1

Introduction

By Jill Slinger, Susan Taljaard and Floortje d'Hont

1.1. Background

This book captures the learning from a cross-comparison of seven international inlet or estuary mouth management situations. The conceptual framing is provided by a focus on systems knowledge and its development and use within coastal management. Systems and systems knowledge have been described as holistic, embodied ways of conceptualising reality, forming "both a way of inquiry and an object of inquiry" (Nelson, 2008). To date there has been little research focussing on the role of systems approaches in informing coastal management despite the early development of systems thinking (late 1950's onwards) (Ison et al., 1997), the general acceptance of the adaptive learning cycle of integrated coastal management (Group of Experts on the Scientific Aspects of Marine Environmental Protection [GESAMP], 1996; Olsen et al., 1999), and ongoing engineering infrastructural and urban development along our coasts. Recently, Reis et al. (2014) undertook a study on systems approaches for implementing integrated coastal management principles in Europe, concluding that there is evidence that systems approaches provide a significant step in advancing multidisciplinary sustainability science. Accordingly, this study adopted a systems approach (the way of inquiry) in seeking to learn across a diversity of case studies (the objects of inquiry), each exhibiting complex bio-geophysical and social dynamics on multiple, nested spatial scales and time horizons. In particular, an international cross-comparison was undertaken to garner knowledge on the role of system understanding in designing and managing nature-based interventions (Slinger, 2016; Waterman, 2010) in a range of inlet and estuary systems. Here, the interventions are regarded as the product of the involved network of scientists, engineers and other stakeholders within the case studies, and their social dynamics over time. In this sense the interventions are knowledgeable actions (Ison, 2008).

Specifically, a transdisciplinary systems approach is reported, in which the linkages between the social, economic and biophysical (ecological) aspects that are studied in the coastal environment form the focus of inquiry, as well as the use of a range of different knowledge types (see Max-Neef, 2005). By explicitly recognizing different types of knowledge, such as model-based knowledge, technical design knowledge, and local community knowledge, new and deeply relevant insights for coastal management in the Netherlands and internationally are obtained. The embedding of deep case-based knowledge within a broad international perspective, yet with a focus on the role of system knowledge, makes the learning useful for coastal decision making worldwide.

The case studies in the international cross-comparison satisfy the following criteria:

- There is an inlet management or estuary mouth management issue,
- The issue is understood to be nested within a broader ecological and social system context,
- Place-based knowledge is used,
- Scientists have been, and are, engaged with coastal management.

More generally, the coastal management situations in the case studies exhibit characteristics of 'wicked', 'messy' or 'unstructured' problems where complexity is inherent, outcomes are uncertain, and there are diverse viewpoints on what is known, and which outcomes are desired (Ackoff, 1980; Enserink et al., 2010; Rittel & Webber, 1973). Schön & Rein (1994) claim that such situations are fundamentally about competing values rather than gaps in scientific knowledge. So developing comprehensive and deeper scientific knowledge in individual disciplines will not necessarily help in solving the coastal management problems. However, like Head and Alford (2015), we argue that partial, provisional solutions can be pursued through scientific learning within and across such situations. The aim of the book, therefore, is to engender such learning across a diversity of case studies in estuary and inlet management.

The diversity of the case studies presents its own particular challenge to learning. Each of the case studies occurs within a different bio-geophysical coastal system and within a different socio-economic context. Which aspects can usefully be compared? In addressing this challenge, we examine a number of theoretical perspectives at the outset. Systems thinking (Ackoff, 1971; Checkland, 1981; Ison et al., 1997; Meadows, 2008) and policy analysis (Thissen & Walker, 2013; W. E. Walker, 2000) are fundamental to our approach, so they are introduced first. These theoretical perspectives provide the analytical lens and the methods (the ways of inquiry) through which we seek to learn about the case studies. Next, a number of integrated environmental management paradigms that have been established as underpinning integrated coastal management (Frantzeskaki et al., 2010; Taljaard et al., 2011) are described. These paradigms include environmental assessment, objectives-based management, adaptive management and ecosystem-based management. Social-ecological systems theory is then described (Berkes & Folke, 1998; Redman et al., 2004) and the move to include multi-disciplinary, place-based learning that rests upon system understanding in the management of the environment is highlighted. Each of the case studies (the objects of inquiry) is subsequently positioned against an integrated environmental management paradigm or social-ecological systems theory.

1.2. Theoretical framing

1.2.1. Systems thinking

Systems thinking tackles complex problems by treating the system - the set of interrelated and interdependent component elements (Ackoff, 1971) - as a whole (Checkland, 1981). In 1968, Von Bertalanffy (1968) stated that an entire system's behaviour cannot be understood by understanding the behaviour of each of the component parts in isolation. Instead systems and their behaviour are more than the sum of the parts and they have emergent properties that do not exist in the parts but are found in the whole (Weinberg, 1975). Many different types of systems have since been recognised in nature and society, ranging from ecosystems, through organisations and industrial systems to information systems and architectures (Costa et al., 2019; Ison et al., 1997). Common across these systems is the need to explore the implications of human interventions and decision making on the system properties and behaviour (Meadows, 2008). This has given rise to diverse fields of study such as cybernetics and simulation modelling (e.g., Forrester, 1961), and policy analysis (Thissen & Walker, 2013; W. E. Walker, 2000), all informed by systems thinking.

1.2.2. Policy analysis

Policy analysis employs a purposeful, systematic process to assist public policy decision makers in choosing which interventions to adopt in a system by (i) clarifying the problem, (ii) outlining the alternative intervention solutions and (iii) displaying the trade-offs amongst the outcomes (W. E. Walker, 2000). Policy analysis has a problem focus, conceptualising the problem as a system (see Enserink et al., 2010), rather than a method focus. A wide range of methods are adopted in organising and presenting information to those involved in policy making to help them in decision making. Indeed, the field of policy analysis recognises that in most complex problems there are many potential interventions, many factors over which the decision maker has no control, many interested stakeholders and many potential outcomes of interest. Frequently, there is more than one decision maker involved and preferences regarding the desirability of the outcomes are diverse. In short, an optimal choice for an action or intervention is seldom possible (see Thissen & Walker, 2013).

This contrasts with decision analysis, a rational, technical approach that assumes that a logically consistent choice can be made based on adequate information and the careful specification of desired targets, provided appropriate methods are applied. The argument is that a knowledge-based approach supports high quality decisions, reducing the risk of ill-informed or emotionally-based decisions. While policy analysis employs techniques from decision analysis in identifying decision criteria, listing out the various alternatives, and deliberating the present and future consequences of each alternative, it does not always ascribe weights to each criterion and rate each alternative on each criterion. Instead the focus lies on understanding the problem. Policy analysis recognises that an individual cannot have complete information, nor can they fully comprehend all alternatives and their consequences. In addition, an individual's preferences may fluctuate or alter over time. In reality, therefore, individuals do not exhibit fully rational decision making behaviour. Indeed, Simon (1955, 1957, 1991) defined an 'administrative' being rather than a purely 'economic' decision-maker, introducing the concepts of 'bounded rationality' and 'satisficing'. Situations in which individuals hold divergent interests and values on the one hand and divergent perceptions of reality on the other hand continue to present a challenge to decision making (Kørnøv & Thissen, 2000; March, 1991; Van de Riet, 2003).

Currently, the field of policy analysis accommodates a range of styles, drawing on a systems thinking base (Mayer et al., 2004). Where rational, technical views predominate the choice amongst alternatives can be supported by decision analysis. Where differences in values, and different perceptions of the problem predominate, the problem structuring (Enserink et al., 2010) and game structuring approaches (Cunningham et al., 2014; Slinger et al., 2014) of participatory policy analysis are most applicable. Three cornerstones for realizing participatory decision making in complex problem settings have been identified, namely: (i) valid policy- or decision-relevant scientific knowledge, (ii) process management whereby the involved stakeholders consent to a process designed to achieve appropriate and information-based decision outcomes, and (iii) stable stakeholders participation that acknowledges different roles and contributions (Agre & Leshner, 2010; Kørnøv & Thissen, 2000; Miser & Quade, 1985; Van de Riet, 2003).

In addition to these participatory engagement methods, there are numerous methods and techniques available to support policy analytic decision making. In particular, a graphical representation method, the system diagram (Figure 1.1), can be used to depict: (i) the demarcation of the problem under consideration (the boundary), (ii) the relationship between factors influencing the system behaviour, (iii) whether these influencing factors are external, internal or comprise the interventions of (managing and other) actors in the system, (iv) the outcomes from the system and how these relate to management objectives. In the system diagram (see Enserink et al., 2010), the policy makers, scientists and societal actors are not included explicitly, but are viewed as sources of knowledge, or as controlling the interventions.

1.2.3. Integrated Environmental Management

For a long time, the management of natural resources and the environment occurred via specific uses or sectors such as forestry, fisheries, agriculture, freshwater supply, wastewater discharge, and housing development (United Nations Environment Programme [UNEP], 2006). Where this approach has persisted, increasing demands on limited natural resources have resulted in conflicts between the different uses, aggravated by ineffective management. The concept of Integrated Environmental Management was introduced in the 1980's to address these issues by adopting a more holistic and interconnective approach (Margerum, 1999; Margerum & Born, 1995), and focussing on system goals through a strategic approach (Born & Sonzogni, 1995; Lang, 1986). This conceptual development

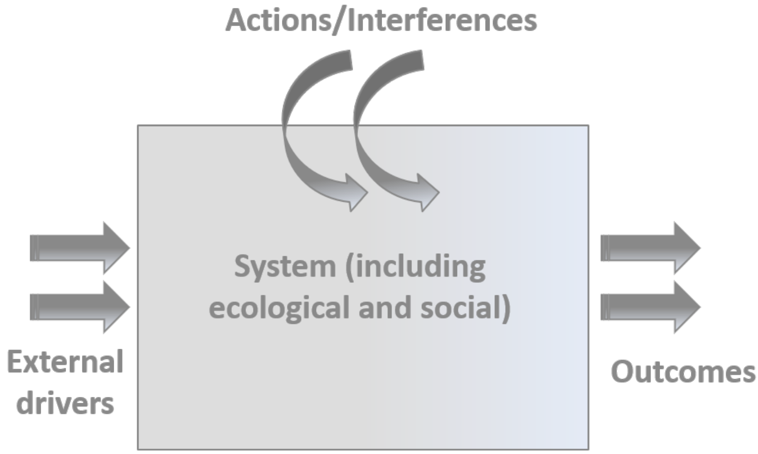

Figure 1.1. The system diagram

in environmental management was mirrored in the coastal environment. In the 1980s, the need became clear for an inter-sectoral approach to the coast taking account of all the activities affecting the coastal environment and its resources, and dealing with economic and social issues as well as environmental (ecological) concerns (Post & Lundin, 1996). Today, the Integrated Coastal Management approach aims to balance development and conservation, to ensure multi-sectoral planning, and to facilitate participation and conflict mediation (Christie, 2005).

Literature on the management of coastal environments emphasises the importance of country-specific knowledge and contextual factors in evaluating implementation of management policies (Cicin-Sain et al., 1998; Olsen et al., 1997; UNEP & Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities [GPA], 2006). Indeed, Taljaard et al. (2011) note that there is no international, generic blueprint for integrated coastal (environmental) management that can be applied routinely to yield predictable and desirable outcomes. However, a number of paradigms have been established as underpinning integrated coastal (environmental) management (Frantzeskaki et al., 2010; Taljaard et al., 2011) and these provide a means of characterizing the predominant management approaches adopted in each of the research case studies.

Environmental assessment paradigm

Internationally, the National Environmental Policy Act of the United States in 1969, represents the first legal requirement for environmental assessment (Jay et al., 2007). Environmental assessments may be undertaken at two levels, namely the individual project level, referred to as Environmental Impact Assessment (EIA) and the plans, programme or policy level referred to as Strategic Environmental Assessment (SEA) (Fischer, 2003). Essentially, environmental impact assessment is a systematic process for determining the potential environmental consequences of a proposed project (or action) (Jay et al., 2007). The primary purpose of this anticipatory and participatory environmental management instrument is to inform decision makers of the likely environmental consequences of a project (or action) so as to support environmentally sound development decisions (Fischer, 2003; Jay et al., 2007). Strategic environmental assessment encompasses a range of analytical and participatory approaches that aim to integrate environmental considerations into policies, plans and programmes so as to clarify the inter-linkages with wider economic and social systems and so include environmental considerations into strategic decision making (Partidário, 1996, 2008; Wallington et al., 2007). Actor participation, appropriate process management, and sound scientific knowledge are viewed as essential to environmental assessment (Taljaard et al., 2011). In this, the environmental assessment paradigm agrees with characteristics of the participatory policy analysis paradigm.

Objectives-based management paradigm

The core concept of objectives-based management as outlined by Drucker (1954) is improving the performance of an organisation by clearly defining and agreeing objectives at all levels within an organisation. By aligning objectives across an organisation, managers and employees can avoid becoming so involved in day-to-day activities that their main purpose or objective is forgotten – the so-called 'activity trap'. Fundamental to the objectives-based management approach is the call for participatory involvement in the strategic planning process, so that implementation is expedited. In applying this concept to environmental management, the participatory involvement of actors at all levels naturally comes to the fore. Involved actors aid in determining environmental objectives. Management strategies (or environmental management programmes) are then developed with the aim of attaining the objectives, which are specified in terms of outcome indicators and associated target values. The implementation and assessment for compliance is undertaken primarily by civil servants at national, regional, and local levels (Edvardsson, 2004; Wibeck et al., 2006). A strength of the objectives-based management paradigm is the emphasis placed on setting objectives holistically for the environment (i.e., incorporating the biophysical environment, the social and the economic environment). In this aspect, the paradigm differs from the primarily biophysical/ecological (and sometimes local social) focus of the environmental assessment paradigm.

Adaptive management paradigm

According to Haber (1964) and Bornmann et al. (1999), the adaptive management concept originated in the early 1900s when ideas of scientific management were pioneered. Fundamental to the adaptive management paradigm is a healthy scepticism regarding predictive environmental assessments, typically undertaken prior to action. Instead, the limitations of model-based or predictive assessments in dynamically uncertain environmental systems are understood, and the value of experiential learning is appreciated. Adaptive management builds on learning from experience, by experimenting and monitoring the results of experiments and then adjusting practices based on the learning attained (Bornmann et al., 1999). Sound environmental monitoring and evaluation programmes to support learning and subsequent adaptation are central to this paradigm. By actively accommodating system changes and the unexpected (Noble, 2000), adaptive management introduces the use of iterative, incremental adjustments as a requirement in managing complex environmental systems.

Ecosystem-based management paradigm

The realisation that natural resources and the environment can be managed more effectively if the ecosystem is placed centrally (Costanza, 1998; Pretty & Ward, 2001) and management occurs through cooperative governance between different sectors led to the concept of ecosystem-based management (UNEP, 2006). Ecosystem-based management recognises that plants, animals, and human communities are interdependent and interact dynamically within a particular physical environment forming distinct spatial units or ecosystems (UNEP, 2006). Humans and development are viewed as an integral part of an ecosystem. There is a shift from centralised, top-down governance of the environment to a decentralised regional and local approach to resource management in which multiple stakeholder groups are involved. Ecosystem-based management further requires that the carrying capacity of the ecosystem is not exceeded, but that development occurs sustainably (Balchand et al., 2007; United Nations, 1987). The ecosystem-based management paradigm supports participatory actor involvement, requiring multi-sector, cooperative governance systems to be established (Taljaard et al., 2011). Management of the environment in its biophysical, social and economic aspects characterises the ecosystem-based management paradigm.

1.2.4. Social-ecological systems and transdisciplinarity

A social-ecological system is a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner, through coupled, non-linear interactions. Moreover, this coupled, complex system is dynamic, exhibiting continuous adaptation (Redman et al., 2004). So, the concept of social-ecological systems as linked systems of people and nature emphasises that humans are viewed as a part of, not apart from, nature (Berkes & Folke, 1998). Inherently a social-ecological system is a nested system with several spatial, temporal and organisational scales that may be hierarchically linked (Redman et al., 2004). The resilience of a social-ecological system is conceived as the capacity of a social-ecological system to absorb or withstand perturbations so as to maintain its structure and functions, and provides an indication of the degree to which the system is capable of self-organisation, learning and adaptation (Gunderson & Holling, 2002; Holling, 1973; B. Walker et al., 2004). A set of seven principles have been identified for building resilience and sustaining ecosystem services in social-ecological systems, namely: maintaining diversity and redundancy, managing connectivity, managing slow variables and feedbacks, fostering complex adaptive systems thinking, encouraging learning, broadening participation, and promoting polycentric governance systems (Biggs et al., 2012).

Social-ecological systems theory embodies a co-evolutionary view of the relationship between humans and nature. Humans and the whole social system are viewed as essentially part of the social-ecological system – an all-encompassing system present at multiple, nested scales. In Figure 1.2, a complex coastal system decomposed into a coupled ecological and social system is depicted. In this view, humans participate

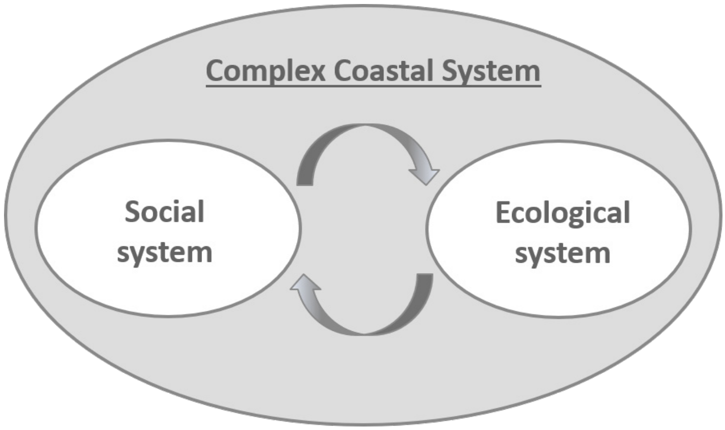

Figure 1.2. A complex coastal system conceptualised in terms of its social and ecological components

naturally in decision making on the environment, and participatory approaches aimed at environmental stewardship are embraced. Social-ecological theory therefore represents an extension of ecosystem-based management, and simultaneously incorporates the incremental learning of adaptive management. Where objectives-based management is applied without accounting for other potential environmental objectives or long-term sustainability, this would lie outside of social-ecological theory. Social-ecological theory recognises multiple sources of (disciplinary) knowledge for system understanding namely, environmental and social science, practice, local stakeholder knowledge and governance or decision making knowledge. Place-based contextual knowledge is also explicitly valued. This leads naturally to the adoption of a transdisciplinary approach in studying complex social-ecological systems.

Transdisciplinary is defined as a scientific approach that seeks to learn across disciplines (multi-disciplinary), using place-based knowledge, involving scientists and society, through convergent and divergent phases of learning and reflection. It seeks to usefully combine the reductionist thinking of scientific disciplines with the local knowledge of a place, and by reflecting on actions and effects now and in the past to make science and scientific practice relevant to society (Bergmann et al., 2012; Max-Neef, 2005).

1.3. The seven case studies

Seven case studies form the basis for the analysis. The case studies are located in the following countries: The Netherlands (2x), The United States of America, Ireland, Sri Lanka, Suriname and South Africa (Figure 1.3). The case studies focus on inlet or estuary mouth management, comprising four micro-tidal estuaries, two larger inlets and a wetland lake intermittently connected to the sea. Each of the case studies is nested within the context of scientific engagement in their respective countries with certain author(s) having a deep familiarity with the study site and its biophysical and/or social context. As such, the material presented here is only a selection of the full range of knowledge on each of the systems and is presented with its own particular slant. Whereas the overarching

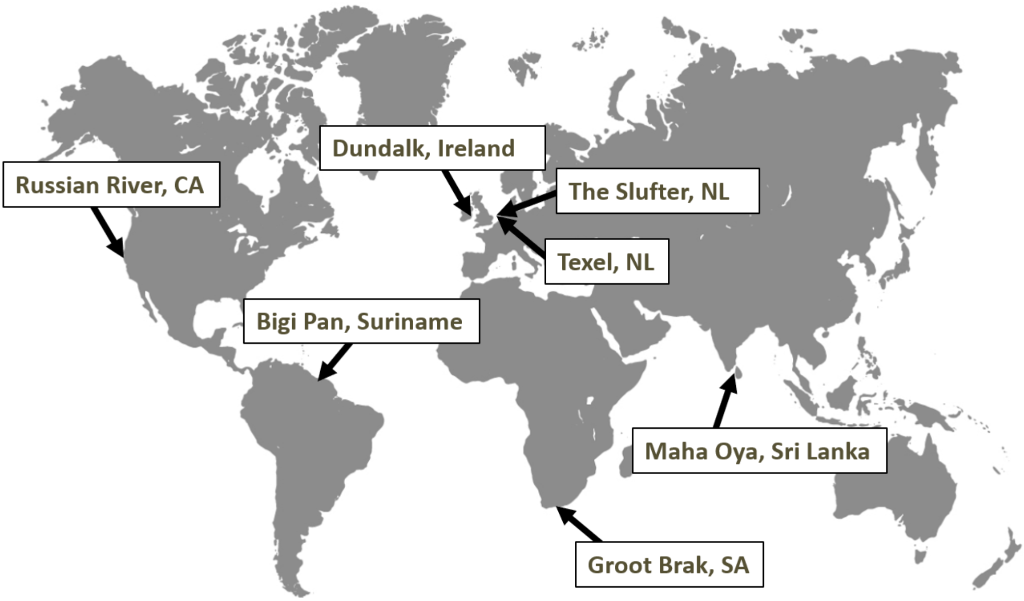

Figure 1.3. Locations of the seven case studies

research approach draws on systems thinking and policy analysis, each of the case studies differs in terms of its predominant theoretical paradigm, as listed in Table 1.1. and described briefly per case study thereafter.

Case study 1: Texel Inlet, the Netherlands

Texel Inlet represents a case study in Dutch coastal management. The imperative to protect the Dutch coast from flooding has been the central issue in coastal management for centuries. The damming of the Zuiderzee, a salt water inlet of the North Sea, formed a fresh water lake - the IJsselmeer, and initiated a process of coastal sedimentary re-adjustment of which the Texel Inlet forms part. However, since 1990 Dutch coastal policy is aimed at preventing structural erosion by maintaining the Dutch coastline at the 1990 position through sand nourishments. This objectives-based policy and associated sand nourishment strategy now ensures that south-west Texel receives a large portion of the sand nourishment budget as it is an erosion hotspot. However,

Table 1.1. Orientation of the case studies against the theoretical paradigms

Case Study	Country	Predominant theoretical paradigm
Texel Inlet	The Netherlands	Objectives-based Management
Dundalk Bay	Republic of Ireland	Environmental Assessment
Maha Oya	Sri Lanka	Environmental Assessment
Russian River	California, United States of America	Objectives-based Management
Groot Brak	Republic of South Africa	Adaptive Management
Bigi Pan	Suriname	Ecosystem-based Management
The Slufter	The Netherlands	Social-Ecological Systems

recent geomorphological insights on the dynamics of the ebb-tidal delta suggest that a large sandy shoal on the north-eastern margin of the ebb-tidal delta will in time attach to the south-western side of the island of Texel. This calls into question the wisdom of continuing to nourish this part of Texel. In essence, the Texel Inlet case study highlights how a single issue – flood risk management - can dominate in determining the objectives for coastal management. It draws attention to the role of scientific insights in improving management and highlights the need for collaborative, participatory approaches in designing alternative coastal management strategies that address multiple objectives.

Case study 2: Dundalk Bay, Republic of Ireland
Dundalk Bay is located on the northeast coast of Ireland and is of social and ecological importance, particularly as a fishing resource and regional harbour. The water quality issues associated with the rivers flowing into Dundalk Bay are the primary driver for the study. There is a need for catchment management to improve the quality of the inflowing water as well as a need for holistic and integrated management approaches. Here, scientists are actively involved in supporting community-based engagement with a view to enhancing integrated management of the water and coastal systems. The case study highlights the need to progress from environmental assessment to engaged co-management approaches in an effort to support learning within a social-ecological system.

Case study 3: Maha Oya, Sri Lanka
The case study of the Maha Oya Estuary in Sri Lanka focusses on the issue of climate change. Modelling research on the effects of climate change on small, wave-dominated estuaries led to the understanding that the frequency, period and duration of mouth closure of the estuary could change owing to both sea level rise and changing river flows. This new knowledge represents a pro-active environmental assessment and serves as a signal to Sri Lankan coastal managers that these external factors cannot be ignored. Coastal management will have to alter to accommodate these effects, particularly as the subsistence fishermen, sand miners and tourism-dependent occupations rely on estuary functioning for their incomes. This case study illustrates the role of scientific knowledge in alerting coastal managers of the need for change.

Case study 4: Russian River, California, United States of America
A 2010 Biological Opinion, a legal instrument, to ensure that the Russian River in California is managed for maintaining the habitat of the juvenile steelhead trout, represents a significant stage in the management of this estuary. Years of research by Californian scientists, particularly the Bodega Marine Laboratory (UC Davis), together with observation records of a citizen living near the mouth, are used to determine the relationship between the state of the mouth of this intermittently closed estuary and the habitat requirements for the endangered species. The biophysical system knowledge based on an extensive data set is shown to be crucial in managing for this single species objective.

Case study 5: Groot Brak, South Africa
Since the construction of the Wolwedans Dam upstream of the Groot Brak Estuary, South Africa, in 1990, this small, wave-dominated system has received both research and

management attention. Initially the attention focussed on designing a water release and mouth management policy for the estuary to prevent flooding and a decline in estuary health, and to ensure that local socio-economic activities were not impacted adversely. The focus of the case study presented in this book is the incremental learning on mouth management practices over a thirty-year period, and the adaptation of the management of water releases and mouth breaching in response to this. The case study reveals ongoing learning regarding the character and functioning of the estuary and highlights how this growing scientific understanding then influenced management practice and policy.

Case study 6: Bigi Pan, Suriname

The Bigi Pan in Suriname is a wetland lake that is intermittently connected to the sea. The case study analyses the implementation problems of the Bigi Pan Multiple Use Management Area (MUMA). The MUMA was designed to accommodate people living within, using and drawing benefit from, an ecologically significant conservation area. It embodies the principles of ecosystem-based management, and institutionalises co-management. The case study draws upon an extensive round of stakeholder interviews regarding the functioning of the MUMA. It highlights the need for system understanding as the foundation for effective coastal management, and identifies a number of strategies to address this gap and improve management.

Case study 7: The Slufter, Texel, the Netherlands

New coastal modelling insights that the estuary mouth may not need to be straightened periodically as a means of mitigating the flood risk to the dike landward of the Slufter Estuary, led to a desire on the part of the Water Board to re-evaluate their mouth management strategy. A social-ecological systems lens was adopted by researchers from the outset. This means that the issue of mouth management was not interpreted only as a biophysical problem, nor only as a flood-risk management issue, but as a multi-facetted issue arising from an increasing awareness of the ecological and social value of the Slufter Estuary, and a desire to work with nature rather than against nature - the Building with Nature philosophy (Ecoshape, 2019; Slinger, 2016; Waterman, 2010). A process of stakeholder engagement was undertaken in which the divergent perspectives and values of local stakeholders in regard to mouth management were explored with the aid of system dynamics modelling (D'Hont, 2014). In this case study, the role of system understanding is shown to be fundamental to learning on coastal management within the social-ecological system.

1.4. Transdisciplinary approach

Diverse environmental concepts (C) and methods (M) - ways of inquiry - are employed by the scientists involved in the seven coastal case studies that form the objects of inquiry in this endeavour (Table 1.1, Figure 1.4). However, the fundamental strategy of inquiry in this book is informed by the systems concepts and methods of the policy analysis scientists. Together, the coastal environmental scientists and the policy analysts have sought to learn from each case study and across the case studies by sharing experiences and reflecting jointly on the theoretical concepts employed, the methods applied, and the particularities of the individual coastal systems (S). The new insights from this transdisciplinary approach were reported in the proceedings of the intensive week-long

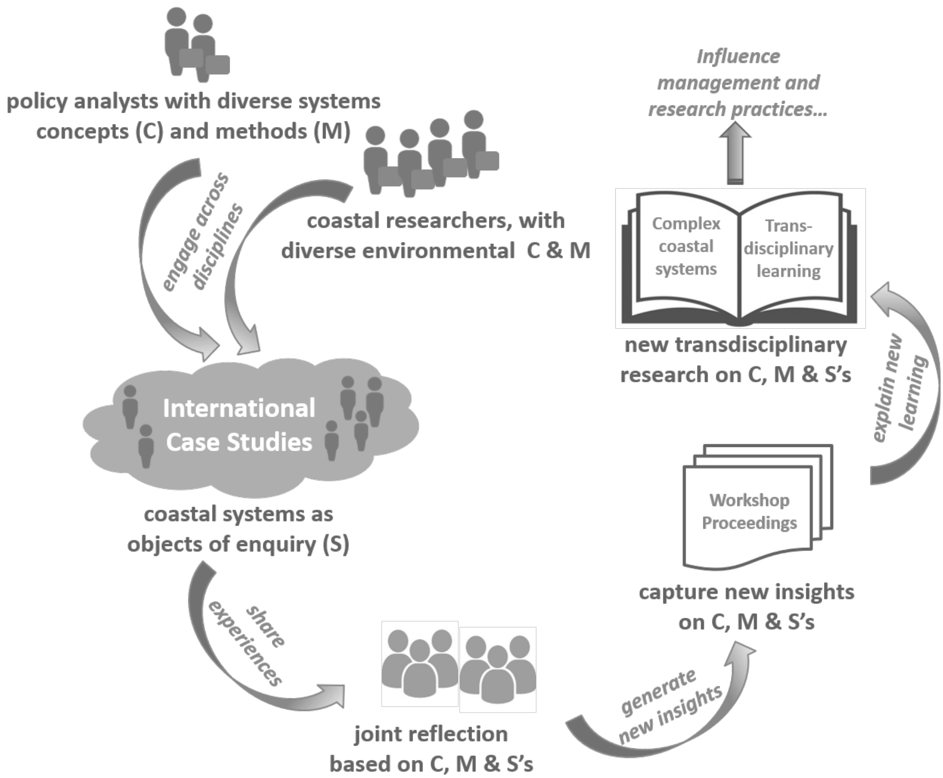

Figure 1.4. The transdisciplinary learning process applied in the cross-comparison of the international coastal case studies

workshop held at Delft University of Technology in September 2017 (D'Hont & Slinger, 2017). In this book, the learning from the full transdisciplinary research endeavour is synthesised by cross-comparing the coastal systems (S), the methods (M) applied and the concepts employed by the involved scientists (C). The cross-comparison is itself informed by concepts from systems thinking and policy analysis, with the aim of influencing coastal management and research practice internationally.

1.5. Reading and use guide

This introductory chapter has established the theoretical underpinning of the book in systems thinking and policy analysis, and has positioned the seven coastal case studies against the paradigms underlying integrated environmental management or social-ecological systems. Each of the case studies differs in terms of its predominant theoretical paradigm in combination with the insights offered and the type of biophysical and/or social system described. Readers primarily interested in big bay or inlet systems are advised to focus on the Texel Inlet and Dundalk Bay case studies. Readers interested in small, wave-dominated estuaries are invited to concentrate on the Maha Oya, Russian River, Groot Brak and Slufter estuaries. Those interested in the social aspects are directed towards the Bigi Pan and Slufter case studies, while those more interested in the biophysical aspects can focus on the other case studies. While each case study chapter can be read as a stand-alone unit, valuable insights are gained from cross-comparing and learning across the case studies as described in the concluding chapter.

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