominica shows some promising examples of self-organized collaboration in the face of land-sea interactions, and experiments with participatory coastal watershed governance in the Saint Lucian case demonstrate promise as well. These examples support an emerging governance network design proposition regarding the specific role of land-sea collaboration or integration in the face of interconnected land-sea resources (Table 24). The challenge remains finding ways of scaling out such collaborative examples and fostering their persistence. Existing nested institutional arrangements help address negative biogeochemical interactions, especially as they relate to the agricultural sector, but they also constrain the emergence of empowered and autonomous local actors that are able to participate in governance networks for addressing land-sea interactions.

Table 24. Governance network design proposition to address land-sea interactions.

Proposed benefits	Building block
Collaboration and coordination between actors who have management authority or interests in interconnected ecological entities across the land-sea interface increases capacities to sustainably manage these entities Both the simple and alternating form are potentially beneficial.	

Our research presents two policy implications related to overcoming constraints on network governance for addressing problems in land-sea systems. First, there is the need to balance the interplay between different co-existing modes of governance. Traditionally, top-down forms of governance have been used to address certain land-sea interactions (e.g., agricultural runoff). Although not without their successes, they have served, in some cases, to disempower local resource users and create contexts where local collectives and organizations are not able to participate autonomously in governance networks (Klak et al., 2011) – thus paralyzing, in some ways, the emergence of network governance. These arrangements also suffer from decreasing legitimacy, as apparent in our interviews as well as other research (Klak et al., 2011). Much discussion to date has centered around the agriculture sector in this regard, yet these insights are equally relevant to the current development challenges facing coastal areas across the Caribbean region. The ongoing, and almost uncontrolled, conversion of many near-coast agricultural and forested lands into peri-urban residential areas warrants attention (Walters, 2016). Currently,

only a select few state agencies are empowered to control such development (e.g., physical planning divisions). Our interviews suggest that these agencies often lack the capacity to monitor and enforce all current developments, and rule-systems are not adequate to prevent attempts at evading the rules, which leads to issues with runoff and sedimentation affecting coastal areas. A potentially more balanced approach to address these issues could involve improved collaboration with local town and constituency councils, who could – with support from state agencies – coordinate other resource users within their jurisdictions to identify development priorities and help monitor their effective implementation.

A second, related insight addresses the potential to leverage existing, network-based capacities to improve network governance. Both cases exhibited limitations in current network structures for fostering collaboration between state and non-state actors and between land- and sea-focused actors. In both cases, the MERGM results suggested that control variables representing triadic closure, or the propensity for ties to form between collaborators who share a collaborator (Lusher et al., 2013b), were significantly driving the existing, observed network (see Appendix D, Supplementary Material). These existing processes could possibly be used to address the identified deficiencies in network structure noted above. Additionally, the interviews suggest certain capacities for self-organization in the case from Dominica, particularly in the diving sector. The divers' self-organization has been supported by state agencies – sometimes through formal partnerships or resource sharing and other times by not constraining the divers' actions. This approach is perhaps instructive to other stakeholders representing different sectors or to other islands as a means of fostering more participation-focused governance networks.

Finally, our work highlights two important questions: How much networking is enough to foster social-ecological fit across the land-sea interface? And how does beneficial network governance

emerge? Our work suggests that governance networks and networking processes are necessary to enhance social-ecological fit, but not always sufficient. There is still the need to consider – specifically in the context of social-ecological fit – nested institutional arrangements and how different types of interventions constrain or facilitate network development (Klijn and Koppenjan, 2012). We have focused on examining network governance in contexts where hierarchies are the dominant mode of governance. More work is required to understand how network governance emerges in such contexts and how networked modes of governance can co-exist with other modes (Kooiman, 2008; Pahl-Wostl, 2015).

Section 5.6. Conclusions

We examined how network governance affects social-ecological fit across the land-sea interface in two case studies from the Lesser Antilles: the southeast coast of Saint Lucia and the southwest coast of Dominica. Our results suggest that social-ecological fit across the land-sea interface remains somewhat elusive in existing network governance arrangements. Yet there is evidence to suggest that network governance has improved social-ecological fit in both cases. Each case study exhibits different approaches aimed at achieving fit. In particular, network governance has contributed to coordinating management of shared and interconnected resources or ecological entities. However, improved network governance is required to (1) better engage knowledge from diverse actors in decision making; and (2) address biogeochemical and ecological interactions across, and not just within marine and terrestrial systems. Strategic use of network processes could help improve social-ecological fit by fostering improved collaborations with diverse groups. Additionally, our research highlights the need to better understand the conditions that foster network governance in support of social-ecological fit across the land-sea interface. In

particular, more research is required to examine how network governance for social-ecological fit emerges in contexts where hierarchical modes of governance currently dominate.

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Chapter 6. Transforming governance to address land-sea interactions in the Lesser Antilles

Section 6.1. Chapter summary

Human activities on land have negative consequences for coastal-marine systems in the Lesser Antilles. Efforts to address these consequences effectively are constrained by existing hierarchical and fragmented governance systems. Network governance may help to address land-sea interactions in the region by promoting improved co-governance and land-sea integration. However, the conditions for and processes of transformations towards network governance in the region are poorly understood. We examine the conditions for and the processes of transformation in four embedded case studies from the Lesser Antilles: Antigua and Barbuda (focus on Antigua), Saint Kitts and Nevis (focus on Saint Kitts), Saint Vincent and the Grenadines (focus on Saint Vincent), and Grenada. We find evidence that governance is currently in transition towards a more networked mode within all the embedded cases. Our results suggest that participation in collaborative projects (e.g., Integrated Watershed and Coastal Areas Management [IWCAM]) has played an important role in initiating transitions. Additionally, multilateral agreements (e.g., the LBS Protocol), boundary-spanning organizations, and experience with extreme events (e.g., tropical storms) provide enabling conditions for network governance. Successfully navigating the ongoing transitions towards improved network governance will require (1) facilitating the leadership of central actors and core teams in steering towards network governance, and (2) finding ways to appropriately engage the latent capacity of communities and non-state actors in governance networks.

Section 6.2. Introduction

Land-sea interactions present significant challenges for governance, which we define here as the processes and institutions through which societies make decisions that affect the environment (Oakerson, 1992). Humans have a detrimental effect on coastal-marine ecosystems due to their land-based activities (Bégin et al., 2016; Halpern et al., 2009; Lamb et al., 2016), yet governance systems are often inappropriately structured to mitigate or reverse these effects (Pittman and Armitage, 2016; Chapter 4). Governance is typically fragmented across the land-sea divide, meaning that terrestrial systems are governed separately from coastal-marine systems (Crowder et al., 2006). This separation produces a context where stressors originating in one system, but having negative consequences for the other, are difficult to manage (Cárcamo et al., 2013; Cárcamo and Gaymer, 2013). The result is a tendency towards unfavourable land use, inappropriate waste management, and ineffective containment of pollutants, whose cumulative effects can undermine coastal-marine sustainability (Halpern et al., 2009). These effects are increasingly problematic in the context of other stressors to coastal-marine environments, such as overfishing, and additional cross-cutting threats, such as climate change-induced changes to precipitation regimes and extreme events (Álvarez-Romero et al., 2011). The sustainability of coastal-marine systems is inherently linked to human activities on the land, and in many cases a change in governance is required to effectively curb these activities (Glavovic et al., 2015).

The Lesser Antilles is one context where governance reforms to better address land-sea interactions are currently unfolding at multiple levels. Network governance, or a decentralized and self-organized mode of governance where multiple state and non-state actors collaborate and coordinate in the face of shared challenges (Ansell and Gash, 2008; Klijn and Koppenjan, 2012; Newig et al., 2010), has demonstrated benefits to address land-sea interactions in the region

(Chapter 4 and Chapter 5). However, the conditions for, and processes through which network governance emerge are poorly understood. We examine a number of embedded case studies from the Lesser Antilles and ask three main questions: (1) what conditions have helped foster network governance? (2) to what extent has network governance emerged in light of these conditions, and (3) what conditions appear to be playing the most significant role within the region?

The emergence of network governance is signalled by two main changes in governance systems. The first relates to the appearance of collaborative governance or co-governance between state (i.e., government agencies) and non-state (e.g., NGOs, resource users' associations and cooperatives) actors. Currently, hierarchical forms of governance are the main mode through which governance occurs in the Lesser Antilles and the Caribbean in general (Scobie, 2016). In theory, improved co-governance would help support flexibility in the face of change and promote inclusiveness and legitimacy (Carlsson and Sandström, 2008; Gupta et al., 2010; Jentoft, 2007; Scholtens and Bavinck, 2013). Second, land-sea integration – or collaboration and coordination between actors with interests in the land and sea – is an important component of network governance to address land-sea interactions (Chapter 4). Collaborative networks among actors with interests in, or jurisdiction over diverse elements of land-sea systems is one possible means of reducing governance fragmentation across the land-sea interface (Chapter 4).

Our paper begins with an overview of the conceptual framework guiding the research. Next, we describe the current context for governance in the Lesser Antilles with a focus on our embedded cases. We then discuss our methods and draw attention to both the qualitative and quantitative processes and features of network governance in the region. Key results point to the importance of multilateral agreements, project participation, boundary-spanning organizations, and experience with extreme events in facilitating transformations towards network governance.

However, in most cases this transformation has not yet fully occurred and governance is currently in transition. Finally, we show that coordinated steering by a core team of governance actors and improved engagement with communities can help navigate the transition to improved network governance for addressing land-sea interactions. Our results contribute to an emerging body of scholarship regarding the process of governance transformation, and offers specific guidance on conditions and processes for better governance outcomes at the land-sea interface.

Section 6.3. Conceptual framework

We aim to examine the emergence of network governance within largely sector-based, hierarchical governance systems. We draw on both network governance theory and the concept of governance transformation in our analysis. Network governance theory highlights four key concepts. First, actors are central to network governance (Klijn and Koppenjan, 2012). Networks emerge and evolve based on the interdependencies of actors and how these actors interpret problems (i.e., their frames) (Klijn and Koppenjan, 2012). Second, complex interactions and relationships – emerging partially based on actors' interdependencies and frames – affect outcomes from networks and provide a malleable, yet firm social structure from which to advance various objectives and priorities (Henry and Vollan, 2014). Third, patterns of interactions over time are both influenced by, and lead to, the emergence of institutions and rules (Klijn and Koppenjan, 2012). Two-way feedbacks between institutions and networks mean that institutions influence network structure, but actors' interactions within a network can also influence institutions (Moore and Westley, 2011). Finally, networks are guided or managed by the strategic interventions of actors both within or outside of the networks in question (Klijn and Koppenjan, 2012). These interventions have both intended and unintended consequences, and we are not suggesting that governance networks are controllable. Rather, we note that actors can

endeavour to facilitate and organize (or not) network interactions based on their objectives (Klijn and Koppenjan, 2012).

Governance networks – the units of analysis in network governance studies – can be conceptualized as complex adaptive systems (Angst and Hirschi, 2016; Booher and Innes, 2010; Lubell, 2013). They are dynamic and continually changing as actors make new connections, take new roles, dissolve partnerships, etc. The dynamics of governance networks are often centered around different, emergent states of the governance system, and multiple states are possible for the same system (Lubell, 2015, 2013; Lubell et al., 2014). The existing state of a governance system results from a myriad of factors, including complex network processes (e.g., emergence, self-organization) but also purposeful design (Pahl-Wostl and Knieper, 2014). Changes in a governance system's state originate in a suite of internal (endogenous) and external (exogenous) drivers (Considine, 2013; Smith et al., 2005). Endogenous drivers occur within the governance system itself and include regulatory reform, partnership formation, collaboration on shared projects, and the alignment or misalignment of objectives. Exogenous drivers include contextual factors, such as embeddedness within, or influence from other levels in a multilevel governance framework. Exogenous drivers can also include pressures originating in the broader social-ecological system, but outside the governance system (Kooiman, 2008).

The concept of governance transformation is useful for understanding the dynamics of complex governance systems (Gelcich et al., 2010). Armitage et al. (in press) define governance transformations as "fundamental shifts to the processes and institutions through which societies make decisions about coastal commons". Governance transformations are thought to occur through three stages: (1) an initial stage focused on preparing for governance transformation; (2) a second stage where the governance system is in transition between states; and (3) a final stage

where the focus is on building the resilience of the desirable state (Chapin et al., 2010; Gelcich et al., 2010; Olsson et al., 2004). During the preparatory phase, the governance systems remains in its initial state, yet there are strategies or actions being undertaken that have the potential to initiate a transformation (Cinner et al., 2012; Olsson et al., 2008). In some cases, preparatory phases last until windows of opportunity emerge for fundamental shifts in the system (Gelcich et al., 2010). In other cases, fundamental change emerges more gradually over time and results from the cumulative effects of multiple incremental changes (Andrachuk and Armitage, 2015). Once a transformation has been initiated, the governance system passes through a transitional state (Chapin et al., 2010). Transitional states are characterized by high uncertainty, and the outcomes of transitions are unpredictable (Olsson et al., 2006). Following a transition, the governance system may establish stability in a new state, which – if the original intentions have been met – is often characterized as the desirable state of the system (Chapin et al., 2010; Gelcich et al., 2010). However, the desirability of the new state is actor-dependent and judged in relation to the values of multiple actors within the system (Andrachuk and Armitage, 2015; Walker et al., 2010).

For our purposes we are interested in fundamental shifts towards network governance to address land-sea interactions occurring through these three phases (Figure 9). We use the emergence of co-governance and land-sea integration as indicators of the current state of the governance system with respect to navigating the phases of transformation. We characterize the initial state (i.e., hierarchical, fragmented) of the governance system as exhibiting limited co-governance and land-sea integration; the transformed state (i.e., networked, integrated) as demonstrating the emergence of co-governance and land-sea integration; and the transitional state demonstrating neither limited nor the emergence of co-governance and land-sea integration.

We use recent developments in stochastic network analysis to determine the degree to which co-governance and land-sea integration have emerged (Lusher et al., 2013a). Stochastic network analysis compares the characteristics of an observed network to those of randomly generated networks to determine whether the observed network is significantly different or not from what would be expected by chance (Lusher et al., 2013a). We characterize the initial state as situations where co-governance and land-sea integration in an observed governance network are significantly less apparent than would be expected by chance. The final state represents the opposite, where co-governance and land-sea integration have emerged in an observed network significantly more than would be expected by chance. The transitional state is characterized by co-governance and land-sea integration that are neither more or less apparent than expected by chance (i.e., essentially indistinguishable in the observed and random networks). Our conceptual framework allows for a systematic comparison of transformations towards network governance to address land-sea interactions across embedded case studies within the Lesser Antilles.

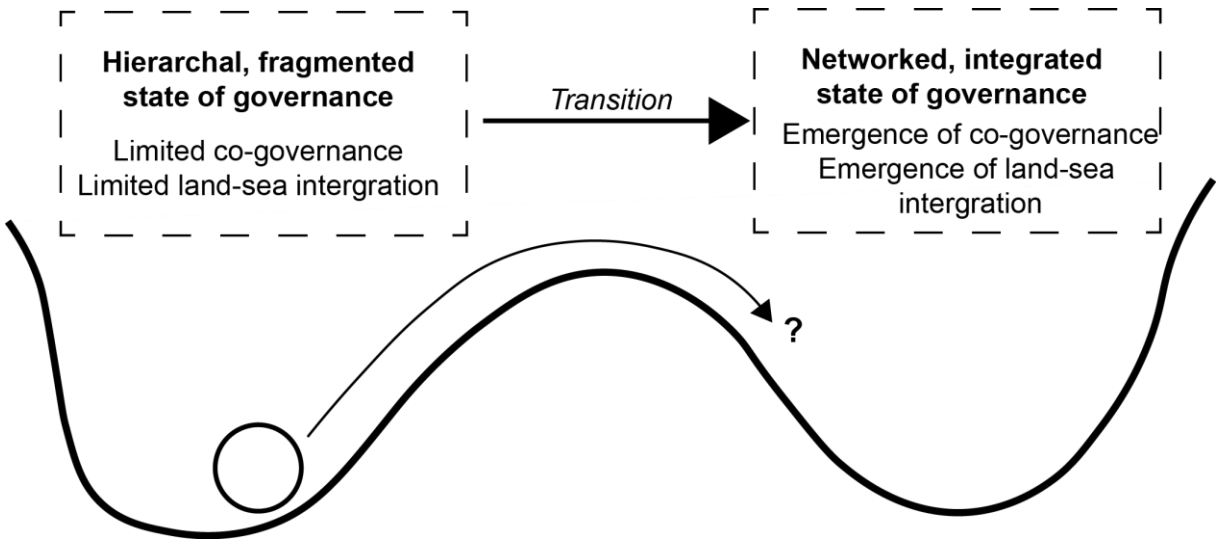


Figure 9. Conceptual model of governance system transformation.

Section 6.4. Research context and case studies

The Lesser Antilles are a group of islands on the eastern edge of the Caribbean Sea, which form the Caribbean Sea's boundary with the Atlantic Ocean (Figure 10). These small, neotropical islands are formed partially from volcanic processes and support a range of forest types, including shrub lands, semi-deciduous evergreens, and mangroves. Additionally, their surrounding coastal areas have historically contained many rich coral reefs and seagrass beds, which support coastal-marine ecosystems. The island nations are characterized as Small Island Developing States (SIDS), and have the associated sustainable development challenges (e.g., small land base, resource degradation). Their economies contain different mixtures of agriculture, tourism, and fisheries. Based on human activities on land, sedimentation and nutrient transport have become important land-sea issues for the region (Sweeney and Corbin, 2011). Additionally, dealing with sewage and other forms of pollution – both point and nonpoint source – have become increasingly challenging for these nations, which are currently struggling to control development. Climate change adds an extra burden to these systems, due to threats of sea-level rise, coastal erosion, and storms. Improved governance to respond to this suite of challenges is urgently required to support the future sustainability of these island systems.

We investigate governance transformations to address land-sea interactions through four embedded cases studies from the Lesser Antilles: Antigua and Barbuda (with a focus on Antigua); Grenada (with a focus on island of Grenada); Saint Kitts and Nevis (with a focus on Saint Kitts); and Saint Vincent and the Grenadines (with a focus on Saint Vincent). Embedded case studies were selected as sub-units of analysis within the broader case (i.e., Lesser Antilles) to capture socioeconomic and environmental diversity within the context (Table 25), and to improve representation at the case-level (Yin, 2009). The island nation was chosen as an

appropriate subunit of analysis within the case, since it is currently the level most empowered to undertake governance across the land-sea interface. The islands' boundaries largely shape and constrain governance across levels within this context. For more information on the cases, please see Section 1.2 and Appendix A.

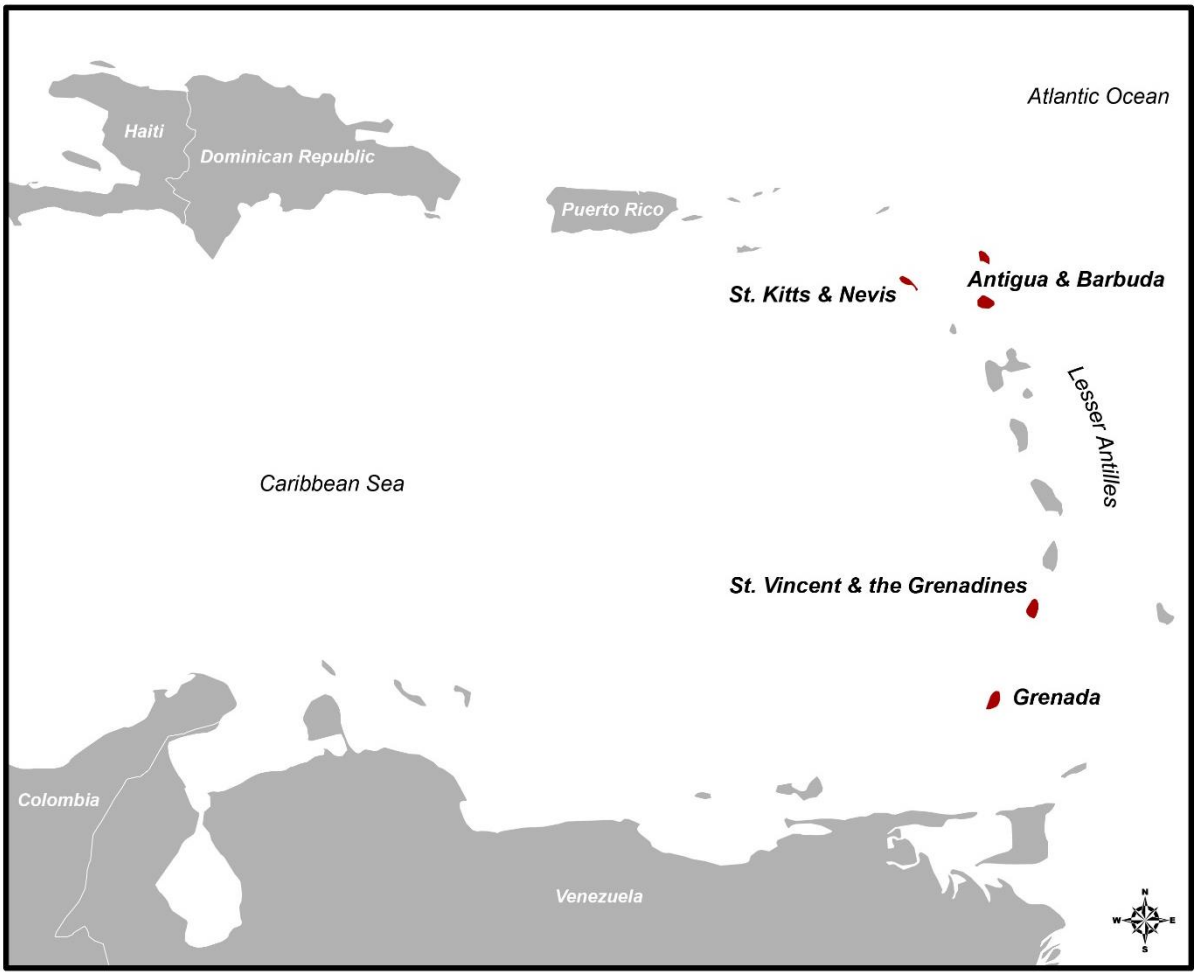


Figure 10. Map of Lesser Antilles and embedded case studies.

Table 25. Selected characteristics of the embedded case studies.

	Antigua	Grenada	St. Kitts	St. Vincent
Area (km^2)	443	347	360	345
Forest area, 2013 (%)	22	50	42	69
Area < 5 m elevation (%)	32	22	19	22
Coast line (km)	260	121	135	84
Population, 2014 (N)	90,900	106,349	54,944	109,360
Population density, 2014 (N/km2)	207	313	211	280
GDP per capita, 2014 (US $)	13,961.70	8,295.50	15,167.00	6,663.30

Source: World Bank, FAO Country Profiles

Section 6.5. Methods

Section 6.5.1. Data Collection

This study employs both qualitative and quantitative techniques to investigate governance networks and transformation within the case studies (Borrás and Olsen, 2007; Luthe and Wyss, 2016). Data were gathered through interviews conducted between July and December 2014 with purposively sampled key informants (e.g., directors, managers, program coordinators) from governance organizations relevant for addressing land-sea interactions (e.g., government agencies, resource user groups, environmental NGOs) (Hay, 2000). An initial list of relevant governance organizations in each case study was developed based on documented participation in certain meetings (e.g., workshops on land-based sources of pollution in the wider Caribbean) or involvement in topical projects (e.g., Integrated Watershed and Coastal Zone Management). From the initial list, the lead or most relevant organizations were determined and contacted. Point people from each lead organization were then consulted on the initial list of relevant organizations, and the list was revised accordingly. The revised list served as the starting point for interview contacts for each embedded case. Additional organizations were sampled if two or

more respondents noted their activity or importance in the governance network. Multiple individuals from the same organization were interviewed until individual responses converged and no new information emerged (Hay, 2000). In some cases, multiple individuals participated in the same interview (Table 26).

The research instrument was designed to capture both quantitative and qualitative data. Governance network data were gathered by asking respondents with which organizations they regularly collaborate or coordinate on issues related to land-sea interactions. A free-recall name generator technique was used, which allows respondents to identify their own network ties (Marsden, 2011). Following the identification of a network tie, the respondent was probed about the exact nature of each tie (e.g., what did collaboration entail) and various attributes of the target organization (e.g., level of governance, mandate). This approach allowed for both binary network information and rich qualitative information regarding the network to be gathered concurrently. Additional qualitative data were gathered by asking open-ended questions on key themes within the research instrument. Key themes included: (1) the evolution of the governance network; (2) important processes or factors driving this evolution; (3) the existence and nature of relevant regulations and rules (e.g., development control, agricultural input control); (4) critical roles and mandates within the governance network; (5) the main challenges related to addressing land-sea interactions; (6) past strategies used to address land-sea interactions; and (7) the effectiveness of these strategies.

Table 26. Overview of sample and the resulting governance networks.

	Antigua	St. Kitts	St. Vincent	Grenada
Interviews (n)	13	27	24	22
Participants (n)	16	28	24	27
Nodes (n)	18	23	24	36
Full information (n)	11	15	15	16
Partial information (n)	7	8	9	20
Density	0.307	0.162	0.167	0.108
Minimum degree	0	1	1	0
Mean degree	5.2	3.6	3.8	3.8
Median degree	4.5	3	3.5	1.5
Maximum degree	15	10	11	17

Section 6.5.2. Data Analysis

Qualitative Analysis

A major goal of the qualitative analysis was to identify the conditions that have helped foster network governance emergence in the embedded cases. To do this, the interviews were transcribed and coded in NVivo 10.0 software using qualitative content analysis. Qualitative content analysis is both a deductive and inductive approach to analysis, which allows for a predetermined analytical framework to be contextualized or grounded with information relevant to a particular set of case studies (e.g., Pietri et al., 2015; Pittman et al., 2015). Our approach included both deductive and inductive rounds of coding, where deductive coding was conducted first across all embedded case studies. Inductive coding followed to refine the topics noted above

and provide added detail. The analysis focused on identifying insights related to the following themes: (1) governance challenges stemming from land-sea interactions; (2) what has worked or not in the past to help address these challenges; (3) existing strengths and limitations of governance; (4) what processes advance or constrain network governance; and (5) governance changes required to better address land-sea connection.

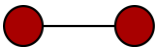
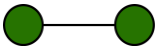
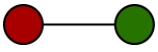
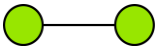
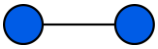
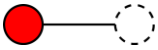
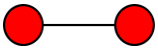
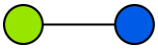
Exponential Random Graph Models

We are interested in building blocks related to the emergence of co-governance and land-sea integration, which consist of governance actors with different attributes (e.g., state, non-state, land, sea, both) and their interactions (Table 27). Exponential Random Graph Models (ERGM) were used to identify the social processes underpinning the observed governance networks. ERGMs use regression techniques to test the observed propensity of specific network building blocks relative to a distribution of randomly generated graphs (Lusher et al., 2013a). The observed network is treated as the dependent variable, and the building blocks are the independent variables. The contributions of theoretically informed and control building blocks are estimated simultaneously by comparing parameter estimates for each building block in the observed network to those in a set of simulated random graphs (Robins et al., 2007a, 2007b; Snijders, 2002). The models converge when all t-scores for building blocks included in the model were less than 0.1, and the goodness of fit of the converged model was tested by ensuring key properties of the network (e.g., degree distribution) were not statistically different (t-score less than 2) between the modeled and observed network (Lusher et al., 2013a). However, one particular limitation of ERGMs is the potential challenges in reaching model convergence, which means it can be difficult to develop a model that produces reliable results when certain building blocks are included (Bodin et al., 2016b; McAllister et al., 2015). We dealt with convergence

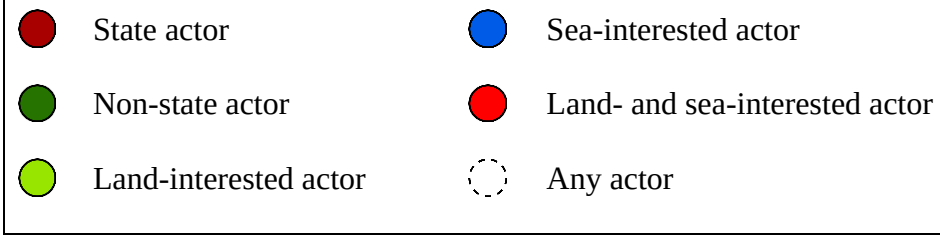
issues by removing from the models the building blocks creating the convergence problems – an approach which has been applied elsewhere (Bodin et al., 2016b; Guerrero et al., 2015b). Although, this problem only arose in one of our case studies (i.e., Grenada).

Parameter estimates that are twice their standard error are considered significant, and the sign of the estimate represents whether or not the building block in question is more or less prevalent in the observed network than expected by chance (i.e., positive sign means more represented and negative sign means less) (Lusher et al., 2013a). For co-governance, the network building blocks represent interactions among state actors (CG1), among non-state actors (CG2), and between state and non-state actors (CG3). These three building blocks encompass the range of interactions expected under co-governance. For land-sea integration, the network building blocks represent interactions among actors with interests in land (LS1), among actors with interests in the sea (LS2), between land- and sea-focused actors (LS5 and LS6), among actors with interests in both the land and sea (LS4), and the general networking activity of actors with interests in both (LS3). Each set of building blocks (i.e., those representing co-governance and land-sea integration) was modelled separately relative to two control building blocks representing popularity and closure in the networks (Appendix D, Table D4). It was important to control for these effects to better interpret our results in relation to these well-established network processes (Guerrero et al., 2015b). Models were built for each set of building blocks separately for each case (i.e., a total of eight models were developed). We used the software MPNet for our analysis (Wang et al., 2014). It is important to note that the whole network does not have to be sampled in order to build an ERGM (Robins et al., 2004).

Table 27. The network building blocks representing co-governance and land-sea integration.

Building block	Code	Description
The emergence of co-governance		
	CG1	Collaboration among state actors.
	CG2	Collaboration among non-state actors
	CG3	Collaboration between state and non-state actors
The emergence of land-sea integration		
	LS1	Collaboration among actors with interests in the land.
	LS2	Collaboration among actors with interest in the sea.
	LS3	Activity from actors with interests in both the land and sea.
	LS4	Collaboration between actors who both have interests in the land and sea (i.e., both actors are boundary-spanning organizations).
	LS5 LS6	Collaboration between actors where one has interests in the land and the other has interests in the sea.

Legend



Section 6.6. Results

Section 6.6.1. What conditions have helped foster network governance?

The qualitative analysis highlighted four main conditions fostering network governance in the embedded case studies: multilateral agreements, project participation, boundary spanning organizations, and experience with extreme events (e.g., tropical storms). These conditions are discussed in turn below.

Multilateral agreements

Multilateral agreements are essentially treaties between three or more sovereign states (Kim, 2013). Although signifying multi-national collaboration, they often contain commitments that each participating nation is expected to meet, which can stimulate or promote enhanced coordination and collaboration between governance actors within each nation. In the context of land-sea interactions there are a number of multilateral agreements that promote coordination and support integrated approaches to addressing land-sea interactions. Most notable is the Land-based Sources of Pollution (LBS) Protocol, which is part of the Cartagena Convention for Protection and Development of the Marine Environment in the Wider Caribbean (CEP, 1983). The LBS Protocol aims to mitigate land-based stressors to the marine environment through a structured approach to monitoring and addressing land-based pollution. A major feature of the LBS Protocol is its focus on multilevel cooperation to address land-based stressors at scales analogous to that of the marine ecosystem. However, only two of the embedded case studies have ratified the LBS Protocol – Antigua and Grenada. The other two case studies – Saint Vincent and Saint Kitts – have ratified the Cartagena Convention in general, but not the LBS Protocol specifically.

Project participation

Multilevel governance in the region has resulted in the implementation of various projects (Sweeney and Corbin, 2011). These projects typically leverage funding and, in some cases, expertise from the international and regional levels, but work to find applied solutions within communities or at the national level. Some projects are focused specifically on land-sea interactions, while others focus more broadly on sustainability or other cross-cutting themes (e.g., climate change adaptation) but have relevance to addressing land-sea interactions. A list of some of the main projects driving coordination and collaboration noted during interviews are found in Appendix D, Table D5. There were similar levels of project participation reported across the embedded case studies.

The key question regarding different projects is: how do seemingly disparate projects lead to the emergence of co-governance? One means is through the need for project coordination, and more importantly the need for coordination over time of multiple projects (Lubell et al., 2014). Sustained engagement on multiple projects can develop networked arrangements important for co-governance. These arrangements can also help improve bureaucratic efficiencies and reduce the transaction costs involved with participating in multiple projects (i.e., existing committees can be used for multiple projects). These points are illustrated in the following quote from St. Kitts:

> *"They're [multiple projects] all at various stages of implementation and so we have not gone across the success indication box yet, to say well, yes, we achieved the objective. But we feel that we are on target, and the key thing is having these coordinating committees. We have a number of the stakeholders involved early on and so when we need to get Ministerial approval, there's already that link in the various agencies. So I am pretty optimistic about the outcome ...we are right in the middle of implementing the work plan so to speak, but all arrows are pointing in the right direction."*
> ***St. Kitts, SKN0022***

When these projects involve coordination across actors with disparate types of interests, the resulting networked arrangements can support management at holistic scales. For example, in Antigua multi-actor coordination has provided a platform for co-governance that leverages technical capacity from diverse agencies:

> *"The ECMMAN position came up because the Environmental Division basically is like home to the Small Grants project. The GEF focal point is on our committee, and she provides a lot of support to the program. So she saw that my committee was working very functionally, delivering. So when ECMMAN was looking for a committee to coordinate the program, she said, 'Why start another committee? Use the same committee.' So we added some technical persons to the committee from Forestry, Fisheries, the DCA, the Coast Guard, and Tourism so we have a bigger committee. And its only 3 months, but we have already gotten our first big project funded. The Environmental Awareness Group, they are working within the priorities of the Fisheries Division. The funds didn't go to Fisheries; they went to an NGO."*
> ***Antigua, ANU0013***

Establishment of a boundary-spanning organization

The interviews also highlighted the importance of boundary spanning organizations for crafting governance networks across the land-sea interface. Boundary-spanning organizations, here, refer to organizations that actively challenge existing governance fragmentation by pursuing collaborations with diverse organizations (O'Mahony and Bechky, 2008; Paige Fischer, 2015). In the embedded cases, boundary-spanning organizations had three common features. First, they were set up with the explicit goal of promoting collaboration (Jacobs et al., 2016). Second, they had management interests on both sides of the land-sea interface. And third, they were typically a state agency. Boundary-spanning organizations have been established in Antigua and Saint Vincent, but not in Grenada or Saint Kitts. Their importance is demonstrated in the following quote:

> *"Environment Division, they are the ones who usually deal with most of these international agencies, and once they get the funding they will call the various stakeholders together and say, 'Okay, I have this fisheries project, it will require these various departments, either Health, Forestry, Extension, Lands, etc.'. And they will pool the resources and say, 'Hey, we need to get this thing executed'. They are somewhat like the Project Management Unit within the Ministry of Finance, who will search and see whether there already is a similar project…[and] recommend to team up together to establish the same thing."*
> ***Antigua, ANU0010***

Experience with extreme events

Additionally, interview participants noted the importance of experience with extreme events – mostly hurricanes and tropical storms – for fostering network governance. Extreme events can be devastating to these islands, and in some cases they produce crisis situations. Previous work has shown how crisis can produce windows of opportunity for transforming governance (Folke et al., 2005; Gelcich et al., 2010). However, there were no particular extreme events highlighted as windows of opportunity in our embedded cases. More so, extreme events were cited as improving awareness and increasing the political salience of addressing negative land-sea interactions (e.g., the intense erosion and subsequent coastal sedimentation following extreme precipitation). The improved awareness and salience was thought to contribute to the perceived value of land-sea integration in network governance.

Experience with extreme events was somewhat different across our embedded cases. Grenada had the least experience with extreme events from 1944-2010 with a total of 15 (10 tropical storms, 5 hurricanes) (Appendix D, Table D6); while Saint Kitts had the most at 25 (11 tropical storms, 14 hurricanes). Although, both Antigua (9 tropical storms, 14 hurricanes) and Saint Vincent (13 tropical storms, 7 hurricanes) also have had notable experience with extreme events.

Based only on the number of hurricanes, both Antigua and Saint Kitts have had slightly higher levels of experience than Saint Vincent and Grenada. These diverse levels of experience with extreme events provide different signals to governance regarding the importance of addressing land-sea interactions.

Section 6.6.2. To what extent has network governance emerged?

The ERGM results allow for an exploration of the extent to which network governance has emerged in each embedded case. These results are presented below for two dimensions of network governance: co-governance and land-sea interaction. Co-governance and land-sea integration were analyzed based on the network building blocks found in Table 27.

Co-governance

Co-governance in all the embedded cases has emerged to some extent (Figure 11). The governance networks all contain both state (red nodes) and non-state (green nodes) actors collaborating and coordinating (grey lines) on issues related to governing land-sea interactions. The ERGMs characterize this emergence relative to what would be expected purely by chance. In Antigua and Saint Kitts, the governance networks are still largely hierarchical and fragmented, which means the parameter estimates for each building block representing co-governance (CG1-3) are significant and negative (Table 28). No form of collaboration – whether between or among state and non-state actors – has emerged to a greater degree than expected by chance in Antigua and Saint Kitts. In Grenada, collaboration among state actors is significant and positive, which suggests co-governance has emerged but only among state actors. Non-state actors are collaborating less than expected by chance, which suggests fragmentation between non-state actors. Collaboration between state and non-state actors relative to chance was not tested in

Grenada due to issues with model convergence. Similar issues with model convergence have emerged in other studies (e.g., Bodin et al., 2016; Guerrero et al., 2015). Saint Vincent's governance network is in transition in relation to all three forms of collaboration (i.e., both among and between state and non-state actors).

Land-sea integration

The observed governance networks also show the emergence of land-sea integration to some degree (Figure 12). The governance networks all exhibit interactions (grey lines) between actors with diverse interests (green nodes are land-interested actors, blue nodes are sea-interested actors, and red nodes have interests in both the land and sea). Yet, similar to co-governance, the ERGM results suggest that the emergence of land-sea integration is greater than expected by chance in very few instances (Table 29). Antigua exhibits a significant and positive effect related to the general network activity of actors with interests in both the land and sea (LS3). Both Antigua and Saint Kitts exhibit evidence of transitions towards land-sea integration with respect to collaboration between land- and sea-focused actors (LS5 and LS6, respectively); while all other cases suggest significant fragmentation in this regard. However, the evidence suggests the embedded cases are in transition with respect to many of the other building blocks, representing collaboration among land- or sea-focused actors and the activity and collaboration of actors with interests in both. Saint Vincent exhibits the most transitional characteristics. However, both Saint Kitts and Grenada also have a relatively high number of transitional characteristics.

Table 28. Current state of co-governance as inferred from the ERGMs.

Building blocks	Antigua	St. Kitts	St. Vincent	Grenada
CG1	○	○	◉	●
CG2	○	○	◉	○
CG3	○	○	◉	[a]

[a] Building block not included in model. Model would not converge when building block included.
Note: See Appendix D, Table D7 for ERGM estimates and standard errors.

Table 29. Current state of land-sea integration as inferred from the ERGMs.

Building blocks	Antigua	St. Kitts	St. Vincent	Grenada
LS1	○	○	◉	○
LS2	○	◉	◉	◉
LS3	●	◉	◉	◉
LS4	◉	◉	◉	[a]
LS5	○	○	○	○
LS6	○	◉	○	○

[a] Building block not included in model. Model would not converge when building block included.
Note: See Appendix D, Table D8 for ERGM estimates and standard errors.

Legend

○ Hierarchical, fragmented

◉ In transition

● Networked, integrated

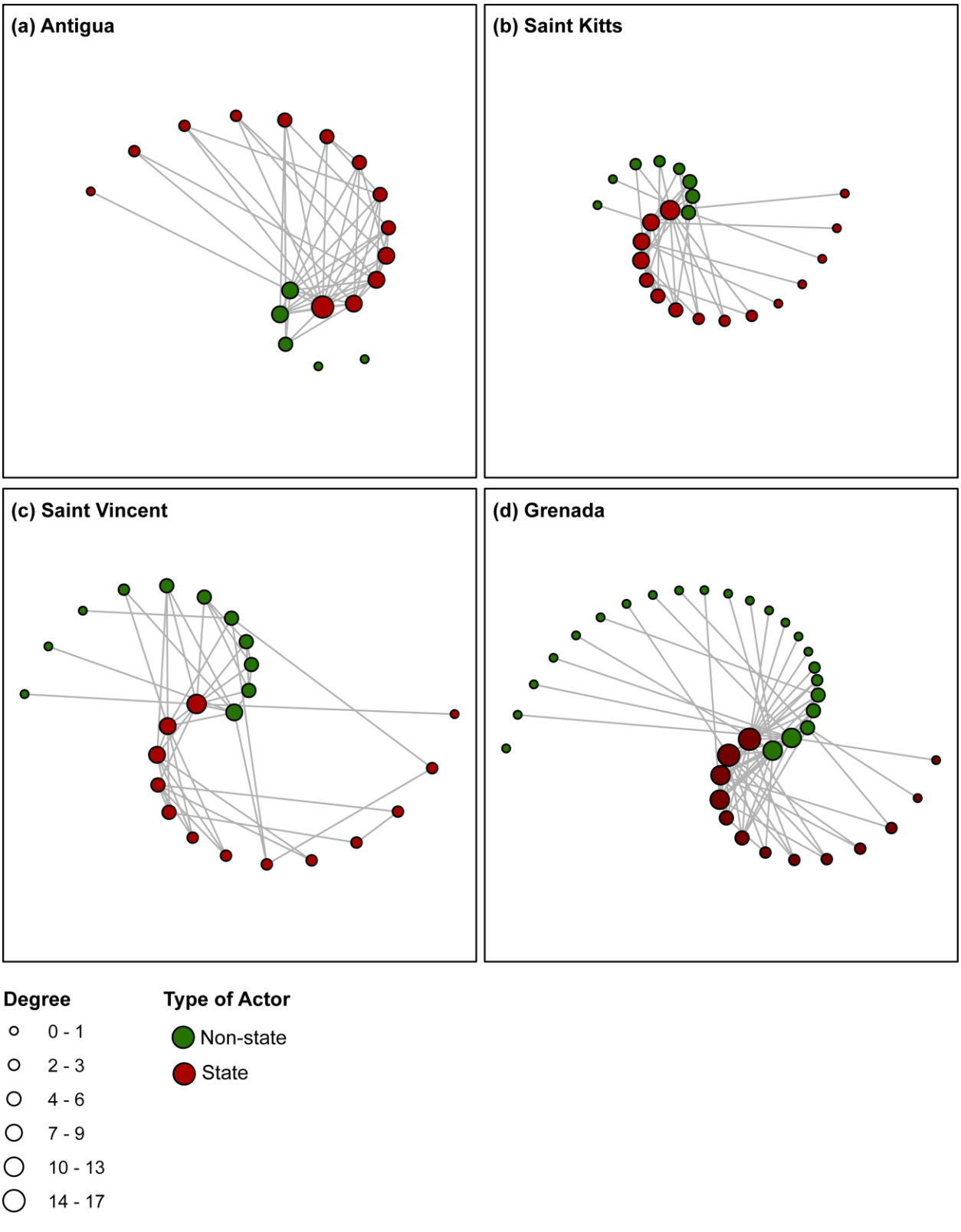


Figure 11. Co-governance networks in the embedded case studies.

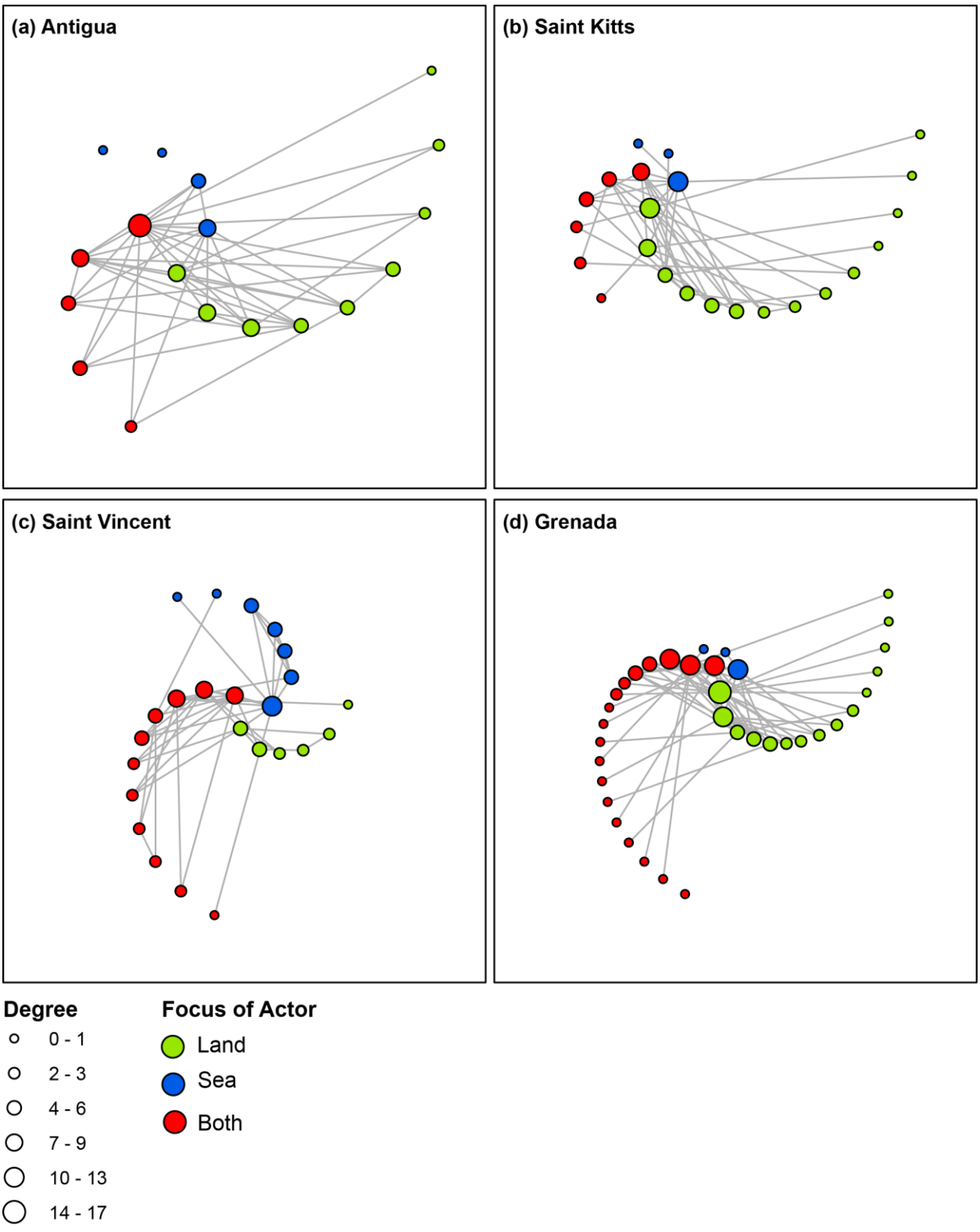


Figure 12. Land-sea integration networks in the embedded case studies.

Section 6.7. Discussion

We have examined the conditions for and emergence of network governance for addressing land-sea interactions in four embedded case studies from the Lesser Antilles. Our findings show that multilateral agreements, project participation, boundary-spanning organizations, and experience with extreme events provide the conditions useful for fostering network governance within the embedded cases. Yet the embedded cases are largely in the transitional phase of a transformation towards network governance. Here, we seek to identify common patterns across the embedded cases and discuss the broader implications of our findings for the Lesser Antilles. In doing so, we will detail the conditions playing the most significant role in fostering network governance and provide insights into how the ongoing transitions can be steered towards a transformation of governance across the land-sea interface.

Section 6.7.1. Synthesis across the embedded cases

The ERGMs suggests that transitions are currently underway regarding many of the examined network building blocks. To simplify across the sets of building blocks (i.e., co-governance or land-sea integration), we take any evidence of transition within a set to mean that a transition is occurring with respect to the broader theme of that set (Table 30). We use as evidence the presence of at least one building block within a set that is either categorized as in transition or networked and integrated as evidence of transition related to the broader set. We believe this evidence appropriately signals a transition related to the broader set since it suggests that some forms of hierarchical and fragmented governance have been challenged or overcome through network governance As a result, we can synthesize – drawing on the logic of process tracing

(Collier, 2011) – how the various conditions important for fostering network governance in each embedded case scale-out to the regional level (i.e., the Lesser Antilles).

Our synthesis has three broader implications. First, participation in projects appears both necessary and sufficient to initiate transitions with respect to land-sea integration. Project participation is the only common condition across all embedded cases, and there is evidence to suggest that all embedded cases are currently undergoing a transition with respect to land-sea integration. Second, project participation is necessary but insufficient to initiate transitions with respect to co-governance. Only two of the embedded cases – Saint Vincent and Grenada – are currently undergoing transitions with respect to co-governance. The only common condition between these two embedded cases is project participation, which suggests this condition is necessary to initiate the co-governance transitions. However, project participation is also present in Antigua and Saint Kitts (i.e., the embedded cases not in transition), which suggests that project participation is insufficient to initiate a transition towards co-governance. Something beyond project participation is supressing transitions in Antigua and Saint Kitts, which highlights the third possible implication. Both Antigua and Saint Kitts had greater experience with hurricanes from 1944 to 2010 than Saint Vincent and Grenada, which suggests experience with hurricanes could potentially inhibit the emergence of network governance. However, both Antigua and Saint Kitts also have higher GDP per capita than the other islands (Table 25), and all islands have considerable experience with tropical storms (see Section 6.6.1). As such, the results must be interpreted with caution, but the insights suggest experience with the stronger storms (i.e., hurricanes) and interactions with contextual conditions (i.e., GDP per capita) could have an influence on network governance emergence.

The importance of project participation provides tractable and actionable insights for policy and governance in the Lesser Antilles. Investments in projects – both financial and human resources – are paying off with respect to their influence on governance within the region. The projects are facilitating transitions towards network governance, which provides additional capacity to address land-sea interactions (Chapter 5). However, navigating a transition is an exceptionally uncertain endeavour. There are no guarantees that network governance will emerge on the other side regardless of the conditions in place. As such, further discussion is required regarding (1) the conditions inhibiting network governance, and (2) how transitions can be navigated in ways that further promote the emergence of network governance.

Table 30. Embedded case synthesis.

	Antigua	St. Kitts	St. Vincent	Grenada
Conditions fostering network governance				
LBS Protocol	●			●
Projects	●	●	●	●
Boundary-spanner	●		●	
Extreme events (hurricanes)	●	●		
	Emergence of co-governance in network governance			
	○	○	◍	◍
	Emergence of land-sea integration in network governance			
	◍	◍	◍	◍

Legend

○ Hierarchical, fragmented

◍ In transition

● Networked, integrated

● Considerably present

Section 6.7.2. What is inhibiting network governance?

The interviews point to three main factors inhibiting the emergence of network governance. First, network governance can threaten powerful actors. For some actors, it is more advantageous to resist network governance than to facilitate and participate in it. Power has been highlighted elsewhere as an important consideration regarding transformative or fundamental change in systems (Moore and Tjornbo, 2012; Nayak et al., 2015). These actors are usually empowered by existing institutions and have formal, legislative authority to enact certain mandates.

Interestingly, certain central actors in our observed governance networks were not formally empowered, either by legislation, regulations or otherwise. In fact, many of the organizations leading the charge towards co-governance and land-sea integration are not supported by any formal legislation – they have a formal mandate towards increased collaboration, but this mandate is not necessarily supported by legislation. This creates a context where existing power relations may be threatened, and actors empowered by hierarchical structures resist attempts to change these structures (Lebel et al., 2005; Njaya et al., 2012). Additionally, the stakes of information sharing can promote network suppression. For example, coastal water quality is an important consideration for tourism, and poor coastal water quality can significantly decrease tourism revenues. By suppressing coastal water quality information, certain actors are able to maintain control of the situation. Actors with control of potentially sensitive information appear more likely to resist collaboration and avoid information sharing. It is important to note that we are not suggesting that there are any potential issues with coastal water quality as it relates to tourism in the embedded case studies. We are merely highlighting that controlling this information places certain actors in powerful positions, which they may endeavour to maintain by undermining network governance.

Second, there are significant challenges associated with promoting community involvement in what one respondent referred to as a "culture of non-participation" (ANU0005). The general public are not accustomed to being consulted or involved in decision making, which sets a certain precedent and additional barriers to network governance. These barriers are deeply engrained and difficult to overcome (May, 2013; Speer, 2012).

Third, a barrier to land-sea integration appears to be the transaction costs associated with collaboration across the land-sea interface (e.g., the costs of organizing or dissemination

information), especially in relation to the perceived benefits of such integration. Many actors are motivated by their formal mandates and their pre-existing problem frames, which often reflect an inherent fragmentation across the land-sea interface. The benefits of integration are difficult to perceive and articulate when success is framed in relation to fragmented mandates (Jentoft et al., 2010). However, our research suggests that project participation can help actors perceive these benefits by providing funds, but also motivation towards measurable and monitored objectives.

Section 6.7.3. Navigating transitions to network governance

The embedded cases suggest that transformations towards network governance are currently in the transitional phase in the Lesser Antilles. As noted earlier, this does not necessarily mean that network governance transformations will be realized. The outcomes of transitions are highly uncertain, and more effort is required to effectively navigate ongoing transitions towards improved network governance – especially with respect to addressing the inhibitors noted above. Our research highlights two considerations for navigating transitions to network governance: (1) steering by centralized actors and core teams, and (2) connecting with non-state-actors. These considerations are discussed in turn below.

Steering by centralized actors and core teams

The embedded cases suggest the importance of centralized actors and core teams in navigating transitions, which supports observations elsewhere (Bodin and Crona, 2009; Ernstson et al., 2010; Hovik and Stokke, 2007; Olsson et al., 2008, 2006). In the case of Antigua, the centralized Environmental Division plays a significant role in coordinating within national governments and with regional and international partners. Its role helps leverage external capacity and then subsequently mobilize this capacity through national networks of diverse actors. In the case of St

Kitts, a core group of actors provides much needed coordination over time, which helps steer projects and ensure results and impacts are cumulative and not redundant:

> *"The core team is there which is basically, Ministry of Sustainable Development representative, Department of Marine Resources representative, and would go as far as to say Ministry of Tourism; those form a core group which is present on all of the different committees."*
> ***St. Kitts, SK0022***

The core team structure also helps reduce the transaction costs associated with organizing, since the history of collaboration between individuals and agencies provides trust and can streamline collaborative processes. Synergistic goals are an essential part of core team effectiveness:

> *"We are well connected. We do not believe that we can effectively do this work [conservation work] in isolation; we do not want to attempt to do it in isolation. But we will also not collaborate with partners whose intentions are really around personal enrichment. Unfortunately, there is that too. But we feel that we are working with the significant partners, and we are open; whoever else is willing and able to put in the work that we do, we will welcome them on board. But we will not compromise our mission and what we set this organization up to do just because other people think we should."*
> ***Grenada, GRE0004***

These examples demonstrate that – despite the focus on co-governance – state actors still play important roles in navigating the ongoing transitions to network governance (Ramsey et al., 2015). Additionally, these actors or teams have interests in both the land and sea.

Connecting with non-state actors

There have been a number of initiatives and strategies that have proven beneficial with respect to engaging non-state actors. For example, the development of bridging organizations that serve as points of contact between state and non-state actors is one way of advancing co-governance. This approach is exemplified in St. Kitts, where project participation funded by the European Union

(EU) has facilitated the creation of a Non-State Actors Panel to bridge non-governmental stakeholders:

> *"Under the EU there is provision for Non-State Actors Panel to have discussions on different matters in terms of national perspective, but also in terms of any interaction that the country would want to have with the EU. We share information with them and they would give their feedback. It's also an opportunity for them to build their [non-state actors'] own capacity as well because sometimes there are other things that may be available that the government is not involved in, but they can access it all on their own as an organization – as a group. So there's a chance for them to do a holistic capacity building as the Non-State Actors Panel, but they can use it for their group on their own individual basis."*
> ***St Kitts, SK0025***

Similarly, creation of a government agency mandated to build community capacity and empowerment helps improve the autonomy of community groups:

> *"A department called Constituency Empowerment got a breath of new life over the past year or two, and so they too have taken on a serious push to try and help the communities to build their own capacity – trying to see how they can help them. I think maybe in the next year – between the end of this year into next year they are going to try to establish the community councils, so that they can have their own discussions."*
> ***St. Kitts, SK0025***

However, significant challenges remain with regard to transitioning to network governance, especially with regard to community empowerment. There is a marked difference between simply connecting with communities and connecting with communities as empowered decision makers. This change in governance has not yet occurred in many of the embedded cases, which is exemplified by the following quote from Saint Vincent:

> *"As I look at the governance structure…we are talking about co-management….in co-management you need to get people involved and that in itself is a very long and tedious assignment."*
> ***St. Vincent, SV0019***

However, in such contexts culturally-appropriate ways of developing governance networks are needed (Meek, 2013). DeCaro and Stokes (2013) highlight the need for people to participate in governance in ways that are meaningful to them. In the context of the embedded cases, finding more socially-appropriate ways of advancing participation may challenge currently held notions regarding the ways community members participate in network governance. For example, communities currently organize – in some situations – around salient issues, which are top-of-mind and require immediate attention (e.g., slope stability, problems with drainage). Once an issue is addressed the community becomes less active. This process indicates the presence of latent capacity within communities that contribute to network governance. However, this situation does not fit the currently held idea of community participation in network governance, which is thought to require formal designation of a community organization and more consistently structured over time interactions with national governments and other non-state actors. Finding ways of leveraging and building the latent capacities in communities is one approach for improving network governance in the Lesser Antilles.

Section 6.8. Conclusions

We have examined the process of transformation towards network governance to address land-sea interactions in the Lesser Antilles through four embedded case studies: Antigua, Saint Vincent, Saint Kitts, and Grenada. My research was guided by three main questions: (1) what conditions have helped foster network governance, (2) to what extent has network governance emerged in light of these conditions, and (3) what conditions appear to be playing the most significant role within the region? We find that a transition towards network governance is currently underway in the Lesser Antilles, and that this transition has been initiated mostly by participation in various collaborative projects aiming to specifically address land-sea interactions

or promote sustainability more broadly. Additionally, multilateral agreements, boundary-spanning organizations and experience with extreme events have provided facilitating conditions for network governance within the embedded cases.

Our results highlight two important considerations for navigating the governance transformations currently underway. First, our work reiterates the importance of considering centralized actors and core teams in governance networks (Bodin and Crona, 2009; Ernstson et al., 2010). These actors and teams can exert significant steering influences over governance systems, and can either help promote or hinder desired governance change (Westley et al., 2011, 2013). However, our work also shows that – at least for the time being – these centralized actors and core teams must have significant representation from the state. Second, our results suggest there is a need for improved consideration of latent capacity – especially at the community-level – with respect to navigating transitions towards network governance. Communities in the region exhibit capacity for collective action, yet this collective action is less structured than expected in existing notions of appropriate network governance. Finding ways to strengthen and mobilize this capacity could greatly improve network governance in the region and provide the means for more appropriate and effective engagement with non-state actors and communities.

The shift towards more inclusive, integrated network governance is essential for addressing sustainability problems across the land-sea interface in the Anthropocene (Glavovic et al., 2015). Such network governance can help curb unsustainable practices, promote the wellbeing of communities, and contribute to sustainable development (Dedeurwaerdere, 2005; Glavovic et al., 2015; Kemp et al., 2005). Our research suggests that shifts in governance are occurring due to the strategies of autonomous actors in the Small Island Developing States of the Lesser Antilles.

However, continued progress will rely on improved strategies for engaging non-state actors and a sustained emphasis on integration.

Chapter 7. Synthesis

The purpose of this chapter is to synthesize the results of the three previous analyses presented in Chapter 4, Chapter 5 and Chapter 6 into a coherent whole and identify their broader contributions to both theory and practice. The chapter begins by recapping the purpose and objectives guiding the research and providing an overview of the major findings previously presented. I then discuss the broader contributions resulting from the research to both theory and practice. Next, the study's limitations are described and future research priorities identified. Finally, the chapter contains some reflections regarding the process of conducting transdisciplinary, action-oriented research.

Section 7.1. Purpose and objectives

I conducted this research to provide a detailed examination of how governance could more effectively account for the social and ecological processes that inherently connect the land and sea. I pursued this topic in response to the observed negative impacts that land-based activities are having on coastal-marine environments around the globe (Halpern et al., 2009; Lamb et al., 2016) and, more specifically, in my study region – the Lesser Antilles (Bégin et al., 2016; Sweeney and Corbin, 2011). My research – building upon a rich body of scholarship (Armitage and Plummer, 2010; Armitage et al., 2009; Bodin and Crona, 2009; Charles, 2012; Crowder et al., 2006; Young, 2002) – rests on the premise that governance is both a major cause and powerful solution for many wicked sustainability problems. My research was guided by the following research question and objectives:

How can we effectively govern across the land-sea interface?

Objective 1. To synthesize extant theory regarding governance across the land-sea interface.

Objective 2. To investigate the network governance processes contributing to social-ecological fit across the land-sea interface.

Objective 3. To examine the strategies and conditions that foster transformations towards network governance to address land-sea interactions.

I employed a multifaceted research design and multi-method approach to achieve these objectives. Each objective formed the basis for a separate chapter. The findings of these chapters are detailed below.

Section 7.2. Major findings

My first objective was to examine what we currently know or theorize about governance across the land-sea interface. To achieve this objective, I used an exploratory and systematic review of the literature to: (1) outline the current state of the literature, (2) examine the predominance of different approaches for addressing land-sea interactions, (3) characterize how governance is conceptualized within these approaches, (4) investigate governance challenges, and (5) provide insights into effective governance. The review found that ecosystem-based management is the most predominant approach to address land-sea interactions found in the literature. In addition, the literature highlights a number of important governance challenges to address land-sea interactions: (1) determining boundaries, (2) addressing cross-scale effects, and (3) accessing knowledge. Effective governance across the land-sea interface is thought to hinge on (1) timely science-policy integration, (2) strong leadership, (3) supportive networks, and (3) social, functional and temporal fit.

My second objective aimed to examine the processes contributing to governance effectiveness across the land-sea interface. I used the concept of social-ecological fit as a means of understanding capacity to address the governance challenges identified in the systematic review (Chapter 4). Social-ecological fit is inherently a multidimensional concept, which takes into account social, functional and temporal fit – thus encompassing some of the identified components of governance effectiveness as well. I used the lens of network governance to understand the remaining components of effectiveness: science-policy integration, leadership, and inclusive networks. My analysis focused on identifying how existing processes related to network governance have led – or not – to capacity to address the governance challenges or, in other words, social-ecological fit. I applied this analysis to two case studies from the Lesser Antilles: the southeast coast of Saint Lucia and the southwest coast of Dominica. I found that network governance has helped coordinate management of shared resources and provided capacity to address interactions between ecological entities. However, network governance has not yet emerged that helps engage diverse actors or address biogeochemical interactions across the land-sea interface. The findings suggest a clear importance of network governance in enhancing social-ecological fit; yet the emergence of network governance has not been fully realized and an improved understanding of how network governance emerges in largely hierarchical governance systems is required.

My third objective aimed to identify the conditions that foster effective governance across the land-sea interface. Chapter 5 showed how network governance can enhance governance effectiveness across the land-sea interface. Chapter 6 sought to understand what fosters the emergence of network governance in the Lesser Antilles. Drawing on insights from practitioners dealing with land-sea challenges in the Lesser Antilles, it appears that participation in

collaborative projects (e.g., Integrated Watershed and Coastal Areas Management [IWCAM]), the ratification of multilateral agreements (e.g., the LBS Protocol), the presence of boundary-spanning organizations, and experience with extreme events (e.g., tropical storms) have provided enabling conditions for the emergence of network governance. Project participation appears to be the common ingredient across the region for initiating transitions to land-sea integration. It appears to be both necessary and sufficient in that regard. However, project participation is necessary but insufficient to initiate transitions towards co-governance. Experience with stronger storms (e.g., hurricanes) and contextual conditions (e.g., GDP per capita) could be inhibiting transformations. Ensuring the ongoing transitions move towards improved network governance will require (1) the leadership of core actors and (2) leveraging and building the latent capacity of communities.

Section 7.3. Contributions and emerging propositions

Each of the major findings discussed above constitutes a contribution in itself to the literature. However, my research also makes cumulative and synthetic contributions across the three analyses. I have chosen to discuss these contributions as emerging propositions – by which I mean theoretical statements that are abstract and suggest relationships between concepts (Reynolds, 2007). These propositions are 'emerging' since they result from looking across the analyses presented in Chapter 4, Chapter 5 and Chapter 6, but are not wholly the result of any single analysis. They should not be taken as final or absolute, since they require further refinement from different conceptual viewpoints or in other empirical contexts. However, they provide some initial insights or lessons for other contexts grappling with governance challenges across the land-sea interface (Propositions 1 and 2), and they make contributions to the body of knowledge surrounding network and hierarchical governance (Propositions 3 and 4) and to the

linkages between governance and social-ecological systems transformation (Proposition 5). The synthesis was completed by bringing together the key findings from the aforementioned analyses, examining their similarities and differences, and reflecting upon the emergent patterns and relationships to the bodies of scholarship summarized in Chapter 2. This section is organized according to these emerging propositions, and I discuss both their academic and pragmatic significance in turn.

Proposition 1. Network governance improves capacity to address land-sea interactions

Much scholarship suggests that network governance is more appropriate than top-down governance for addressing complex sustainability problems (Armitage et al., 2009; Carlsson and Sandström, 2008; Guerrero et al., 2015a); however, each distinct governance network exhibits different capacities for addressing these problems. There are many sustainability problems associated with negative land-sea interactions, such as coastal eutrophication, reef and seagrass sedimentation, point (e.g., sewage) and non-point (e.g., agrochemicals) source pollution, and marine litter. My research found that network governance provides some useful capacity for addressing these problems. However, I provided some important caveats regarding the particularly beneficial structures of governance networks and their implications for capacity; specifically, these caveats address the limitations of network governance to address extreme events and the necessary interplay between network and top-down governance in providing capacity to govern land-sea interactions.

Chapter 4 – the systematic review – highlights that there are two main approaches found in practice to address land-sea interactions: integrated management and ecosystem-based management. These approaches rest on different implicit assumptions regarding the benefits of collaboration and how governance can help achieve desired outcomes in land-sea systems.

Integrated management – with roots in the social sciences and planning – proposes collaboration and coordination as key to eroding the jurisdictional barriers that lead to governance fragmentation (Cheong, 2008). However, the treatment of coordination and collaboration in integrated management does not acknowledge that different patterns of coordination and collaboration will lead to different outcomes (Newman and Dale, 2005). There appear to be implicit assumptions (1) that more collaboration and coordination is inherently better, and (2) that all collaborative or coordinating relationships between actors are essentially of equal value.

Ecosystem-based management – although still placing importance on collaboration and coordination (Bodin et al., 2016b; Sandström et al., 2015) – has more guidance on appropriate bounds and ways of differentiating the value of diverse relationships. Ecosystem-based management aims to improve the coherence between governance and various ecosystem properties – scale, in particular. Improving this coherence usually entails matching the scales of governance to the scales of ecosystems, which means, for example, developing spatial units for governance large enough to encompass ecosystem processes (e.g., the Large Marine Ecosystems) (Long et al., 2015). However, these attempts at rescaling governance can be problematic, especially if they shift scales in ways incongruent with the attitudes of local resource users or in ways that hinge on top-down governance approaches (Charles, 2012; Ruckelshaus et al., 2008; Sievanen et al., 2013).

I aimed to reconcile guidance from integrated and ecosystem-based management by drawing on network governance theory and the concept of social-ecological fit (Chapter 5). Following Aswani et al. (2012), I started with the view that integrated and ecosystem-based management are not incompatible and in fact can be quite synergistic. I drew the idea from integrated management that collaboration and coordination between diverse actors (e.g., those interested in

the land and sea) can be beneficial (Ernoul and Wardell-Johnson, 2013). I also used the prescriptions from ecosystem-based management as a means of determining the relative value – or the contribution to matching ecosystem properties and interactions – of different collaborative or coordinating relationships between actors. My results showed how the synergies between integrated and ecosystem-based management could be realized through network governance. Network governance plays a role in coordinating management of shared or interacting resources, which improves capacity for sustainable management. However, the potential benefits of network governance in terms of engaging diverse actors and, specifically, addressing biogeochemical interactions across the land-sea interface can be more difficult to achieve. Governance networks represent a manifestation of the underlying structural and relational dimensions of power. For example, the limited participation of local, agricultural Fair Trade Organizations (FTO) from Saint Lucia in network governance is partially a consequence of how the rules for Fair Trade are largely determined and controlled from the outside, which provides little incentive or autonomy for the FTOs to participate in land-sea governance (see Chapter 5). Collaborative projects appeared as useful tools for initiating transitions towards network governance arrangements more capable of realizing these additional benefits. Yet collaborative projects can suffer from limited time horizons and, potentially, reproduce constraining power relations if adequate attention is not given to engaging with structurally inhibited groups, such as FTOs. Essentially, projects may simply be too short or the transaction costs too high to address some of the underlying structural power dimensions inhibiting the ability to steer network governance transitions to full transformations.

There are three main take-away messages for practice emerging from Proposition 1 (Box 2). First, it is important to promote and facilitate coordination among actors with interests in shared

resources. Coordination is extremely important for improving social-ecological fit in land-sea systems. Second, collaborative projects involving actors with interests in both the land and sea can help catalyze transitions towards governance capable of matching land-sea interactions. Third, strategic and purposively designed network governance can help develop synergies between integrated and ecosystem-based management approaches in land-sea systems.

Box 2. The take-away messages for practice from Proposition 1.

(1) Promote and facilitate coordination among actors with interests in shared resources.

(2) Develop projects that bring together actors with interests in the land and sea to tackle shared challenges or pursue common goals.

(3) Pursue synergies between integrated and ecosystem-based management through strategic and purposive network governance.

Proposition 2. Network governance for land-sea interactions can be overwhelmed by extreme events.

My research contributes an important understanding of the potential limits of network governance to address land-sea interactions. The idea that there are limits to governance and what it can achieve is nothing new. This idea is encapsulated in many related concepts, such as governability (Kooiman, 2008; Kooiman et al., 2008, 2005) and adaptive capacity (Armitage and Plummer, 2010; Engle and Lemos, 2010; Gupta et al., 2010). These concepts help illuminate the strengths and weaknesses of different modes of governance to address different types of sustainability challenges and problems.

My contribution focuses specifically on the role of network governance to address land-sea interactions in relation to extreme events (e.g., hurricanes, heavy precipitation) that amplify

certain land-sea processes (e.g., erosion, sedimentation, material transport). As noted in Chapter 6, extreme events can provide an impetus for and help foster conditions that lead to network governance by broadening awareness of negative land-sea interactions (e.g., excessive erosion and sedimentation). However, my research suggests that the specific networked governance arrangements and mechanisms that help address negative land-sea interactions (e.g., coordinate management of shared resources) are overwhelmed and largely ineffective for steering through the crises sometimes associated with extreme events. During such crises, priorities shift to a focus on human safety and the sustainability challenges associated with addressing land-sea interactions become a lower priority (Pittman et al., 2015).

I propose that network governance to address land-sea interactions can help reduce vulnerability to extreme events well in advance, or help rebuild in sustainable ways following an extreme event. These abilities are evidenced – for example – by the Trust for the Management of Rivers in Saint Lucia, who have undertaken several hurricane preparedness activities (e.g., establishment of rainwater harvesting as back up water supplies at hospitals; see Appendix A). However, the specific role of land-sea governance networks in steering through crisis is less clear. In many of the case studies, there already exist fairly extensive governance mechanisms – including both networked and hierarchical modes – supporting disaster management, which are usually steered by a central national agency. These national agencies have significant capacity to deal with disasters. My research suggests that improved integration of the various governance mechanisms in place to address land-sea interactions and those in place to address disasters is necessary. Such integration could help ensure land-sea interactions are addressed in ways that reduce vulnerability to extreme events and improve coherence with steering processes already in place to navigate disasters.

There are two main take away messages for practice from Proposition 2 (Box 3). First, there is the need to mainstream disaster preparedness into existing efforts to address land-sea interactions. Second, improved linkages are required between the processes and actors governing both land-sea interactions and disaster response.

Box 3. The take-away messages for practice from Proposition 2.

(1) Mainstream disaster preparedness into existing efforts to address land-sea interactions.

(2) Improve linkages between processes and actors steering land-sea governance and those steering disaster response and recovery.

Proposition 3. Network governance is most beneficial when coexisting and interacting with other modes of governance.

Both Kooiman (2008) and Pahl-Wostl (2015) propose that multiple modes of governance can coexist and that perhaps it is even necessary that multiple modes are apparent at any given time. This premise is also somewhat relevant for the idea and value of hybrid forms of governance supported by Lemos and Agrawal (2006). Despite a growing acceptance that multiple modes of governance do in fact coexist, and that this coexistence has observed benefits, very few studies provide clear examples of how and why such coexistence is maintained and preferred.

Building upon Proposition 2, my research demonstrates that different modes of governance are suited to address different types of problems. These different modes of governance may not entirely be synergistic, as Chapter 5 demonstrates how the interplay between network governance and hierarchies can at times be problematic. However, a general diversity in modes appears to be beneficial to deal with problems with multiple temporal, functional and spatial attributes. Such diversity builds on, but extends beyond the institutional variety called for by

Dietz et al. (2003) to acknowledge that governance centres around multiple attractors – each consisting of its own institutional variety. Also, the idea of multiple, coexisting governance modes extends beyond the network management or strategic guidance highlighted by Guerrero et al. (2015) as important for achieving social-ecological fit with network governance. Network management is an essential component of the networked mode of governance (Klijn and Koppenjan, 2012), and it does not imply a coexistence with an alternative mode. My research challenges a dichotomous view of the relationship between network governance and other modes, such as hierarchical governance. Rather, I propose that a more pluralistic view of governance is required, where multiple governance modes exist and interact in an overall functioning governance system. My findings suggest that network governance provides autonomy and the space for self-organization; while hierarchical governance helps provide a consistent, unifying structure that ideally empowers actors to address the challenges they face.

However, further reflection is required on the latter point regarding empowerment. The emergence or suppression of network governance in general, and the relationships within a network governance topology, are inherently issues of power. Power, in this sense, is multifaceted, and it involves the wills and capacities of individual actors participating, or choosing not to, in networked or collaborative modes of governance (Giddens, 1986); however, power also involves deeply rooted and extremely persistent patterns of domination that underpin prevailing discourses and become potentially reproduced in all elements of social life, including governance (May, 2013). Practical and actionable insight to address power issues and foster the co-existence of, and synergies between, network and hierarchical modes of governance is scarce in the existing literature and did not emerge from the systematic review (see Chapter 4). My findings suggest that power both helps guide governance transformations in terms of the

leadership and insight of key actors and core groups, but also constrains them by entrenching a pervasive land-sea jurisdictional divide and limiting the capacities or willingness of communities to participate in governance. For example, the Environment Division of Antigua and Barbuda, at the time of this research, was not supported by any formal, legislative authority to implement or enforce environmentally beneficial practices (see Chapter 6 and Appendix A). Essentially, this produces a context where powerful political players (e.g., large tourism developers) can potentially exert influence over the types of development projects implemented, which threatens the legitimacy of existing environmental governance arrangements on both sides of the land-sea interface. Without the proper legislation and structural elements of power in place, network governance could be doomed to have limited impact on the actual course and trajectory of development pathways.

Proposition 4. Neither network governance nor hierarchical governance is sufficient on their own to overcome the pervasive 'implementation gap' to address land-sea interactions.

Proposition 4, building upon Propositions 2 and 3, shifts from a focus on governance process to outcomes related to the potential benefits of multimodal governance. Many initiatives in the Caribbean suffer from an implementation gap, or the gap between the crafting and execution of multilateral agreements, policy recommendations, projects or initiatives aiming to address land-sea interactions (Hinds, 2003). I propose that both network and hierarchical governance provide unique capacities for closing the implementation gap, but neither is sufficient on its own in this regard. Simplified for illustrative purposes, hierarchical governance provides formal authority and responsibility to implement; while network governance helps to provide broader accountability, to distribute efforts, and to enhance legitimacy. For example, the multi-stakeholder, collaborative Trust for the Management of Rivers in Saint Lucia was able to install a

series of constructed wetlands to reduce sewage impacts on the marine environment by leveraging the authority and expertise of key actors (e.g., the Water and Sewage Company of Saint Lucia) and inspiring the public through fair and genuine participatory process (see Chapter 5 and Appendix A). This example demonstrates how networked (e.g., multi-stakeholder collaboration) and hierarchical (e.g., authority and expertise) modes synergistically help advance on-the-ground action from land-sea governance.

Propositions 3 and 4 have three main take-away messages for practice (Box 4). First, it is important to build network governance and the regulatory portfolio and authority of the state or other actors simultaneously. This approach will help ensure hierarchies and networks coevolve in meaningful ways. Second, it is important to continually promote governance innovation and experimentation outside of currently dominant governance modes in order to foster diversity. Third, it is necessary to promote both network and hierarchical governance to close the implementation gap associated with many land-sea management strategies.

Box 4. The take-away messages for practice from Propositions 3 and 4.

(1) It is important to build network governance and the regulatory portfolio and authority (and structures and processes and visionary objectives) of the state or other actors simultaneously.

(2) It is important to continually promote governance innovation and experimentation outside of current governance modes in order to foster diversity.

(3) Efforts to close the implementation gap should be made by promoting both network and hierarchical governance.

Proposition 5. The efforts of key actors and core teams help promote broader awareness of the complex social and ecological processes that traverse the land-sea interface.

Proposition 5 deals with the underlying knowledge, ideas and assumptions that underpin land-sea governance processes, which can be referred to as images (Jentoft et al., 2010; Song et al., 2013). Images are "a way of thinking and a way of seeing that pervade how we understand our world generally" (Morgan, 1997:4). Chapter 6 identified key actors and core teams as playing an essential role in steering ongoing governance transformations. For example, the National Parks, Rivers, and Beaches Authority (NPRBA) in Saint Vincent is inherently committed to advancing a holistic and participatory approach to managing and conserving Saint Vincent's land-sea resource systems that acknowledges the interconnections between the land, sea, human communities and socioeconomic activities. Their commitment is reflected in their National Parks and Protected Areas System Plan (see Appendix A), but also in the actions of their staff who advance an holistic vision. I propose, here, that organizations like the NPRBA play an especially important role to promote an image of LS-SESs that highlights both land-sea and social-ecological connectivity, but also an image of governance as responsible for accounting for such connectivity. This role involves fostering broader shifts in perspectives away from viewing both the system-to-be-governed and the governance system as fragmented. Key actors and core teams can help realize this role, in part, through continued engagement in collaborative projects, extending the current network of collaboration, and developing means for more effectively engaging communities. The spread of holistic images provides one potential pathway or feedback between the governance transformations examined in Chapter 6 to broader social-ecological systems transformations, as facilitated by broad shifts in images (Chapin et al., 2010; O'Brien, 2012a, 2012b). This proposition has one clear message for practice: encourage the

efforts of key actors and core teams to enable their steering capacity towards, not only governance transformation, but broader social-ecological system transformation towards future social and ecological sustainability.

Section 7.4. Study limitations and priorities for future research

I believe there are three main limitations to my research, which also signal potential research priorities regarding governance across the land-sea interface. First, there is the need to expand beyond a focus on network governance to include other governance-related concepts. My research has highlighted institutional change and latent capacity as additional concepts, which – in conjunction with ideas of power, equity and social justice – could deepen our understanding of effective governance across the land-sea interface. Second, there is the need to expand beyond a focus on a single context to produce more broadly applicable insights regarding effective governance across the land-sea interface. Third, there is the need for improved treatment of multi-scale land-sea interactions and their associated governance challenges. These limitations and priorities are discussed in turn below.

Section 7.4.1. Institutional change and latent capacity

Throughout this dissertation I've adopted a view that governance networks and institutions are inherently related (Klijn and Koppenjan, 2012). For example, actors operating through governance networks play a role in modifying and crafting institutions, while institutions partially underpin the decisions of actors regarding how they engage with governance networks and with whom they are more likely to cooperate. In other words, governance networks and institutions co-evolve as part of a broader governance system (Lubell, 2015, 2013).

That said, my particular methods and approach provided a higher level of descriptive and analytical focus on networks than on institutions. The influence of institutions is apparent in the governance networks I examined and in the interviews I completed. However, the overall focus was on the governance network in a geographically defined region and how it has evolved. Despite the focus on networks, my research highlighted two important intersections with institutions. First, Chapter 5 demonstrated how hierarchical institutional arrangements and network governance can – despite having the same or similar objectives – undermine the foundations upon which the other is built. For example, rules governing environmentally friendly agricultural practices can disempower local governance actors and constrain their autonomous participation in governance networks. Second, Chapter 6 demonstrated how the latent capacity found in communities – which in turn is related to local norms and broader institutions defining participation – challenges our existing conceptualization of network governance and how to achieve it in particular contexts – in the Lesser Antilles, in my case. Latent capacities refer to those that are present and somewhat observable, yet have not fully manifested or been applied (Tschakert, 2007; Tschakert and Dietrich, 2010). In the context of my research, latent capacities refer to those somewhat observable in the ways communities organize around salient issues (e.g., uncontrolled runoff); however, this organization seems to disappear or become latent once the issue has been addressed, which limits opportunities for sustained community participation in governance networks. An improved understanding of how the norms and community-level institutions underpinning this latent capacity can become synergistic with broader network governance initiatives and their associated institutions is required. This line of investigation also opens up the possibility for a more thorough examination of power, equity and social justice issues than I have provided in this dissertation.

Section 7.4.2. Synthesis and learning across contexts

My research – although drawing on many different levels of analysis – was entirely situated in the Lesser Antilles context. There are definite benefits of situating in a single context, especially related to the potential for producing actionable results (e.g., the problems explored and solutions proposed are salient to that context). However, two particular limitations are (1) the ability to make externally valid claims regarding effective governance to address land-sea interactions and (2) the ability to identify lessons or governance innovations in other contexts that may have applicability in the context under examination. Chapter 4 – the systematic review – attempted to address the latter; however, not enough empirical case studies of governance across the land-sea interface were found in the existing literature. There is a definite need to analyze and synthesize case studies of governance across the land-sea interface in diverse contexts. Such an analysis and synthesis could advance middle-range theorizing regarding effective governance for addressing land-sea interactions.

Section 7.4.3. Governance for multi-scale land-sea interactions

An additional limitation in my research design is the treatment of multi-scale land-sea interactions and, more specifically, land-sea interactions occurring at a particularly large scale. Most notable is the recent experience in the region with an influx of sargassum seaweed to coastal areas. Sargassum is a genus of pelagic brown algae, which has recently exploded in growth. The recent explosion is hypothesized to be related to nutrient availability – largely from land-based sources – and warming ocean waters (Franks et al., 2011; Gower et al., 2013; Johnson et al., 2012). The Lesser Antilles have been hit multiple times since 2011 by large amounts of sargassum accumulating in near-coastal areas. There are potential benefits of

sargassum (e.g., renewable energy, increased availability of fish, fertilizer); however, the impacts to date have largely been negative, as the seaweed limits tourism potential, affects fishing equipment, and emits an unpleasant odour as it decays on beaches.

Evidence suggests the recent outbreak of sargassum partially results from nutrient inputs originating in South America and Africa (Johnson et al., 2012). These inputs have contributed to large blooms formed in the Atlantic Ocean, which then become dislodged and have found their way throughout the Caribbean region, parts of North America and, in some cases, back to western parts of sub-Saharan Africa. The processes contributing to the sargassum outbreak, and subsequently its redistribution and decay after it makes landfall, represent land-sea interactions occurring at a particularly large scale – a scale at which my doctoral research would have little influence. My research treated sargassum as essentially a sea-to-land interaction in each case study and examined local response to the issue. The underlying drivers of the sargassum outbreak are, in fact, land to sea interactions occurring in very different locations. My approach – for better or worse – treats the symptoms of the sargassum outbreak but does little to address the cause.

This type of large scale land-sea interaction adds an impressive spectrum of challenges for governance. The problem is essentially multi-jurisdictional (i.e., involving multiple nations), multi-regional (i.e., involving nations from the Caribbean, North and South America and Africa), involves ocean areas both within and beyond national jurisdiction, and does not align with existing attempts at large scale ocean governance (e.g., Large Marine Ecosystems). Although some interesting governance innovations involving multiple jurisdictions are apparent – as evidenced, for example, by recent workshops in Barbados (Sebastian, 2015) – there have been very few attempts to govern the sargassum issue at a scale matching that of its potential causes.

Governance at such a scale may, in fact, be unrealistic or too cumbersome; however, there are some potentially valuable directions for future research examining the strengths, weaknesses, and possibilities for governance to address such large scale land-sea interactions.

Section 7.5. Reflections

Sustainability science has progressed towards a focus on transdisciplinarity and, in relation to that, actionable research (Clark et al., 2016; Lang et al., 2012; Palmer et al., 2016). However, there are no blueprints for conducting or achieving either. Here, I offer a number of reflections based on my experience in attempting both.

Section 7.5.1. Was my research transdisciplinary?

Wickson et al. (2006) claim there are three key features that distinguish transdisciplinary research. First, transdisciplinary research is typically action-oriented and focused on problems at the interface of human and natural systems (Palmer et al., 2016; Wickson et al., 2006). Second, transdisciplinary research is inherently collaborative (Lang et al., 2012). Third, transdisciplinary research employs an evolving methodology, which means the methods are crafted to bridge epistemologies and allowed to respond to changing research priorities (Carew and Wickson, 2010; Wickson et al., 2006). My research contained many of these features, but with some important caveats. My problem focus and action-orientation align with the features of transdisciplinary research, and these features are discussed earlier in Chapter 3. However, the collaborative nature of my research and my application of an evolving methodology deserve further attention.

Individual transdisciplinary researchers typically collaborate with non-academics throughout the research process (Wickson et al., 2006). Although a plethora of definitions exist, the discourse

seems to be centering around two types of collaboration in particular: co-design and co-production. For my purposes, I use co-design to describe collaboration between a researcher and non-academics in framing a research problem, and co-production to describe collaboration in actually conducting the research or trying to address the problem (i.e., gathering data, interpreting results) (Leemans, 2016; Ramesh et al., 2016; Sitas et al., 2016; Turner II et al., 2016). I pursued partnerships and collaborations with a number of organizations. I formed formal partnerships with the Fisheries Division in Dominica, the Saint Lucia National Trust, the Ministry of Sustainable Development in Saint Lucia, and the Forestry Division in Grenada. In Dominica, I was effectively embedded within the Fisheries Division. I formed more informal partnerships or received guidance from the Fisheries Division in Antigua and Barbuda, the Department of Constituency Empowerment in Saint Kitts and Nevis, and the National Parks, Rivers and Beaches Authority in Saint Vincent and the Grenadines. My collaboration with these organizations exhibits elements of co-design. In fact, my motivation for asking governance questions across the land-sea interface emerged from interviews with coastal-marine managers in Saint Lucia as part of an earlier project (see Pittman et al., 2015). Additionally, all partners and collaborators influenced the contextualization of the research process in each context. However, co-production is somewhat limited in my research. Although, some co-production is apparent in my remote interactions with key collaborators in each site as I interpret results and seek feedback (via Skype, email, WhatsApp, etc.). This process does not reflect an ideal form of co-production, but seems a cost-effective option for my current circumstance. I am actually pleasantly surprised by how connected I can remain even when not based in the field.

In terms of evolving methodology, I believe my approach reflects what Wickson et al. (2006) call an evolved methodology, since I bring together methods from different disciplines with

divergent epistemological roots into an overall coherent methodology (Chapter 3). However, I'm not entirely confident my approach was evolving. My methods were largely set as I developed and defended my proposal. I deviated in minor ways from the original plan, yet these deviations are hardly of note (e.g., I conducted more interviews than I anticipated in each site). As I recognized my study's limitations (Section 1.4), I did not significantly modify my plan to tackle new concepts, expand to new contexts, or examine the problems at a greater spatial scale. As such, I don't feel my approach was evolving, per se. However, perhaps my doctoral research – if considered as part of an ongoing research program I intend to maintain – exemplifies an evolving methodology, but time will tell.

Section 7.5.2. Was my research actionable?

Transdisciplinarity implies an inherent action-orientation, as I've discussed elsewhere (Chapter 3). The intent is to conduct research that has pragmatic and applied outcomes for practitioners, resource users and other stakeholders or collaborators involved with the research. While there are no formal requirements within the academy to conduct actionable science, the desire to tackle real world problems can outweigh the lack of academic incentives to pursue applied outcomes (Pittman et al., 2016). However, the reality is these outcomes are difficult to trace, rarely directly connected to any formal or traditional research product (e.g., peer-reviewed publications, dissertations), and often involve effort above and beyond typical research activities (Cornell et al., 2013; van Kerkhoff and Lebel, 2006). Evidence suggests that meaningful coproduction is important for fostering applied outcomes (Clark et al., 2016; Posner et al., 2016). Yet even with coproduction researchers can struggle to have an impact to policy or practice (Cáceres et al., 2015).

Based on my experience, I would suggest that I have a number of actionable findings (Section 5.3), but it is too early to tell if they will have a meaningful impact to policy or practice. I believe that my potential to influence policy and practice will be contingent on my continued engagement and interaction with policy makers and practitioners in the Lesser Antilles. I also think that any potential impacts resulting from my work will be both direct and indirect. Direct impacts could manifest through dissemination of my findings (e.g., production of policy briefs), while indirect impacts will require innovative, creative, and demand-driven approaches to working outside the academy. In line with the latter, I have undertaken a few activities of note: 1) I prepared an environmental awareness survey report for the Praslin Seamoss Farmers Association in Saint Lucia; 2) I reviewed and provided feedback on briefing notes to the Minister responsible for fisheries in Dominica regarding the sargassum issue; and 3) I fundraised for a marine conservation science event aimed at youth hosted by the Fisheries Division of Dominica and Dominica's Sea Turtle Conservation Organization Inc. (DomSeTCO). These activities help apply my understanding of effective governance across the land-sea interface based on my research, yet they do not necessarily directly apply my findings. Do such activities count as actionable outcomes? I will leave that question for the time being.

Section 7.6. Concluding remarks

I have contributed to an ongoing conversation regarding governance across the land-sea interface. My results highlight the potential for network governance to improve capacity in this regard, and I have identified selected conditions that promote the emergence of network governance – namely, participation on collaborative projects, ratification of multilateral agreements, the presence of boundary-spanning organizations, and experience with extreme events. Additionally, I have provided valuable insights regarding strategies to improve

governance in the face of negative land-sea interactions. There has been significant progress towards network governance to address land-sea interactions in the Lesser Antilles. I look forward to observing and participating as the ongoing transitions towards network governance unfold.

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Appendix A. Historical and contextual overview of case studies

The recent history of the Lesser Antilles is grounded in European colonialism. Shortly before colonialism, the region was inhabited by two main cultural groups of Indigenous peoples – the Arawak (Taíno) and Kalinago (Carib) – both with roots in South America. The Arawak people are believed to have migrated first from South America through the Lesser and Greater Antilles; and the Kalinagos are believed to have migrated later and established themselves as the dominant peoples of the Lesser Antilles prior to the colonial era (Watts, 1994). The colonial era, beginning in the 15th century, brought a mix of European and African peoples to the region, the former as colonizers and the latter as slaves (Watts, 1994). These newcomers focused on establishing plantation agriculture on the islands, which is essentially the genesis of the drive towards land use change that is still relevant today (Watts, 1994). The islands' histories and experiences with colonialism influence the governance structures and broader discourses currently underpinning land-sea governance. Most of the islands eventually ended up under British control after significant struggles between Britain and France. Slavery was abolished by Britain in 1833 by the *Slavery Abolition Act*, and many of these nations became independent in the mid-1900s.

Since then, various sectors have developed – tourism, agriculture, fisheries – under the oversight of national governments; but some have argued that these sectors have always been structured to suit the needs and priorities of the former colonial powers. For example, the banana industry that was lucrative in this region during the 1970s and 1980s was essentially given guaranteed and preferential access to the market in the United Kingdom (i.e., a former colonial power; Klak et al., 2011). The export-oriented nature of the banana sector, fueled by European subsidies, fostered an external dependence that made the eventual collapse – which was brought on by the neoliberal ideals of the World Trade Organization to end preferential market access – that much

more devastating (Klak et al. 2011). Others have drawn similar links between postcolonialism and the tourism sector that suggest colonial power structures are in some ways reproduced as the once island colonies become preferred destinations for their old colonial oppressors (Hall and Tucker, 2004). Fisheries, although for the most part not export-oriented, also found their roots in colonial times, which arguably established small-scale fisheries as the subsistence activity that persists today (Price, 2009). Brief histories and current contextual conditions for each island are described below.

Saint Lucia

Archaeological evidence suggests Saint Lucia was inhabited by the Arawak peoples, who were superseded by the Kalinago before European contact. There were two failed attempts at British colonial settlement before 1639 (Mitchell, 2010). Beginning in the mid-1600s, the French were able to gain a foothold and, by 1780, they had established twelve settlements and a significant population, which consisted mostly of slaves from West African decent (Breen, 1844; Mitchell, 2010). Claim to the island remained contested, and it switched between British and French control fourteen times before 1814, when British control of the island was solidified. Despite British control, the islands' culture remained rooted in the West African and French traditions, which are reflected in the predominance of the Kweyol language (Mitchell, 2010). Saint Lucia gained its independence from Britain in 1979, but remains a member of the British Commonwealth.

The current government structure of Saint Lucia contains many actors with relevance to land-sea governance. The Ministry of Sustainable Development, Energy, Science and Technology plays a coordinating role and houses the Coastal Zone Management Unit. The Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives has a broad mandate towards

many facets of socioeconomic activity and development. The sub-structure of this ministry is fragmented according to the different sectors mentioned in its title. The Ministry of Tourism, Information and Broadcasting oversees and regulates the tourism sector. The Water and Sewage Company of Saint Lucia has a mandate and interest in fresh water resources. It functions as quasi-government, despite being officially a corporation. The Saint Lucia National Trust (SLNT) is a similar, arms-length organization, which is particularly important in the case study area. SLNT has become the *de facto* champion for the Pointe Sable Environmental Protection Area with informal responsibilities for coordinating across the various stakeholders (e.g., Aupicon Charcoal Producers).

Outside of government, there are a number of key organizations to note. The Soufriere Marine Management Authority (SMMA), despite being outside the case study area in Saint Lucia, is a well-known example of participatory governance attempts, which were used to diffuse conflict between a rapidly developing tourism sector and the longstanding small-scale or artisanal fisheries in Saint Lucia (Sanderson and Koester, 2000). Despite residing outside the case study area, the SMMA's efforts are important because they serve to set a precedent and provide a working example of participatory coastal governance in Saint Lucia and the Lesser Antilles more broadly. The Trust for the Management of Rivers (TMR) is a similar governance experiment with participation in coastal watershed management, which was born out of the Integrated Water and Coastal Areas Management (IWCAM) program. TMR is much more focused on land-sea interactions than the SMMA, but was established with similar participatory ideals. TMR has undertaken a number of on-the-ground projects, such as (1) the development of constructed wetlands to filter sewage; (2) the establishment of rain water harvesting systems as back up water supplies at hospitals; and (3) the reduction of source water contamination risk from

livestock operations. Also of note is the plethora of community-level actors in Laborie – e.g., the Anse Kawet Crafters, Laborie Fishers and Consumers Cooperative, Laborie Development Foundation – that collaborate extensively amongst themselves on issues relevant to social and ecological sustainability (e.g., drainage, disaster preparedness).

Dominica

Dominica exhibits a similar narrative regarding Indigenous peoples' occupation as Saint Lucia, since it was also first occupied by the Arawak people and then the Kalinago. However, it is the only island in the Lesser Antilles with an officially recognized Kalinago Territory that exists today. As France and Britain battled for control of the island and much of the region during the 18th century, Dominica remained a firm stronghold for the Kalinago, which was even recognized in certain treaties between France and Britain, such as the Aix-la-Chapelle treaty of 1748 (Burke, 1998). This treaty declared Dominica under Kalinago control and as neutral territory between France and Britain (Burke, 1998). Despite the declarations in the treaty, Britain continued to wage war on the Kalinago and eventually gained control of the island in 1763, but provided the Kalinago with a certain territory under their control (Burke, 1998). This territory was expanded to its current extent in 1903, and the Kalinago chief was also officially recognized by the British (Burke, 1998). Dominica became an independent republic in 1978 and remains a member of the British Commonwealth. Since independence, the Kalinago Territory officially is held by the Carib Council (Burke, 1998).

In the current governance structure, the Environmental Coordinating Unit works to establish ties across the government and interact with broader, international organizations on environmental issues. The Ministry of Agriculture and Fisheries oversees these sectors and has an internal structure fragmented based on sectoral divides. The Ministry of Planning, Economic

Development and Investment is mandated to oversee and regulate infrastructure developments on the island. The Ministry of Housing, Lands and Water Resource Management is mandated to manage land and water resources for social and economic development. The Ministry of Tourism and Urban Renewal seeks to advance Dominica's tourism sector mostly by promoting the island as an ecotourism destination. The Dominica Water and Sewerage Company is a quasi-government organization with interests in fresh water resources.

Outside of government, Dominica is home to a number of community fisheries cooperatives – Woodbridge, Saint Mark's, New Town – and two national fisheries cooperatives – the Dominica Fisheries Cooperative and the National Fisheries Cooperative. The latter recently replaced the former as the main national cooperative in Dominica. The diving industry reflects a similar structure, where individual dive shops coordinate under the Dominica Water Sports Association to collaboratively market their industry and undertake certain programs (e.g., Lionfish hunting). The Scott's Head Soufriere Marine Reserve (SSMR) Local Area Management Authority (LAMA) is a multi-stakeholder organization designed to manage the marine reserve. In addition to stakeholders in the communities of Scott's Head and Soufriere, the SSMR LAMA is supposed to engage stakeholders up the coast from Pointe Michelle (e.g., the informal fishers' group) and further inland from Gallion (e.g., the informal crab harvesters' group). However, the SSMR LAMA is currently in a period of renewal following a few years of reduced presence.

Saint Vincent and the Grenadines

Saint Vincent and the Grenadines exhibits similar patterns as Saint Lucia and Dominica of occupation by Indigenous peoples and struggles for control by Britain and France during colonial times. However, the history of Saint Vincent is somewhat distinct due to the predominance of the Garifuna people or 'Black Caribs', who were descendants of Kalinago people and escaped West

African slaves most likely from Saint Lucia and Grenada (Carton, 1996). The Garifuna fiercely resisted British control of Saint Vincent until they were eventually defeated and deported to Honduras in the mid-1700s. Saint Vincent existed as a British colony from 1763 until it gained independence in 1979. It remains a member of the British Commonwealth.

The key actor in terms of land-sea governance in Saint Vincent is the National Parks, Rivers and Beaches Authority (NPRBA), which was created by the *National Parks Act* (2002) and is guided by the National Parks and Protected Areas System Plan. The NPRBA is a key player in guiding an integrated and collaborative approach to land-sea governance. The Ministry of Agriculture, Forestry, Fisheries and Rural Transformation oversees the various sectors in its name and exhibits the same fragmented internal structure eluded to in early case descriptions. There are a number of fisheries cooperatives in Saint Vincent – e.g., Barley, Caliaqua, Goodwill – and a number of active environmental NGOs in the Grenadines (e.g., Sustainable Grenadines, Union Island Environmental Attackers). These organizations all have a role to play in land-sea governance and bring a mix of their respective interests to the forefront.

Grenada

Again, the historical narrative for Grenada regarding Indigenous occupation and colonial struggles is similar to the islands discussed above. An important distinguishing feature for Grenada occurred more recently. Grenada became independent from Britain in 1974 and remains a member of the British Commonwealth. However, a coup in 1979 overthrew the previous democratic government and instated a Marxist-Leninist regime with close ties to Cuba and the Eastern Bloc in Europe (Brizan, 1998). This was followed by a military coup in 1983, which led to an invasion by U.S. and Caribbean troops and the eventual reinstatement of the original democracy (Weber, 1994; Brizan, 1998). The U.S. interests were related to the ongoing Cold

War and difficult relations with the Eastern Bloc and Cuba. The U.S. wanted to remove the possibility of strategic Eastern Bloc control of the region by way of establishment and foothold in Grenada, which made Grenada an important geopolitical nation in light of Cold War politics (Weber, 1994; Brizan, 1998).

Currently, the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment contains many of the departments with formal authority over land-sea governance. The Forestry Division is responsible for watershed management; while the Fisheries and Agriculture departments are responsible for their respective sectors. The Physical Planning Unit within the Ministry of Works, Physical Development and Public Utilities is responsible for regulating many aspects of infrastructure development. There are a number of conservation-oriented NGOs operating in Grenada – e.g., St. Patrick's Environmental and Community Tourism, Ocean Spirits, People in Action, Grenada Fund for Conservation Inc. - and the Grenada Community Development Agency has a particular focus on sustainable community development. Grenada has a broad scope and diversity of capable and effective community-level organizations working on land-sea governance issues. Many of these organizations work directly with issues at the land-sea interface (e.g., sea turtle conservation, run-off control).

Antigua and Barbuda

Following Arawak and Kalinago occupation, Antigua was claimed by British settlers from Saint Kitts in the 1630s (Appleby, 1996). It became a formal British colony in 1667. The island was quickly transformed in 1674 following the successful establishment of sugar plantations owned by the British, but worked mostly by a majority population of West African slaves (Watts, 1994). These slaves lived in deplorable conditions and eventually planned an uprising in 1736, which was led by a slave named Prince Klaas (Kras, 1997). However, the uprising was unsuccessful

and the island remained in British control. Antigua was an important and strategic vantage point for the British throughout colonial history, and it found itself under French control far less than the other islands discussed above. Antigua gained independence in 1981 and remains in the British Commonwealth.

The Environmental Department in Antigua works to establish networks across government departments that facilitate a holistic approach to land-sea governance. The Department has been extremely successful in securing funding from international donors to undertake a number of activities and projects. The National Parks Authority is responsible for managing the terrestrial and marine parks; however, Nelson's Dockyard is the main managed park. The Central Board of Health is responsible for monitoring and regulating coastal water quality. The Development Control Authority is mandated to control development, but suffers from a pervasive lack of resources to effectively fulfill its mandate. The Christian Valley Agricultural Center – part of the Ministry of Agriculture, Lands, Fisheries & Barbuda Affairs – tests and cultivates a number of innovative crops (e.g., mangoes) to spread throughout Antigua. The Forestry Unit is mandated – among other things – to control deforestation and erosion in terrestrial environments. The Environmental Awareness Group is the main environmental NGO, which has an impressive reputation and long track record of projects with relevance to land-sea governance (e.g., reduction of overgrazing).

Saint Kitts and Nevis

Saint Kitts and Nevis, following Arawak and Kalinago occupation, was settled by the British in 1623 and the French in 1625 (Watts, 1994; Appleby, 1996). The original British settlers allowed the French settlers to remain in attempts to outnumber the local Kalinago populations (Jonnard, 2010). The British believed the Kalinago people were planning an attack. Written history

suggests that, in 1626, Kalinago people from Saint Kitts, Nevis and Dominica were plotting to raid the European colonies on Saint Kitts; however, this historical narrative remains contested and the exact intentions of the Kalinago in gathering on Saint Kitts are not confirmed. Nonetheless, the colonizers essentially slaughtered the Indigenous Kalinago populations in light of these suspicions – an event known as the Kalinago Massacre of 1626 (Jonnard, 2010). Saint Kitts became partitioned between British and French control, and it remained as such until 1783 when British control over the entire island was established by the Treaty of Versailles (Watts, 1994). Saint Kitts and Nevis became independent in 1983 and remain in the British Commonwealth. An additional important note regarding this twin island nation is the considerable autonomy provided to the two islands. They share a single National Assembly, but Nevis also has its own assembly and administrative bodies.

Currently, the Ministry of Sustainable Development is a major player in land-sea governance in Saint Kitts. The Ministry contains many of the relevant departments – e.g., Physical Planning and Environment, Lands and Surveys – related to sustainable terrestrial development. The Department of Marine Resources – the lead organization on marine sustainability – is found within the Ministry of Agriculture, Human Settlement, Cooperatives and Environment. Saint Kitts and Nevis participated in an innovative marine zoning project in collaboration with The Nature Conservancy and funded by USAID; however, the zoning recommendations from the project are still in the process of being implemented. The main NGO for fisheries in Saint Kitts is the National Fisherfolk Organization.

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Appendix B. Interview Guide

Note: specific language was tailored for each context

Setting the stage

1) What is the mandate of your organization? Probe: main thematic work areas
2) What is your role within the organization?
   a. How long have you been in this role?
   b. What role(s) did you have previously?

Drivers and stressors

3) What are the main issues or challenges facing coastal-marine areas?
   Probe: sedimentation, agrochemicals, sewage, invasive species, heavy metals, litter

   a. What is the most important challenge?
4) What are the main issues facing watersheds/ terrestrial ecosystems?
   Probe: salination of water supplies, storm surge, soil salination

   a. What is the most important challenge?
5) Are these challenges interrelated? If so, how?

Structure and activities of organization

6) How does your organization address land-ocean interactions?
7) What types of projects or activities does your organization typically undertake to address land-ocean interactions? Probe: stream enhancement, riparian area management, agricultural extension, public awareness, planning, monitoring, scientific assessment, sedimentation control, regulation, evaluation.
8) Where have these projects taken place? (Show and record on map)
9) Which projects/activities have been most/least successful?

Monitoring, evaluating and facilitating success

10) How does your organization monitor and evaluate success/failure?
11) What enables your ability to implement successful projects/activities?
12) What constrains your ability to implement successful projects/activities?

Governance

13) How are land-ocean interactions currently managed? Probe: main policies, programs, committees, etc.

a. Are there chances to participate?
b. Who is typically involved in decisions? Or consulted? Who is in charge?
c. Should others be involved in decisions? Who?
d. Are you satisfied with how you're involved?

14) Who should be responsible for addressing land-ocean interactions?
15) How successful has the current approach been in addressing land-ocean interactions?
    a. How do you define success? What does success in this regard mean to you?
16) What has not been addressed well?
17) What are the main strengths of the current approach?
18) What are the main weaknesses of the current approach?

Organization-level networks

19) Is your organization involved with any coalitions or multi-stakeholder committees?
    a. What other organizations are on each committee or a part of each coalition?
    b. Has participation in these coalitions or multi-stakeholder committees been beneficial? Why/not?
20) Does your organization jointly implement projects with other organizations?
    a. Please describe the nature of collaboration with each organization.
    b. Were these endeavours successful? Why/not?
21) Does your organization coordinate its actions with other organizations?
    a. Please describe the nature coordination with each organization.
    b. Were these endeavours successful? Why/not?
22) Does your organization share/receive resources (e.g., equipment, staff, funds) with other organizations?
    a. Please describe the extent of the resource sharing with each organization.
    b. Please describe the importance of the resource sharing with each organization
23) Does your organization share/receive information or advice with other organizations?
    a. Please describe the extent of information sharing with each organization.
    b. Please describe the importance of information sharing with each organization

Individual-level networks

24) Whom do you ask when you have a question about the status of the coastal-marine environment?
    a. Please list up to five individuals and their organizations.
    b. How frequently do you ask each individual?
    c. Where else would you get information?
25) Whom do you ask when you have a question about how to address coastal-marine issues within your projects?
    a. Please list up to five individuals and their organizations.
    b. How frequently do you ask each individual?

c. Where else would you get information?

26) Whom do you ask when you have a question about the status of the terrestrial environment?
    a. Please list up to five individuals and their organizations.
    b. How frequently do you ask each individual?
    c. Where else would you get information?

27) Whom do you ask when you have a question about how to address terrestrial environmental issues within your projects?
    a. Please list up to five individuals and their organizations.
    b. How frequently do you ask each individual?
    c. Where else would you get information?

Future solutions

28) If things continue how they are now will the future be sustainable?
29) What needs to be done to better address land-ocean interactions?

Probe: regulations, incentives, awareness, power, authority, legislation, planning

30) How do the required changes compare with how things are now?
31) What are some realistic short-term goals or actions?
32) What are some long-term goals or actions?
33) Which groups/organizations have the most influence over the future approach?
34) Which groups/organizations are most actively engaged in shaping the future?

Appendix C. Ethics Approval

UNIVERSITY OF WATERLOO

OFFICE OF RESEARCH ETHICS

Notification of Ethics Clearance of Application to Conduct Research with Human Participants

---

Faculty Supervisor: Derek Armitage **Department:** Environment & Resource Studies

Student Investigator: Jeremy Pittman **Department:** Environment & Resource Studies

ORE File #: 19949

Project Title: Governance fit and the challenge of navigating interactions at the land-ocean interface

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This certificate provides confirmation the above project has been reviewed in accordance with the University of Waterloo's Guidelines for Research with Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. This project has received ethics clearance through a University of Waterloo Research Ethics Committee.

***Note 1**: This ethics clearance is valid for one year from the date shown on the certificate and is renewable annually. Renewal is through completion and ethics clearance of the Annual Progress Report for Continuing Research (ORE Form 105).*

***Note 2**: This project must be conducted according to the application description and revised materials for which ethics clearance has been granted. All subsequent modifications to the project also must receive prior ethics clearance (i.e., Request for Ethics Clearance of a Modification, ORE Form 104) through a University of Waterloo Research Ethics Committee and must not begin until notification has been received by the investigators.*

***Note 3**: Researchers must submit a Progress Report on Continuing Human Research Projects (ORE Form 105) annually for all ongoing research projects or on the completion of the project. The Office of Research Ethics sends the ORE Form 105 for a project to the Principal Investigator or Faculty Supervisor for completion. If ethics clearance of an ongoing project is not renewed and consequently expires, the Office of Research Ethics may be obliged to notify Research Finance for their action in accordance with university and funding agency regulations.*

***Note 4**: Any unanticipated event involving a participant that adversely affected the participant(s) must be reported immediately (i.e., within 1 business day of becoming aware of the event) to the ORE using ORE Form 106. Any unanticipated or unintentional changes which may impact the research protocol must be reported within seven days of the deviation to the ORE using ORE form 107.*

Maureen Nummelin, PhD
Chief Ethics Officer

6/25/2014
Date

OR
Julie Joza, MPH
Senior Manager, Research Ethics

OR
Sacha Geer, PhD
Manager, Research Ethics

Appendix D. Supplementary Materials

Table D1. Search terms used to identify papers and their occurrences in each database.

Search terms	**Scopus (N of hits)**	**Web of Science (N of hits)**
governance AND ("ecosystem-based management" OR "integrated coastal zone management") AND (coastal OR marine)	148	184
governance AND integrated AND watershed AND coastal	14	12
governance AND (“integrated coastal and oceans management" OR “integrated land-sea”)	3	0
TOTAL	165	196

Note: The searches were completed in August 2014.

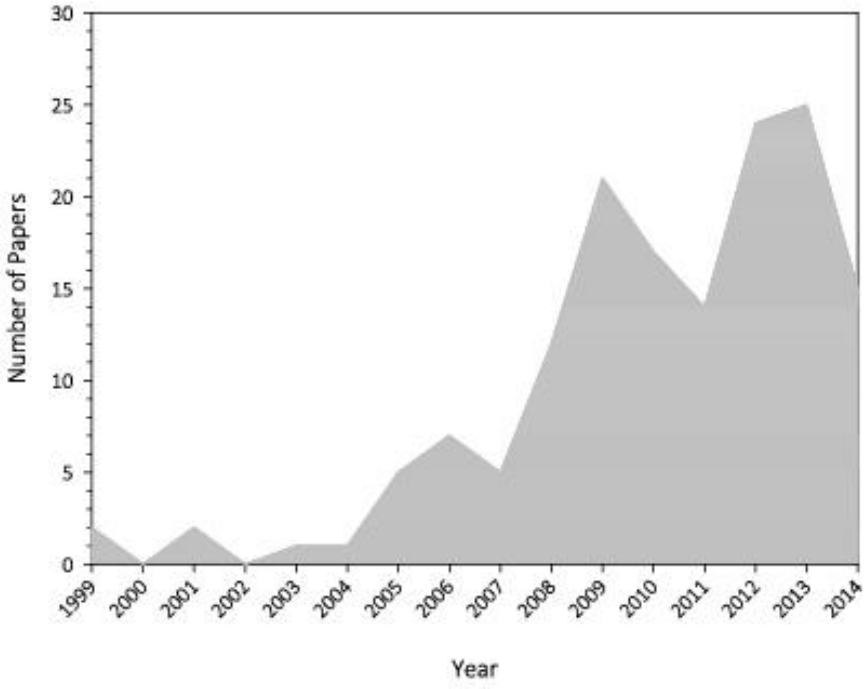


Figure D1. Number of papers published per year in the sample.
Note: The search was completed in August 2014.

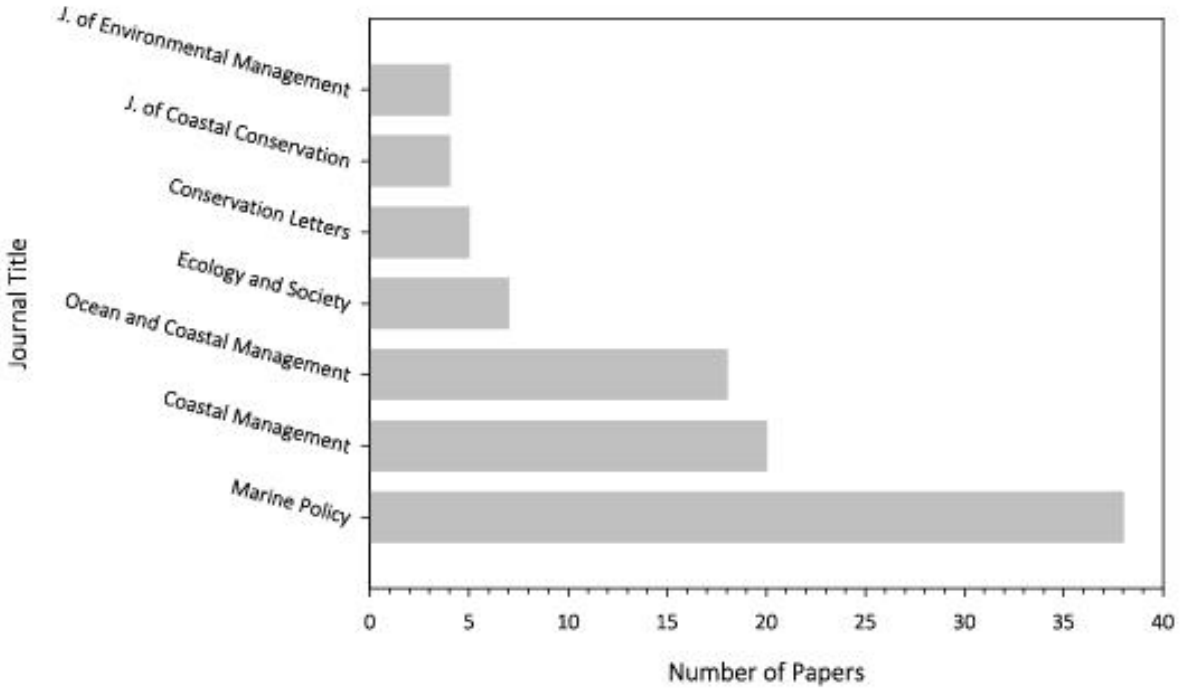


Figure D2. Number of papers published in selected journals.

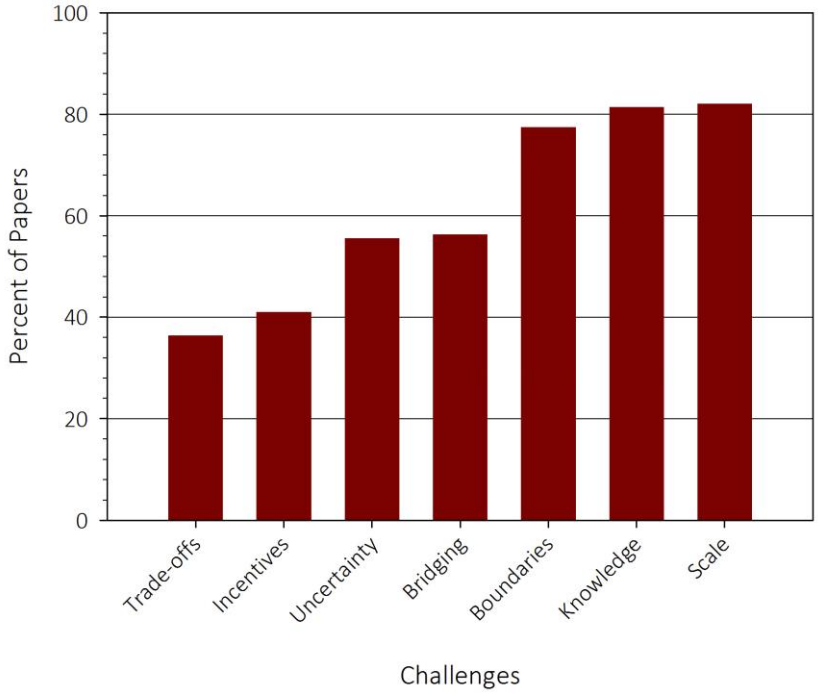


Figure D3. Predominance of governance challenges in the literature.

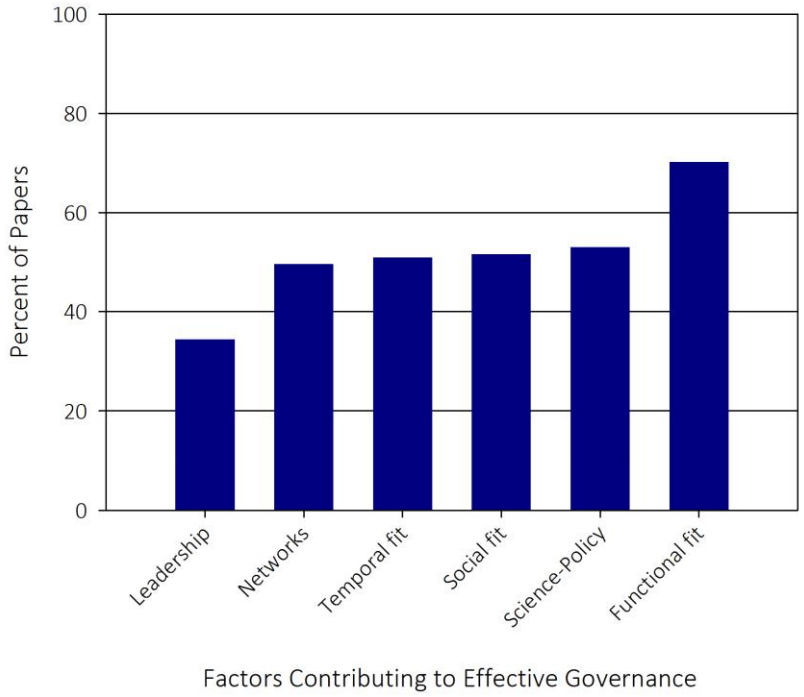
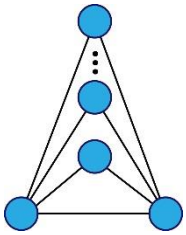
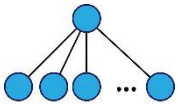
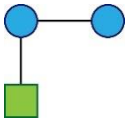
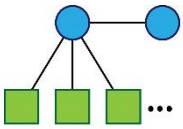


Figure D4. Predominance of factors contributing to governance effectiveness in the literature.

Table D2. Social-ecological network control configurations.

Control configurations		
	C1	Triadic closure
	C2	Alternating triadic closure
	C3	Popularity
	C4	Cross-level activity
	C5	Alternating cross-level activity

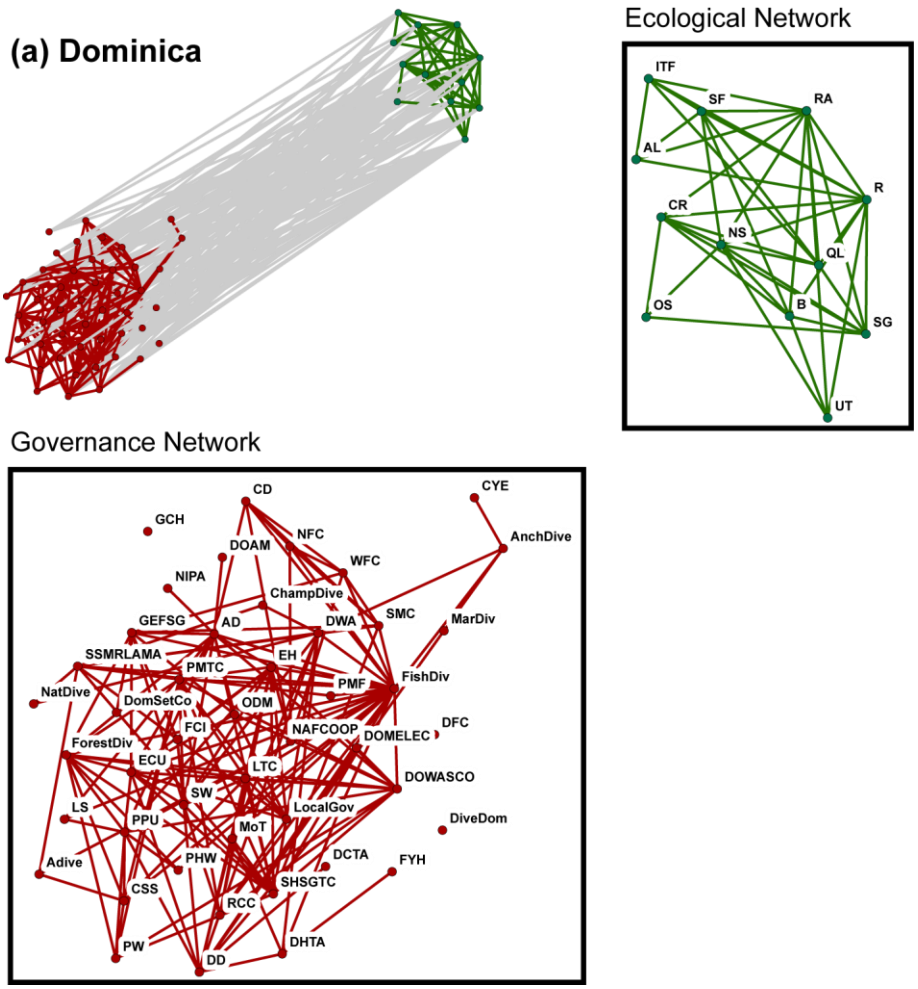


Figure D5. Social-ecological network from the southwest coast of Dominica.

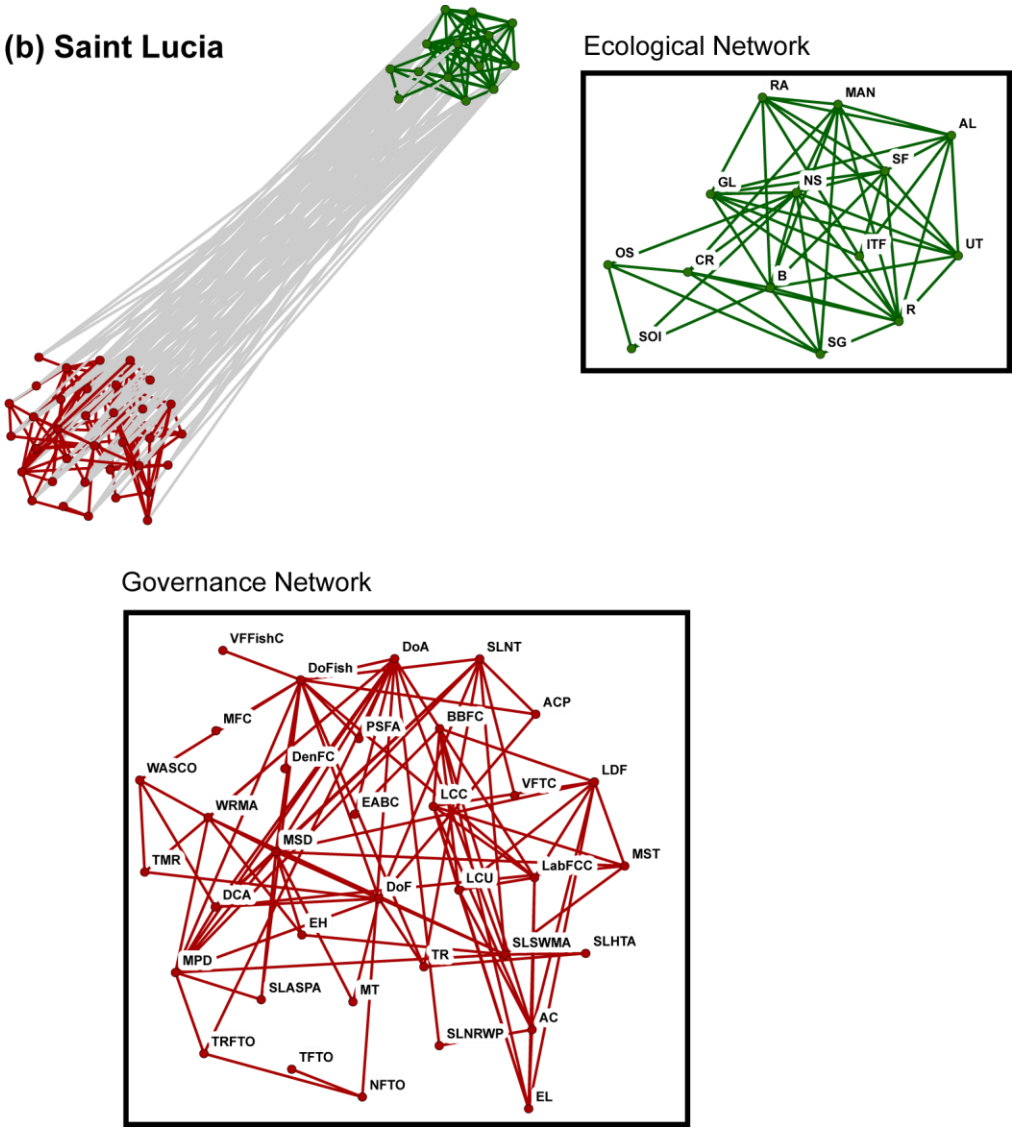


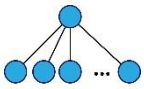
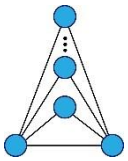
Figure D6. Social-ecological network from the southeast coast of Saint Lucia.

Table D3. MERGM estimates.

Building block	Saint Lucia		Dominica	
	Estimate (Standard error)	Observed (t-stat)	Estimate (Standard error)	Observed (t-stat)
C1	0.6524 (0.079)*	90 (0.075)	0.36 (0.049)*	205 (-0.054)
C2	0.4314 (0.201)*	127 (0)	1.1263 (0.223)*	245 (-0.029)
C3	-0.4735 (0.39)	251 (0.014)	-0.3153 (0.273)	449 (-0.055)
C4	-0.6253 (0.238)*	508 (-0.042)	-0.4773 (0.151)*	811 (0.086)
C5	0.2068 (0.142)	498 (-0.026)	0.0975 (0.073)	760 (0.085)
MA1	-0.6676 (0.173)*	29 (0.071)	-0.1138 (0.174)	66 (-0.066)
MA2 (land)	-0.1401 (0.215)	16 (0.089)	-0.0369 (0.172)	41 (0.09)
MA2 (sea)	-0.2458 (0.267)	38 (-0.071)	-0.3921 (0.189)*	42 (-0.095)
CM1	0.2684 (0.29)	88 (-0.012)	0.4451 (0.179)*	200 (0.082)
CM2	0.6464 (0.469)	60 (0)	0.1641 (0.311)	128 (0.08)
BI1	0.0823 (0.07)	450 (-0.047)	0.0627 (0.047)	756 (0.081)
BI2	0.649 (0.213)*	667 (-0.045)	0.5068 (0.158)*	804 (-0.001)

* significant effect

Table D4. Governance network control configurations.

Control effects		
	C6	The likelihood that certain actors will be popular collaborators.
	C7	The likelihood that collaborators of collaborators will be collaborators.

Note, parameters were conditionally estimated with density fixed.

Table D5. Main projects.

Projects	Antigua	St. Kitts	St. Vincent	Grenada
IWCAM (N)	4	3	5	2
IWECO	X	X	X	X
CATS		X	X	X
ECMANN	X	X	X	X
MSP		X		
OPAAL	X	X	X	X
EU	X	X	X	X
GEF Small Grants (N)	28	1	15	15

Table D6. Hurricanes and tropical storms tacking within 60 nautical miles, 1944-2010.

Type	Antigua	St. Kitts	St. Vincent	Grenada
All hurricanes (N)	14	14	7	5
Hurricanes, H3-H5 (N)	6	6	2	3
Tropical storm (N)	9	11	13	10
Total (N)	23	25	20	15

Source: (K. Knapp et al., 2010; K. R. Knapp et al., 2010; NOAA, 2016; StormCARIB, 2016)
Note: 60 nautical miles = 69 miles = 111 kilometres

Table D7. ERGM parameter estimates related to multi-actor governance.

	Antigua	St. Kitts	St. Vincent	Grenada
	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Focal effects				
CG1.	-3.156 (1.04)*	-2.9195 (1.134)*	-1.2787 (1.384)	0.7655 (0.279)*
CG2	-3.3332 (1.227)*	-3.3898 (1.208)*	-1.4121 (1.328)	-0.7181 (0.336)*
CG3	-3.4278 (1.052)*	-3.1773 (1.114)*	-2.1233 (1.401)	[a]
Control effects				
C6	-0.3663 (0.498)	0.3084 (0.408)	-0.2612 (0.461)	-1.0564 (0.113)*
C7	1.7047 (0.534)*	0.2789 (0.218)	0.5642 (0.227)*	0.9898 (0.193)*

* significant effect

[a] Building block not included in model. Model would not converge when building block included.

Table D8. ERGM parameter estimates related to land-sea integration.

	Antigua	**St. Kitts**	**St. Vincent**	**Grenada**
	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Focal effects				
LS1	-3.3056(1.173)*	-3.3518(1.057)*	-1.7669(1.211)	-3.6224(0.565)*
LS2	-3.4985(1.502)*	-2.3155(1.557)	-1.3906(1.341)	-3.7036(1.859)
LS3	2.5638(0.943)*	1.3316(0.877)	0.5056(0.838)	1.7038(0.936)
LS4	-1.6929(1.26)	-0.579(1.171)	-0.0667(1.169)	[a]
LS5	-1.9285(0.929)*	-2.303(0.956)*	-2.5821(0.967)*	-3.5315(0.629)*
LS6	-2.2959(0.952)*	-1.146(0.898)	-2.0967(0.997)*	-2.1591(0.964)*
Control effect				
C6	-0.3232(0.546)	0.3734(0.393)	0.1974(0.469)	0.2081(0.237)
C7	1.6557(0.559)*	0.278(0.219)	0.3235(0.228)	0.7551(0.202)*

* significant effect

[a] Building block not included in model. Model would not converge when building block included.