Opportunities and challenges for mainstreaming ecosystem services in decision making

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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Nadia Sitas

December 2014

Dedication

This research is dedicated to Alexia and Athena who remind me every day to stop,

look,

listen,

breathe,

and be present.

Abstract

Ecosystem service research has grown significantly in recent years, highlighting links between ecosystem services and human well-being. Few studies are however, geared towards providing user-friendly, user-useful and user-relevant information suitable for implementing effective local management of areas that deliver ecosystem services, resulting in a gap between ecosystem service research and management.

In response to this challenge, it has been argued that in order to safeguard the benefit flows provided by ecosystems, the concept of ecosystem services should be mainstreamed into land-use (and water-use) planning and management processes. As the conservation of ecosystem services is ultimately a social process operating in a social context, understanding the complexity of the research-management interface demands input from a range of stakeholders. Thus, mainstreaming the environment into decision making requires multi-stakeholder engagement processes that facilitate the co-production and exchange of knowledge.

Accordingly, through the use of a transdisciplinary, mixed method approach, this dissertation contributes to a better understanding of some of the opportunities and challenges for mainstreaming ecosystem services in development planning at a local level, using a case study in the Eden District (Eden) of South Africa. Through an extensive stakeholder engagement process which explored what the information needs, responsibilities and capacities of decision makers in Eden are, both opportunities that facilitate the integration of ecosystem service information in decision making, and challenges impeding integration, have been identified.

This research found that despite a history of ecosystem service research in Eden, there has been limited integration of the concept of ecosystem services into decision-making processes driving development. Insufficient capacity, limited resources, minimal proactive planning, a weak regulatory environment, entrenched disciplinary thinking and insufficient communication amongst diverse stakeholders on the benefits of using an ecosystem-based approach remain as challenges for the mainstreaming of ecosystem services in decision making. However, strategic opportunities for mainstreaming ecosystem services into decisions regarding current and future

development trajectories were also found. It was found that the development, and nurturing of transdisciplinary learning networks that are problem driven, and action oriented, using a communities of practice model of engagement, can facilitate legitimate knowledge exchange processes. In this regard, the role of individual and institutional knowledge brokers was found to be critical. It was also found that the concept of risk was useful as a mainstreaming tool in bridging the gaps between different disciplines, and between science, policy and practice. A frame of risk enabled different disciplinary and knowledge communities to participate in joint activities and discussions during which information was co-produced and exchanged. Through this work, new relationships were built that facilitated both learning and action with regards to the importance of ecosystem services for mitigating risk.

KEYWORDS

Communities of practice, ecosystem management, human well-being, knowledge exchange, risk management, sustainable development, stakeholder engagement, transdisciplinarity.

Opsomming

Ekosisteemdiens-navorsing het aansienlik gegroei in die afgelope jare, met ‘n klem op die verband tussen ekosisteemdienste en menslike welsyn. Min ondersoeke is egter gerig op die verskaffing van gebruikersvriendelike, -nuttige en -relevante inligting wat geskik is vir die implementering van doeltreffende plaaslike bestuur van die gebiede wat ekosisteemdienste lewer, en dit lei tot 'n gaping tussen ekosisteemdiens-navorsing en -bestuur.

In reaksie op hierdie uitdaging word aangevoer dat ekosisteemdienste gehoofstroom moet word in prosesses ter beplanning en bestuur van grond- en watergebruik, ten einde die voordele wat deur ekosisteme gebied word, te beskerm. Omdat die behoud van ekosisteemdienste per slot van rekening `n sosiale proses is wat in `n sosiale konteks in werking is, word insette van 'n verskeidenheid van belanghebbendes vereis, om die ingewikkelde aard van die koppelvlak tussen navorsing en bestuur te verstaan. Dus, om die omgewing in besluitneming te hoofstroom, vereis prosesse van betrokkenheid van veelvuldige belanghebbendes, wat die medevervaardiging en uitruil van kennis fasiliteer.

Gevolglik, deur die toepassing van `n transdissiplinêre, gemengde metode benadering in `n gevallestudie in die Eden Distrik (Eden) van Suid-Afrika, dra hierdie verhandeling by tot `n beter begrip van sommige van die geleenthede en uitdagings verbonde aan die hoofstroming van ekosisteemdienste in ontwikkelingsbeplanning op 'n plaaslike vlak. Deur `n uitvoerige proses van deelname met belanghebbendes is inligting benodig deur besluitnemers in Eden, sowel as hul verantwoordelikhede en vermoëns, verken, en sodoende is beide die geleenthede wat die integrasie van ekosisteemdiens-inligting in besluiteming fasiliteer, en uitdagings wat integrasie belemmer, geïdentifiseer.

Hierdie navorsing het bevind dat, ten spyte van `n geskiedenis van ekosisteemdiens-navorsing in Eden, is daar beperkte integrasie van die konsep van ekosisteemdiens in besluitnemingsprosesse wat ontwikkeling dryf. Onvoldoende kapasiteit, beperkte hulpbronne, minimale proaktiewe beplanning, 'n swak reguleringsomgewing, verskanste dissiplinêre denkwyses en onvoldoende kommunikasie tussen uiteenlopende belanghebbendes oor die voordele verbonde aan die gebruik van 'n ekosisteembenadering, bly uitdagings vir die hoofstroming van ekosisteemdienste in besluitneming. Maar strategiese geleenthede vir die hoofstroming van ekosisteemdienste in

besluitneming in verband met huidige en toekomstige ontwikkelingsbane is ook aangetref. Daar is bevind dat, deur transdissiplinêre leernetwerke wat probleemgedrewe en aksie-georiënteerd is, te ontwikkel en koester met behulp van 'n praktykgemeenskappemodel van betrokkenheid, legitieme kennisuitruilingsprosesse gefasiliteer kan word. In hierdie verband is die rol van individuele en institusionele kennismakelaars as krities bevind. Daar is ook bevind dat die konsep van risiko nuttig is as 'n hoofstromings-instrument in die oorbrugging van die gaping tussen die verskillende dissiplines, en tussen wetenskap, beleid en praktyk. `n Raamwerk van risiko het verskillende dissiplinêre en kennisgemeenskappe in staat gestel om deel te neem aan gesamentlike aktiwiteite en besprekings, waartydens inligting saam geproduseer en uitgeruil is. Deur hierdie werk is nuwe verhoudings gevestig, wat beide leer en optrede rakende die belang van ekosisteemdienste vir risikotempering gefasiliteer het.

"*When one tugs at a single thing in nature, he finds it attached to the rest of the world*"

(John Muir)

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It took more than a village to raise this child….

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Acronyms

AACIFI	Advancing Adaptation through Climate Adaptation for Financial Institutions
BAAM	Business Adopt a Municipality
CAPE	Cape Action for People and the Environment
CBA	Critical Biodiversity Area
CBD	Convention on Biological Diversity
CDKN	Climate and Development Knowledge Network
COP17	Conference of the Parties 17
DEAT	Department of Environmental Affairs and Tourism
EIA	Environmental impact assessment
EMP	Environmental management plan
ESA	Ecological support area
FIA	Financial Intermediaries Association
FEWLE	Food and Energy, Water, Land, Environment Nexus project
GCBR	Gouritz Cluster Biodiversity Reserve Forum
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRI	Garden Route Initiative
IAIA	International Association for Impact Assessment
IDP	Integrated Development Plan
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goals
NEMBA	National Environmental Management: Biodiversity Act
NGO	Non-governmental organisation
NRF	National Research Foundation
OECD	Organisation for Economic Co-operation and Development
PES	Payments for ecosystem services
ProEcoServ	Project for Ecosystem Services
PSI	Principles of sustainable insurance
RADAR	Risk and Development Annual Review

SAFMA	South African Millennium Ecosystem Assessment
SAIA	South African Insurance Association
SALGA	South African Local Government Association
SANBI	South African National Biodiversity Institute
SAPECS	Southern African Programme on Ecosystem Change and Society
SBI	Sustainable Business Institute
SDF	Spatial Development Framework
SKEP	Succulent Karoo Ecosystem Partnership
SOER	State of the Environment Report
STEP	Subtropical Thicket Ecosystem Project
TEEB	The Economics of Ecosystems and Biodiversity
TSAMA	Transdisciplinary, Sustainability, Analysis, Modelling and Assessment
UN	United Nations
UNEP	United Nations Environmental Programme
UNEP FI	United Nations Environmental Programme Finance Initiative
UNFCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute

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Chapter 1: Introduction

Development, ecosystem services and mainstreaming: The emergence of a research question

1.1 The environment and development

Humans depend on the environment for sustenance and survival. The benefits we derive from biodiversity and ecosystems such as clean water, sense of place, soil formation and hazard regulation sustain our economies, underpin our development and enhance our well-being (Carpenter et al. 2009; Costanza et al. 2014; Duraiappah 1998; MA 2005). However, over the last century rapid human development has dramatically altered the structure and function of ecosystems worldwide (MA 2005; Rockström et al. 2009; Vitousek et al. 1997), and the environment increasingly depends on human intervention to prevent it from changing into states that may not support people. While some human-mediated alterations to the environment have resulted in positive outcomes, linked to increasing food and fuel production, evidence suggests that most of the change has been deleterious (MA 2005; Raudsepp-Hearne et al. 2010). Of particular concern is the degradation of ecosystems that enhance social-ecological resilience in the context of global change, including those ecosystems that are critical for reducing the impacts of extreme events (e.g. floods and droughts) (ISDR 2009). In this context, resilience is viewed as the capacity of a system to absorb, change or cope with a disturbance, and to sustain and develop its fundamental function, structure, identity and feedbacks as a result of recovery or reorganisation in a new context. (RA 2014). Accordingly, environmental degradation is a major factor contributing towards social-ecological vulnerability, by threatening local livelihoods and development, and therefore environmental protection has been identified as one of the eight international Millennium Development Goals (MDG 2014).

In order to ensure future well-being, the environment needs to be a major consideration in both current and future decisions regarding development (Adams 2009; Sachs 2012), as a

result, there have been increasing calls to mainstream the environment into decisions and investments that drive development (CBD 2010; Dalal-Clayton & Bass 2009; WRI 2009). Mainstreaming is defined as the informed integration of "relevant environmental concerns into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action" (Dalal-Clayton & Bass 2009). The potential benefits of mainstreaming the environment into decision making are improvements in terms of the productivity, resilience and adaptability of social-ecological systems (Berkes et al. 2000; Folke et al. 2011). However, in a synthesis of lessons learnt from a variety of environmental mainstreaming initiatives, Dalal-Clayton and Bass (2009) list the following issues as notable constraints:

1. the prevalent development paradigm which considers the environment as an institutional and economic externality;
2. inadequate resources (including data, information and institutional capacity) to forge environment-development links;
3. insufficient political will for change; and
4. limited evidence of environmental mainstreaming initiatives that could provide practical examples worth following.

As environmental mainstreaming is essentially about knowledge integration, a critical factor in mainstreaming processes is the way in which knowledge is produced, but also how it is exchanged. Knowledge-exchange processes are those that involve the generation, sharing and/or use of knowledge through various methods appropriate to the context, purpose, and participants involved (Fazey et al. 2013). Knowledge, for the purposes of this dissertation is conceptualised as "justifiable belief", and includes the information and skills acquired through experience, and/or the theoretical and/or practical understanding of a subject (van Kerkhoff & Lebel 2006).

However, in order for environmental mainstreaming to elicit change, mainstreaming processes need to catalyse action. Cash et al. (2003) posit that, in order to effectively link knowledge and action to meet the demands of development while protecting important ecosystems, knowledge-integration processes need to pay attention to issues of legitimacy, credibility and saliency. Legitimacy relates to the "fairness" of the information producing process, and whether the process has acknowledged the diverse perspectives, values and concerns of different stakeholders (Cash et al. 2002). The credibility of a knowledge

production process is concerned with issues related to how authoritative, believable and trusted the information is; while saliency refers to how relevant the knowledge is to decision-making processes (Cash et al. 2002). Historically, scientists, managers and policy makers have focused mostly on creating and using credible information (Cash et al. 2003). This was generally achieved through peer-review processes and the vetting of, or reliance on "experts" conducting research (Merton 1973). While basing decisions on credible information is critical, ignoring the issues of saliency and legitimacy can result in information being produced that it not used. The failure to acknowledge the interplay, and to balance potential trade-offs, between these key issues is evident in the many 'knowing-doing' gaps that exist in social-ecological research (Esler et al. 2010; Knight et al. 2008; Lauber et al. 2011; Pfeffer & Sutton 1999).

In response to these challenges, increasing attention is being paid to the importance of boundary work (Guston 2001), i.e. research conducted within the "boundaries" between disciplines and knowledge types (e.g. scientific and lay knowledge). Boundaries are the socially constructed and negotiated borders between science and policy, academic disciplines, nations and scales (Cash et al. 2003). While it has been suggested that these boundaries may be functional, e.g. by limiting political influence in science, they can act as obstacles to communication, collaboration, knowledge integration and action (Cash et al. 2002; Merton 1973). Thus there is a need to better understand the types of processes, strategies and tools that might facilitate boundary work, especially in terms of linking knowledge to action for enhanced ecosystem management (van Kerkhoff & Lebel 2006). In this regard, research that involves potential end users of its results, and brings together different role players to produce a shared understanding, is critical (Cowling et al. 2008). A research approach which acknowledges the need for such a plurality of perspectives is that of transdisciplinary research. Transdisciplinary research transcends disciplinary boundaries and focuses on developing enhanced understanding of complex social-ecological challenges by exploring different knowledge forms in an attempt to transform existing conditions (Pohl et al. 2007). As such, this research approach is increasingly being advocated as a mechanism for bridging 'knowing-doing gaps' (Jahn et al. 2012).

1.2 Emergence of ecosystem service research

Globally, science-and-policy communities have heeded the call for credible information regarding environment–development linkages, and over the last two decades the concept of ecosystem services– i.e. the benefits humans receive from ecosystems– has rapidly gained interest. This is evident from an increasing number of journal publications (Fisher et al. 2009; Seppelt et al. 2011), reports (Gómez-Baggethun et al. 2010) and policy interest, and illustrated by numerous international agreements and research initiatives [e.g. Conservation of Biological Diversity (CBD) Aichi Targets (CBD 2014), Millennium Ecosystem Assessment (MA) (MA 2005) and Intergovernmental Platform of Biodiversity and Ecosystem Services (IPBES) (IPBES 2014)]. While the concept of ecosystem services is not new– its origins can be traced back to at least 400 BC when Plato outlined the benefits humans derived from healthy ecosystems (Mooney & Erlich 1997) – the term was popularised by the MA released in 2005.

The MA outlined the interconnectedness of human well-being and ecosystems through four categories of ecosystem services, namely provisioning services (e.g. food, fuel and fibre), regulating services (e.g. pollination, as well as climate and natural hazard regulation), cultural services (e.g. sense of place and tourism), and supporting services (e.g. soil formation and nutrient cycling).

Ecosystem services stem from a cascade of ecological processes and functions (Haines-Young & Potschin 2010), and their interaction with social systems as both beneficiaries and creators of ecosystem services, and a major force in the transformation and modification of ecosystems to enhance human well-being (Reyers et al. 2013) Figure 1-1. While there has been rapid and widespread adoption of ecosystem service-based frameworks in policy and practice, ethical and operational challenges with the concept of ecosystem services remain (de Groot et al. 2010; Jax et al. 2013; Luck et al. 2012; Nahlik et al. 2012; Tallis et al. 2008).

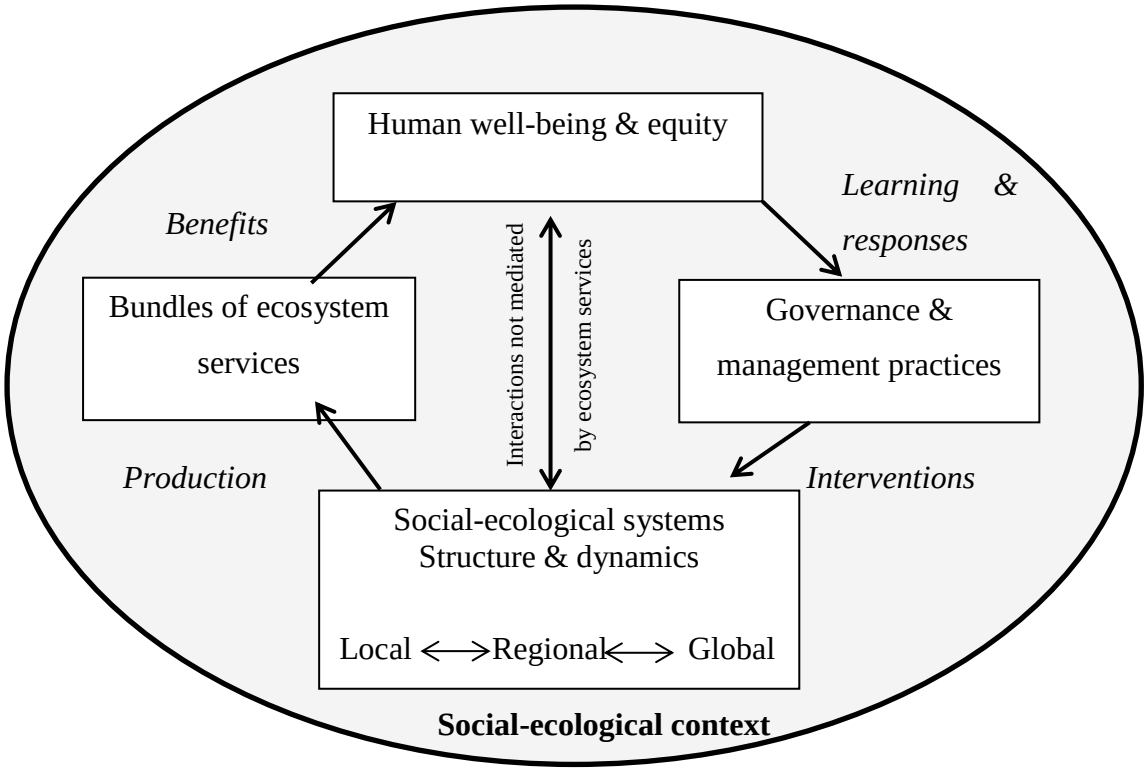

Figure 1-1: Conceptual diagram of elements of a social-ecological system adapted from the Southern African Programme for Ecosystem Change and Society (SAPECS) (SAPECS 2014)

The ethical challenges associated with the concept of ecosystem services relate to power in terms of: who defines what legitimate decisions to be taken concerning ecosystem services are on the one hand (i.e. whose voice or values count); and to the commodification or monetary valuation of ecosystem services which may be given preference over, or undermine, other types of value e.g. moral or cultural, on the other (Luck et al. 2013; Bowles 2008; Büscher 2012). These challenges highlight the need to better understand ecosystem services as a contested concept, especially with regards to the design and implementation of strategies aimed to promote human well-being (Schröter et al. 2014). While the term 'ecosystem service' and its implementation may be contested (McCauley 2006; Norgaard 2010; Redford & Adams 2009), the notion of the benefits that societies and economies derive from nature is not (Berkes et al. 2000). In order to understand the nature of the contestation, it is imperative to bring a plurality of perspectives on ecosystem services together through multi-stakeholder dialogue (Cornell et al. 2013; Jax et al. 2013; Lang et al. 2012; Schröter et al. 2014).

1.3 Mainstreaming ecosystem services in decision making

The field of ecosystem service research emphasises the importance of sustaining specific flows of ecosystem services to ensure that human development goals are met, thus, it has the potential to have a large impact on the management of ecosystems and resulting benefit flows. As such, there is increasing support for mainstreaming links between ecosystem services and development into decision-making (Armsworth et al. 2007; Carpenter et al. 2009; Cowling et al. 2008; Daily et al. 2010; WRI 2010). Although there have been significant advances in knowledge and awareness of the political and socio-economic importance of ecosystem services, actual integration and implementation of ecosystem services in planning and decision making is still in its early stages (Cowling et al. 2008; de Groot et al. 2010; Ruckelshaus et al. 2013; von Haaren & Albert 2011).

A multitude of tools and approaches exist for measuring, mapping, valuing and framing ecosystem services (Costanza et al. 2014; Crossman et al. 2013; Daw et al. 2011; Fisher et al. 2009; Maes et al. 2012). However, many of these approaches still remain untested in practice (Nahlik et al. 2012). And while the science of ecosystem services is rapidly advancing, evidence that it has been integrated into decision-making processes and has informed ecosystem management activities on the ground appears to be scarce (Ruckelshaus et al. 2013). As the conservation of ecosystems is ultimately a social process, operating in a social context, understanding the complexity of the research–management interface demands input from a range of stakeholders. This is especially important to ensure that the voices and choices of different stakeholders are recognised (Jax et al. 2013). Thus deeper insights are needed into the social conditions and processes that facilitate or impede the production and exchange of legitimate, credible and salient ecosystem services-related knowledge in ways that support action.

1.4 Aims, objectives and scope of this research

The argument underlying this dissertation builds on the assertion that the concept of ecosystem services holds much potential as a mechanism for mainstreaming the environment into decision making. Its overall goal is to contribute to the knowledge, theory, evidence and tools needed to realise the potential offered by the concept of ecosystem services to mainstream the environment into decision making.

This goal is achieved by focusing on development planning processes at the municipal level (i.e. local and district level). In South Africa, the government system is formally comprised of three spheres: national, provincial and local. There are nine provincial governments in South Africa, and the country is divided into local municipalities, of which there are three types: metropolitan (in the six biggest cities of South Africa), local (areas that fall outside the six metropolitan municipal areas) and district (an aggregation of local municipalities that fall within one district).

Development planning identifies the role that different sectors of society need to play in order to improve human well-being by addressing social, economic and environmental issues in an integrated way. South Africa's development trajectory is determined at the national scale on the basis of a National Development Plan, which outlines sector-specific goals for reducing poverty and mechanisms to tackle cross-cutting issues that impact South Africa's long-term development. Local municipalities contribute towards enforcing statutory regulations on behalf of other spheres of government, and play a strong role in the provision of public services such as promoting local tourism, electricity delivery, sanitation and sewerage, storm-water and disaster management and recreation facilities. Local government is the sphere of government closest to the scale at which ecosystem management activities and decisions take place, thus, understanding how the concept of ecosystem services relates to development-planning processes at the local level is important.

The main objectives of this dissertation are to explore development planning, policies and processes at the local level in South Africa in order to identify the opportunities and challenges for mainstreaming ecosystem services, and to improve understanding of the ways in which ecosystem service research can be harnessed more effectively for action. In particular, this study seeks to answer the following research questions:

- **Research question 1**: How does the concept of ecosystem services currently manifest in development planning processes at a local level in South Africa?
- **Research question 2**: What are the opportunities and challenges for mainstreaming ecosystem services in decision making at a local level in South Africa?
- **Research question 3**: What strategies facilitate the mainstreaming of ecosystem services in decision making processes in South Africa?
- **Research question 4**: What evidence exists that ecosystem service-based research has catalysed action in South Africa?

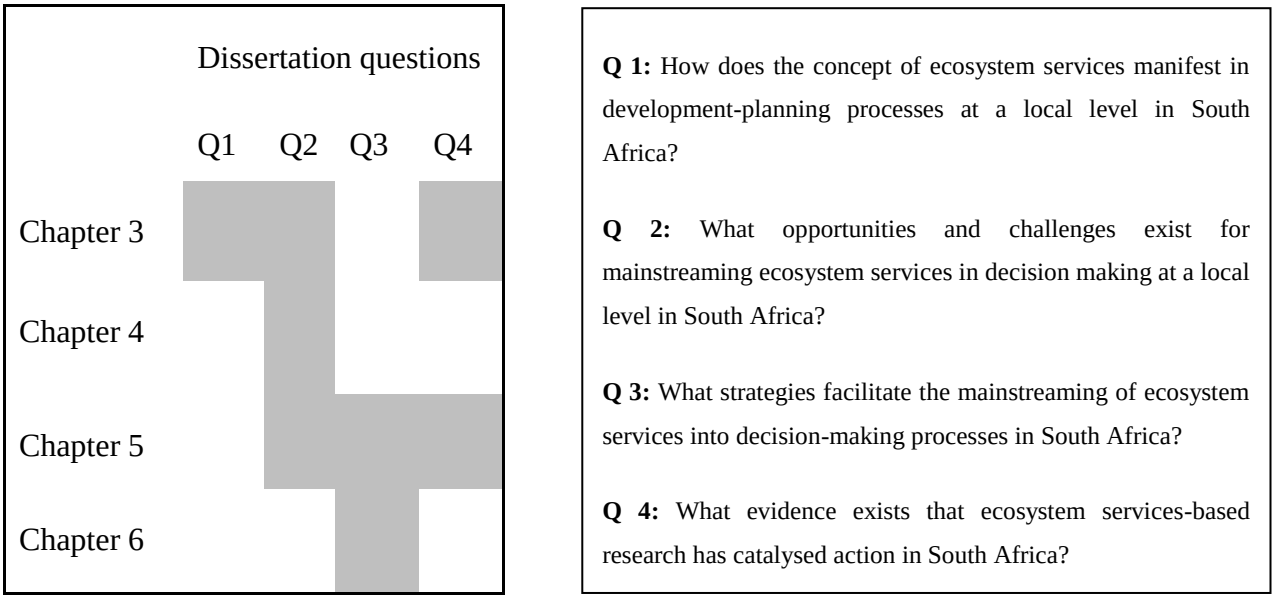

Figure 1-2: Outline of research questions addressed by the different chapters of this dissertation

1.5 Structure and overview

This dissertation comprises 7 chapters. This first chapter provides an introduction to the key theoretical and practical challenges this research seeks to address, and outlines its aims, scope and objectives, influencing all subsequent chapters, their objectives and scope. As the dissertation reports on research of an exploratory nature, it has been approached in a step-wise fashion, with results from each chapter informing the content and structure of subsequent chapters. Conducting the research iteratively, and adaptively, allows for a more integrated understanding of the opportunities and challenges of mainstreaming ecosystem

services in development-planning. Figure 1-3 details how the chapters of this dissertation relate and link to each other.

Chapter 2 outlines the methodology underpinning this research, conceptualises, and links some of the key concepts that are used in this research, and introduces the specific social-ecological challenges in the study site (Eden). This methodology permeates throughout the thesis determining approaches, study sites and participants in the research.

Chapter 3 aims to develop a deeper understanding of how research–management gaps manifest, and can potentially be bridged, by exploring whether and how (implicitly or explicitly) the concept of ecosystem services is considered in development planning processes. This aim is achieved by designing a transdisciplinary review framework which is used to inform a content analysis of decision-support tools identified as important by decision makers, as well as transcripts from interviews conducted with key decision makers involved in development-planning processes. Chapter 3 helped set the scene for Chapter 4 by highlighting the gaps in mainstreaming in the region.

Chapter 4 builds on the results of the research strands reported in Chapter 3 and involves the development and testing of a research approach which seeks to elicit multi-stakeholder perceptions on the most important challenges of, and opportunities for, mainstreaming ecosystem services in development planning at a local level. This is carried out using a combined qualitative and participatory approach that involves applied thematic analysis of the data collected. Chapter 4 was instrumental in highlighting areas where mainstreaming seemed to be evident and was used to establish the focus on disaster management sectors and the Eden Project for the subsequent chapters

Chapters 5 and 6 were conducted in tandem and built on the opportunities identified in the earlier chapters. These final two empirical chapters focused on, and analysed an existing multi-stakeholder, multi-disciplinary and multi-sectoral project in Eden (“the Eden project” outlined in more detail in Chapter 2).

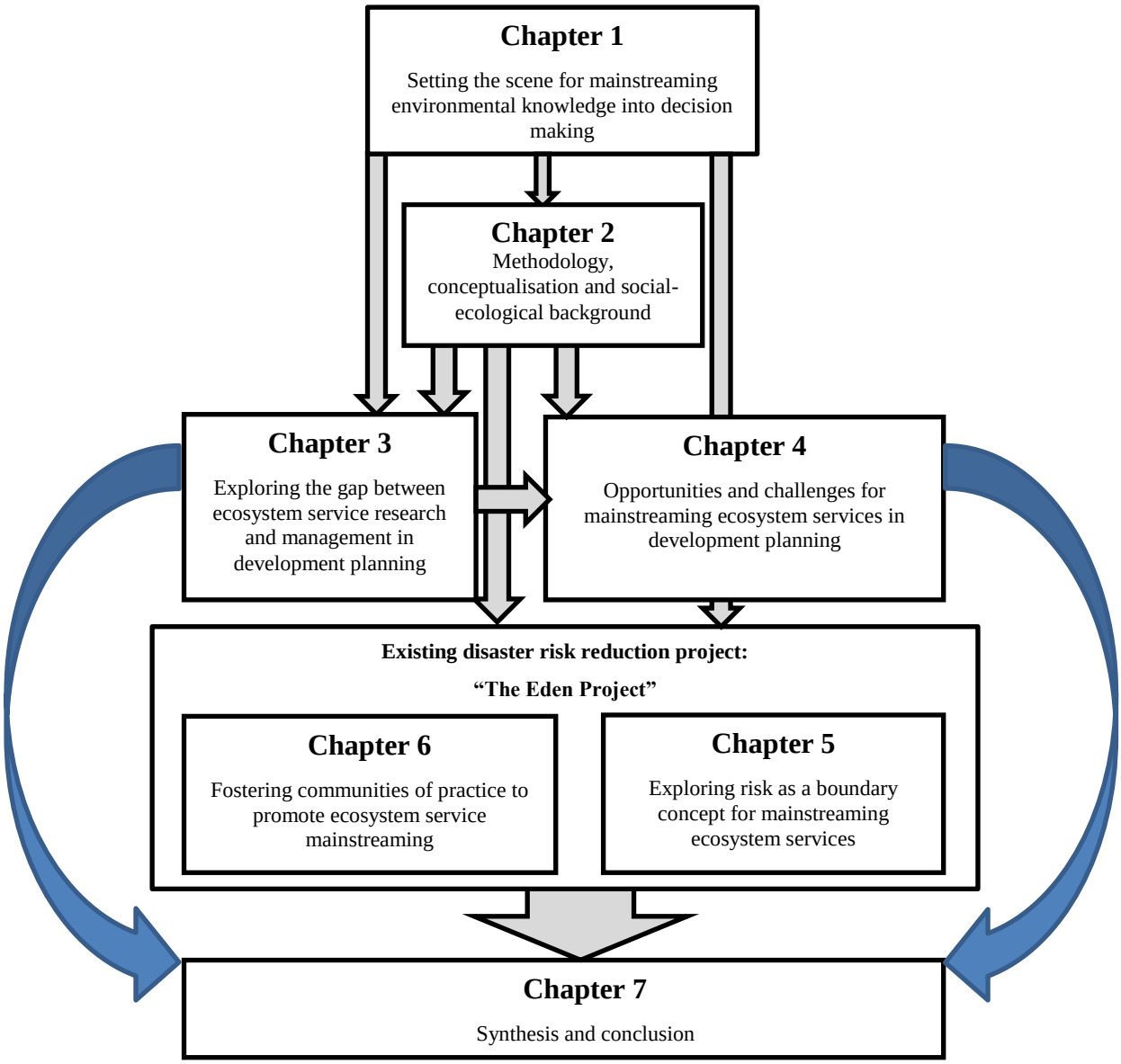

Figure 1-3: Diagram depicting how the chapters of this dissertation link and relate to each other.

The Eden project is used as a case study in Chapter 5 to explore whether, and how the concept of risk associated with extreme events might facilitate the type of boundary work which is necessary for those knowledge production and exchange processes that are linked to mainstreaming. Further, Chapter 5 aims to establish whether any evidence exists that attempts to mainstream ecosystem-based information into decision making processes have been incorporated into decision-making processes to any extent. These aims are pursued through the combination of an inductive and deductive approach, with the use of applied thematic analysis.

Chapter 6 is also based on the Eden project and follows an iterative process, where the process of data collection and analysis proceed in tandem, repeatedly referring back to each

other. The chapter seeks to improve understanding of how different knowledge types can be integrated and used to inform action related to improved ecosystem management, through the exploration of the critical factors which have assisted in integrating environmental concerns into decision making via the Eden Project.

Finally, Chapter 7 provides a synthesis of the study and presents the main insights gained from this dissertation as well as their implications for research and practice. The challenges and limitations of the research are also outlined in this concluding chapter.

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Chapter 2: Setting the scene

Research methodology and background to the study site

Due to the interdisciplinary and at times transdisciplinary nature of this research, I spent much time and effort on the development of conceptual frameworks and research design, learning new methods and adapting existing methods from both the natural and social sciences for use in this study. Thus, it is necessary to explore in more detail the conceptual framework and methodological approach which are only briefly summarised in the subsequent chapters.

This chapter starts by providing a broad outline of the key concepts used in this research, which are highlighted in the conceptual framework (Figure 2-1.). It then describes the overarching research approach (Figure 2-4.) which guided the data collection and analysis techniques (outlined in more detail in Chapters 3 to 6). This chapter concludes with a social-ecological description of the Eden district which is where the research reported in this dissertation was conducted.

2.1 Conceptual framework

All natural systems have been shaped to some extent by human impacts, and no social systems exist that are separate from nature, thus social and natural systems are not only linked, but are intricately interconnected, co-evolving across space and time as social-ecological systems (Gunderson 2001; Hannigan 2006; Uggla 2010). Therefore, exploring the relationship between the environment and development requires simultaneously navigating multiple world views and complex social-ecological systems (Berkes et al. 2000; Gadgil et al. 1993). Complex systems according to Cilliers (1998) are open systems that consist of a large number of interacting components whereby the components interact in ways that are non-linear, short range, and often create feedback loops. Complexity emerges from the different interactions between components of the system over time (Cilliers et al. 2013).

Social-ecological systems are considered complex in part because they exhibit characteristics such as cross-scale interactions, nonlinear feedbacks and uncertainty (Cundill et al. 2005; Gunderson 2001). Development, in this dissertation is understood as those actions that seek to improve human well-being (WRI 2009), relies on the implementation of complex planning processes which attempt to reconcile social, economic and environmental issues (Dalal-Clayton & Bass 2009). Research on ecosystem services (informed by the notion that humans benefit from interactions between social systems and the end products of ecological processes and functions) is increasingly being advocated as an important consideration in development planning to ensure human well-being (Biggs et al. 2004; Dasgupta 2001; Haines-Young & Potschin 2010; MA 2005; Reyers et al. 2013).

The governance of social-ecological systems is complex, as it involves finding a balance between the interests of groups of people for whom the system has different purposes, benefits and meanings (Folke et al. 2005; Lebel et al. 2006). As these interests are often conflicting, management is intrinsically contested, and it is in this contested space that development planning and decision making with regard to natural resource management often takes place.

While advances in the natural and social sciences have improved understanding of how components of social-ecological systems might operate, knowledge on the way in which many of the mechanisms operating in the systems function and interact, remains incomplete. Further, as science has advanced through a "division of labour", resulting in different disciplines, arriving at a comprehensive understanding of how social-ecological systems might function is in itself complex and highly challenging, as it requires integrating knowledge from distinct intellectual communities, each with their own values (Mollinga 2008). While the integration of different types of knowledge poses a significant intellectual challenge, the escalating severity of problems linked to global change (e.g. population expansion, migration and climate change) and the associated development challenges, compels us to respond to this challenge.

Industries, universities and civil society have responded to the problems associated with global change in a variety of ways, e.g. establishing new research institutes and degrees, and developing technological responses, such as solar technology (Lang et al. 2012). In particular, academia responded in the late 1990s through the initiation of a new field of research referred to as "sustainability science" (Burns & Weaver 2008; Cash et al. 2003; Clark & Dickson

2003; Komiyama & Takeuchi 2006). Sustainability science operates as a problem-and-solution oriented field. It acknowledges that current social-ecological challenges necessitate a move away from seeking "single correct models" for dealing with issues related to natural resource governance (Ostrom et al. 2007), towards the (co)development of research strategies that utilise a plurality of perspectives and strive to integrate diverse stakeholder to produce a shared understanding. Thus, it is underpinned by practices which are community-based, interactive, participatory, and which cross boundaries, including intellectual boundaries between disciplines; those between research and policy on the one hand and between expert and local knowledge on the other; and organisational boundaries between different institutions (Hirsch Hadorn et al. 2006; Jahn et al. 2012; Scholz & Binder 2011).

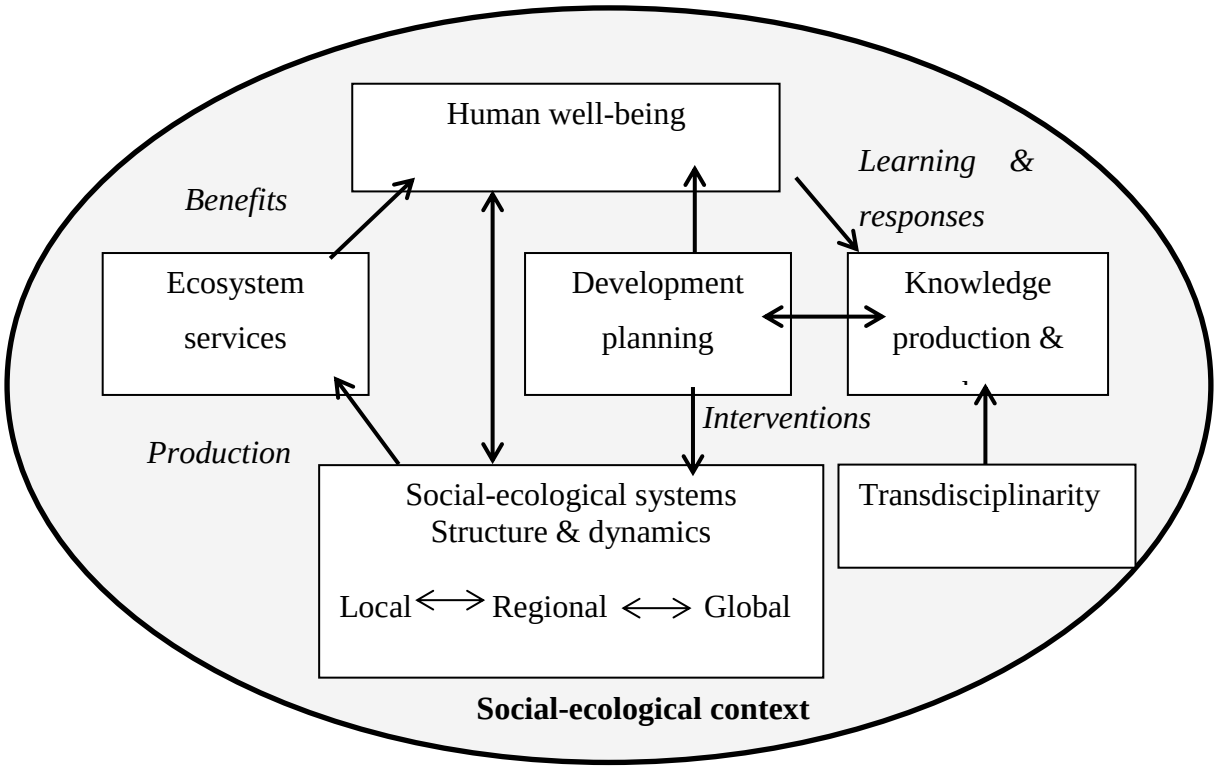


Figure 2-1: Conceptual framework linking the key concepts employed in this dissertation, based on the conceptual framework of SAPECS (SAPECS 2014).

Overcoming the barriers to boundary crossing is a key challenge in ensuring that knowledge is effectively produced and exchanged in ways that facilitate action (Cash et al. 2003). This is especially important in terms of linking knowledge on the ways in which the environment underpins development and promotes human well-being, with the actions that prevent developmental activities from eroding the resilience of social-ecological systems. Knowledge is defined as justifiable belief, with different forms of knowledge emerging,

underpinned by different sets of justification criteria (Rorty 1979;van Kerkhoff & Lebel 2006). The definition of knowledge used in this dissertation includes information and skills acquired through experience, or theoretical or practical understanding of a subject, and focuses mainly on research-based knowledge (van Kerkhoff & Lebel 2006). The focus on research-based knowledge aims to include all facets of systematic inquiry justified by their acceptance of a specific research process defined by peers, with a particular focus on research orientated towards practice.

Sustainability science highlights both the production and integration of knowledge as two important factors that assist with linking knowledge and action. The co-production of knowledge relates to ensuring that the knowledge that will be used to inform action is produced through credible, salient and legitimate processes (Cash et al. 2003). Knowledge integration concerns the importance of undertaking inter-and transdisciplinary research (Cash et al. 2003; Clark et al. 2011; Mollinga 2008).

Inter- and transdisciplinary research, along with multidisciplinary and participatory research are forms of integrative research which aim to combine different knowledge 'types' (e.g. disciplinary or local knowledge) to varying degrees. Tress et al. (2005) provide a framework to distinguish these approaches, which is shown in Figure 2-2.

While numerous definitions of transdisciplinary research exist (see Hirsch Hadorn et al. 2008; Lang et al. 2012; Scholz & Stauffacher 2007), in this dissertation it is conceptualised as an approach that is reflexive, integrative, and method-driven; and that aims "to find solutions to societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al. 2012).

Pohl and Hirsch Hadorn (2008) and Messerli and Messerli (2008) suggest that transdisciplinary research should encompass three interdependent "types" of knowledge:

- systems knowledge, which is knowledge concerning the current situation;
- target knowledge, i.e. the knowledge of the desired target state/situation; and
- transformation knowledge: the knowledge necessary for fostering transformation processes, i.e. from the current situation to the target situation.

The research outlined in this dissertation is well aligned with the objectives of transdisciplinary research as it aimed at improving understanding of both the systems

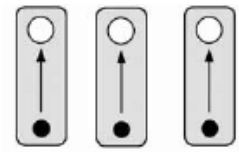
knowledge (i.e. knowledge concerning the current situation regarding how the concept of ecosystem services currently manifests in development-planning process, and what opportunities and challenges exist for mainstreaming ecosystem service information into those processes) and transformation knowledge (i.e. knowledge concerning which strategies might facilitate the mainstreaming of ecosystem services in decision-making processes) needed for integrating ecosystem services in development-planning processes.

Environmental mainstreaming is the way environmental issues are brought to the attention of decision makers and the way environmental considerations are incorporated into decision-making processes. The definition used for this research builds on the definition used by the International Institute for Environment and Development which sees mainstreaming as " the informed integration of relevant environmental concerns into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action" (Dalal-Clayton & Bass 2009).

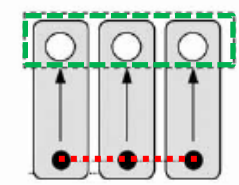
The objective of the research presented in this dissertation is inherently complex in that it explores current development-planning policies and processes at the local level in South Africa, in order to identify the opportunities and constraints for mainstreaming ecosystem services, as well as to improve understanding of how ecosystem service research can be harnessed more effectively for action. It therefore requires inputs from different disciplines, as well as from the broader society. In order to achieve this objective, and address the research questions posed in Chapter 1, this research is therefore embedded in a transdisciplinary approach. The issue-driven approach taken in this research is presented in Figure 2-3, which outlines interactions between the key stakeholders and issues that this research attempts to address. As Jahn et al. (2012) posit, transdisciplinary research is an approach – not a theory, methodology or institution – and should as a rule still involve disciplinary practice. I therefore highlight the important disciplinary contributions that are needed in order to address the issues in Figure 2-3.

The remainder of this chapter describes the methodology of this study and provides an overview of the study site, highlighting the important social-ecological features of the region.

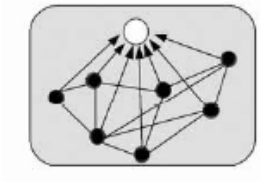
Disciplinary
- Within one academic discipline
- Disciplinary goal setting
- No cooperation with other disciplines
- Development of new disciplinary knowledge and theory



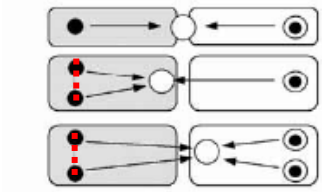
Multidisciplinary
- Multiple disciplines
- Multidisciplinary goal setting under one thematic umbrella
- Loose cooperation of disciplines for exchange of knowledge
- Disciplinary theory development



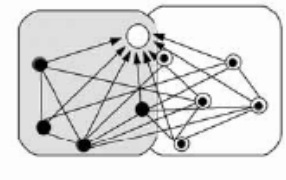
Interdisciplinary
- Crosses disciplinary boundaries
- Common goal setting
- Integration of disciplines
- Development of integrated knowledge and theory



Participatory
- Involves academic researchers and non-academic participants
- Exchange of knowledge, but knowledge bodies not integrated
- May be disciplinary or multidisciplinary
  Not necessarily research; goal may/may not be academic



Transdisciplinary
- Crosses disciplinary and scientific/academic boundaries
- Common goal setting
- Integration of disciplines and non-academic participants
  Development of integrated knowledge and theory among science and society



Key

Discipline
Non-academic participants
Goal of a research project
Movement towards goal
Cooperation
Integration
Thematic umbrella

Academic knowledge body
Non-academic knowledge body

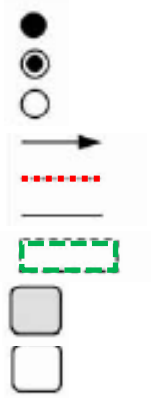


Figure 2-2: Overview of the concepts; disciplinary, multidisciplinary, participatory, interdisciplinary and transdisciplinary, adapted from Tress et al. (2005).

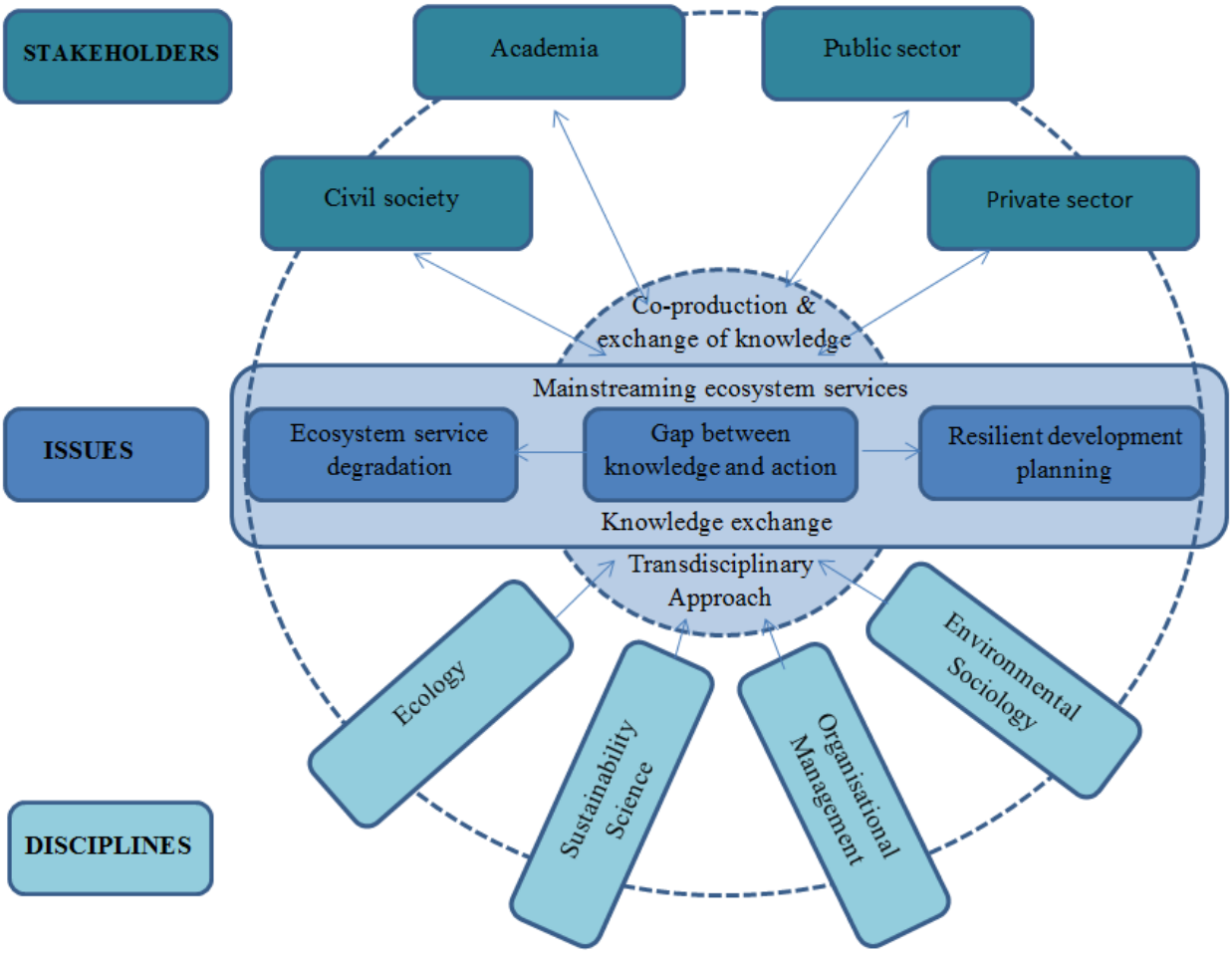


Figure 2-3: Relational framework linking issues, disciplines and stakeholders for the transdisciplinary co-production of knowledge (adapted from Pohl & Hirsch Hadorn [2008])

2.2 Research strategy and design

This study employed a multiphase mixed-methods strategy embedded within a transdisciplinary approach, as outlined above. By collecting both qualitative and quantitative data through distinct but interrelated strands of research (discussed in more detail in Chapters 4-7, as well as below), it is hoped that a deeper understanding of the opportunities for and challenges of mainstreaming ecosystem services in development planning can be arrived at. An overview of the methodological framework guiding the overarching research approach is provided in Figure 2-4. This framework recognises that both the natural and social sciences are important for understanding how knowledge can best be developed and used to inform

action, and the research presented in this dissertation attempts to blend both scientific domains within an exploratory and pragmatic framework.

This study is largely exploratory in nature, due to the lack of a well-established tradition of previous studies conducted to understand similar phenomena, and the need for an open and flexible research strategy (Babbie 2012; Mouton 1996). This flexibility was important as the research was problem-driven and therefore the research strategy could be adjusted according to what was learnt by engaging with stakeholders in earlier phases of the research.

According to Creswell (2014), research designs are the strategies and procedures for research that outline decisions regarding broad assumptions, and specify how data will be collected and analysed. Accordingly, three interconnected considerations are important when designing a study, namely: philosophical worldviews, selected strategies of inquiry and research methods.

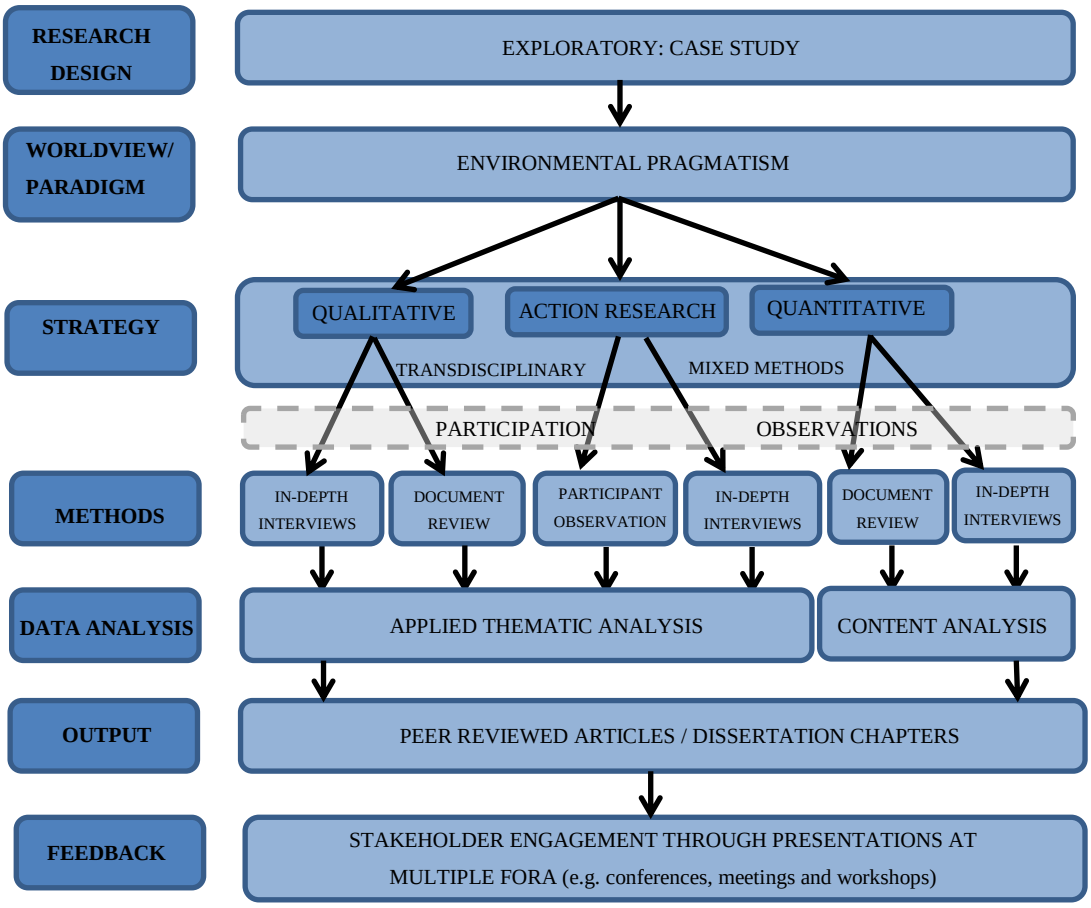


Figure 2-4: Methodological framework guiding the overarching research approach, adapted from Zylstra (2014)

2.2.1 Philosophical world view

Although philosophical world views are often not reported in research, especially in the natural sciences, it is critical that they are identified, as they greatly influence the practice of research (e.g. justification of chosen methodology and methods), and can influence the validity of a research design (Crotty 1998; Moon & Blackman 2014). Thus, acknowledging and understanding the principles and assumptions that are embedded in disciplines is important for interpreting research outcomes (Moon & Blackman 2014).

The world view or "general orientation about the world and the nature of research that a researcher holds" (Creswell 2014) that best describes the nature of the research presented in this thesis is that of pragmatism and, more specifically, environmental pragmatism (Light & Katz 1996).

Pragmatism in essence follows a 'what-works' approach, geared towards problem solving (Patton 2005). A pragmatist perspective relies on both qualitative and quantitative assumptions, thus drawing on both qualitative and quantitative methods, and emphasises the need to better understand a 'real-world' problem; the value of knowledge is therefore judged with respect to how well it serves societal goals (Moon & Blackman 2014). Instead of concentrating on methods, pragmatists focus on the research problem and use all available tools to better understand the issue (Creswell 2014). Pragmatism has been advocated by Creswell (2014), Cherryholmes (1992) and Morgan (2007) as a solid base for research, as it allows the researcher to access different world views and assumptions, multiple methods, and associated data collection and analysis techniques. Further, as pragmatism is problem-driven, it is a suitable approach to research aimed at various applications, whether the applications are to understand, deconstruct or liberate (Moon & Blackman 2014). A pragmatic approach works well within the context of undertaking transdisciplinary research that seeks to integrate multiple knowledge systems and assumptions. As such, there is consensus amongst pragmatists that research always occurs in specific contexts (e.g. social, historical and political), which might necessitate a theoretical lens that is reflective of the social justice and political aims. Acknowledgement of these aims is important as they have a large role to play in understanding how to move towards a more equitable situation which is an important aspect of transformative research (Creswell 2014; Hadorn et al. 2008).

Environmental pragmatism builds on pragmatism and acknowledges that the environment does not have a reality external to humans (Parker 1996), but that humans and the

environment exist as social-ecological systems. Further, it asserts the importance of acknowledging environmental ethics in decision making, especially in relation to public-policy procedures (Seeliger 2009).

By engaging in problem-driven research, with an emphasis on producing solution orientated knowledge for mainstreaming ecosystem services, this research can have a transformative impact. To understand which mainstreaming solutions were feasible within a practical context required engagement with the end users of the knowledge that this research set out to produce. This was a complex and uncertain process which required a flexible approach that could respond to the insights that were gained as the research progressed and new information was gathered. Thus, situating this doctoral research within a pragmatic paradigm, which is problem-driven rather than theory-driven, was most suitable and aligns well with the transdisciplinary approach outlined in more detail above.

2.2.2. Strategy of inquiry

This research follows a mixed methods approach, as it involves combining qualitative and quantitative methods, and is informed by a pragmatic, transdisicplinary approach. A mixed methods approach was chosen, as neither a qualitative or quantitative strategy alone would have captured the richness and complexities of the phenomena under study. When combined, the strengths of the two strategies enabled a more holistic understanding of the opportunities and challenges of mainstreaming ecosystem services, as they enabled a large amount of information to be generated from a variety of sources and perspectives.

This research combined qualitative and quantitative strategies for the purpose of triangulation, complementarity, development, initiation and expansion (Babbie & Mouton 2001; Creswell 2014), and to ensure that the results of the research are trustworthy, by paying attention to issues related to credibility (how credible or believable the results are) and transferability (the degree to which the findings can be generalised or transferred to other contexts or settings). An outline of these strategies summarised from Creswell (2003), Babbie and Mouton (2001) and Green et al. (1989), is listed below:

- Triangulation refers to the use of two or more methods to measure the same phenomenon, e.g. how the concept of ecosystem services manifests in decision-making processes, as elaborated in Chapter 3. It was applied in order for different angles or perspectives (whether converging or corroborating) to add weight to the interpretation of the phenomenon or result (Creswell 2003). Triangulation is

considered by Babbie and Mouton (2001) to be "the best way to elicit the various and divergent constructions of reality that exist within the context of a study", thereby greatly contributing to the credibility of the research. The results in this research were triangulated using a combination of in-depth interviews, document reviews and participant observation.

- Credibility of the research (i.e. the extent to which the results "ring true") was further enhanced by prolonged periods of engagement with various stakeholders in the field; persistent observation, which focused on coupling multiple interpretations of the phenomena with processes of tentative analysis; sufficient referential adequacy through detailed note-taking; audio recordings of interviews; and peer debriefing through conversations with colleagues and 'critical friends' not involved in the study, but with sufficient understanding of the nature of the study (Babbie & Mouton 2001).
- Data from interviews and document reviews were also compared and combined to ensure complementarity, i.e. results from one method were used to elaborate, illustrate, clarify or enhance the results from another. Alternatively, in order to study various aspects of these phenomena, data were combined and compared to contribute to a more holistic understanding of the barriers to mainstreaming ecosystem services in development planning, as well as to identify possible opportunities for mainstreaming using different methods (Greene et al. 1989). For example, document reviews were carried out in order to identify possible points of integration of ecosystem service information; however, in order to understand the challenges for such integration in practice, interviews with practitioners allowed for a deeper understanding of the realities of ecosystem management processes in Eden.
- Development was ensured by using sequential methods to refine the research process, whereby earlier phases of the research were used to inform subsequent ones (e.g. results reported in Chapter 3 and 4, which showed risk to be a useful construct for exploring environmental mainstreaming options, informed the research design applied in the research reported in Chapter 5 and 6).
- Initiation is the process whereby results of qualitative and quantitative strands are compared to identify areas of concordance and/or discordance, which are then used to arrive at new insight. For example, in Chapter 2, the results from the content analysis of decision support tools were compared with the results of the thematic analysis of interviews with decision-making practitioners.

- Similar to complementarity, the methods selected for this research facilitated expansion, which enabled integration of the results from the various research strands, with the intention of improving understanding and providing a broader perspective or insight into the problem (Greene et al. 1989). Combining the results from the various chapters in this thesis, which moved towards addressing the research questions outlined in Chapter 1, allowed for a more profound understanding of, and contributed towards, addressing issues associated with mainstreaming ecosystem services in development planning.
- With regards to the extent to which the results of the study can be applied in other contexts, i.e., their transferability, thick descriptions were provided of the data within context (e.g. how opportunities for mainstreaming ecosystem services manifest in relation to development-planning processes), and participants were purposively selected from different sectors of society (e.g. municipal officials, government departments and civil society), as discussed in more detail in the section below on stakeholder engagement.

Considering its aim to provide rich, in-depth insights into the complex issues related to mainstreaming ecosystem services that reflect the realities of practice, this study also used a case study approach (Stake 1995). Two case studies were used in this research: the first is discussed in more detail in Chapters 3 and 4, and in this instance the unit of analysis was the development planning process in the Eden District; the second case study involved an in-depth analysis of a collaborative project – "The Eden Project", a partnership between public- and private-sector entities, researchers and decision makers, forged in order to better understand the causes of the risks associated with extreme events and their impacts in Eden, which is outlined in more detail below and in Chapters 5 and 6 – in order to identify potential strategies for mainstreaming ecosystem services. Both case studies were based in the Eden District, which was the study site where the majority of the data collection was undertaken. These case studies may be described as instrumental, in accordance with Stake (1995), as they seek to provide insight into an issue and contribute to theory on the challenges and opportunities of mainstreaming ecosystem services in development planning, and facilitate the understanding of broader issues relating to environmental mainstreaming. An overview of the study site is presented below, in section 2.3, in order to provide contextual background to the case studies, and to highlight that the research reported in this dissertation was conducted in an attempt to address some of the social-ecological challenges that are found in this region.

Conducting this research using case studies enabled an intensive analysis of the conditions which might facilitate or hamper mainstreaming efforts within a 'real-world' context, i.e. development planning in the Eden (Bryman 2012; Rule & Vaughn 2011).

Furthermore, this research can also be described as action research, as the emphasis of the study is on process and change, and there was extensive collaboration with participants in order to better understand how to implement specific actions, so as to improve the seemingly poor integration of ecosystem concerns into development-planning processes. Although this study contains elements of participation, it cannot be viewed as 'true' participatory action research, as the participants were not actively involved in the problem framing, design or implementation of the research, or in the interpretation of the results (Babbie & Mouton 2001).

2.2.3 Data collection

Data were collected using a variety of methods, which were selected on the basis of their suitability to address the relevant research questions (see Chapters 3–6 for more detailed accounts of specific methods used). A combination of unstructured and semi-structured interviews, document analysis and participant observation was used to develop a holistic understanding of the challenges and opportunities for mainstreaming ecosystem services. This produced a variety of data, such as interview transcripts, decision-support tools (e.g. integrated development plans), meeting minutes and agendas, stakeholder presentations, project reports and field notes. Documents for analysis were identified on the basis of an iterative process informed by expert and practitioner opinion, and an examination of literature and legislation governing development planning and natural resource management in South Africa. In order to develop an understanding of the phenomena of interest, which ranged from current development planning and natural resource management practices, to how insurance agencies and local authorities respond to increasing risk, a range of interviews were conducted. These were in-depth, (either semi- or unstructured), depending on the specific context and nature of the data required. Detailed field notes were taken throughout the data collection processes, and the majority of interactions were recorded and transcribed, with permission from the participants (for more detail on the informed consent process, see section below on ethical clearance).

2.2.3.1 Stakeholder engagement

Participants in this study were purposively selected at both the local and district levels, from key departments involved in, or affected by, decisions related to ecosystem management and development planning. All core members of the "Eden Project" and associated stakeholders with whom there was active engagement, e.g. members from provincial, district and local government, were also selected. For the purpose of this study, stakeholders are defined as ''anyone with an interest in a particular decision'' (Gardner et al. 2009). This interest can stem from the potential to influence a decision, and/or from the potential to be influenced by that decision, including being affected by the outcomes of the decisions made by others. The format of engagement for this research varied in terms of structure, with some interactions entailing formal, semi-structured interviews and workshops, while others could be described as more informal information-gathering sessions during conversations and in meetings.

This research reflects engagement with more than 200 such stakeholders, representing sectors linked to infrastructure, land-use planning, disaster management, water and urban planning, insurance, climate change adaptation, as well as biodiversity and the environment. Stakeholders emanate from a variety of institutions (e.g. government agencies, research institutions, non-governmental organisations and business) with different interests, mandates and capacities. Representatives of these different sectors were purposively selected using a combination of snowball, criterion, opportunistic and convenience sampling techniques (Creswell 2014) in order to glean knowledge from individuals with a particular expertise (e.g. knowledge on land-use planning or disaster management), and to highlight new areas of interest and/or provide access to other participants. The majority of stakeholder interactions were conducted at the workplaces of the participants, or within work-related situations, e.g. meetings, workshops and fora. This facilitated the development of a first-hand appreciation of the lived realities of the participants (e.g. availability of resources), and enabled participants to share information (e.g. documents and maps) as well as assist with introductions to other potential stakeholders.

2.2.4. Data analysis

Data were analysed using a number of different methods, which are expanded upon in Chapters 3–6, with the choice of method influenced by the specific research design of each study. A combination of qualitative and quantitative data analysis procedures was used, including applied thematic analysis and content analysis (Babbie & Mouton 2001; Creswell 2014; Guest et al. 2011). Applied thematic analysis comprises a series of iterative steps exploring the topics and items of interest embedded within textual data in order to identify specific themes (e.g. the opportunities and challenges identified in Chapter 4), and is used in order to better understand complex phenomena, and answer research problems of a practical nature (Guest et al. 2011). Content analysis the analysis of a variety of different texts (e.g. the interview transcripts and decision-support tools in Chapter 3) and includes both qualitative and quantitative approaches. Neuendorf (2002) asserts that content analysis can be used for summarising and analysing messages, relying on the scientific method by paying attention to details such as objectivity, reliability, validity, generalizability and replicability. Further, content analysis is not limited to the context in which the messages are presented or created, or the types of variables that can be measured (Neuendorf 2002).

2.2.5. Ethical considerations

The participatory and exploratory nature of this research required sustained interaction with stakeholders in Eden and participants in the Eden project. Thus, prior to conducting fieldwork, an application for ethics approval was submitted to, and granted by, Stellenbosch University's Ethics Committee for Human Research in the Humanities (Protocol #: HS659/2011). However ethics approval was not without its challenges, due to the exploratory and participatory nature of the research it was difficult to know, prior to the field work, what ethical approval should be applied for as the methods developed as the research process unfolded. All research was carried out with full participant informed consent, which involved providing participants with information about the study's purpose, design, duration and potential risks and benefits to participants, as well as on the way in which issues of confidentiality would be addressed. It was made explicit throughout the study that all participation was voluntary and participants could withdraw from the study at any time, if they wished to do so; however, none of the participants felt the need to do so. In order to respect the anonymity of individuals, in the reporting of the research no direct, identifiable

reference was made to any specific individual. All documents that were sourced for analysis were either available in the public domain, or permission to use the document was granted by the participants who supplied them.

2.2.6. Feedback

While this research was conducted for the purposes of studying towards a PhD, the results from the various research strands have been disseminated widely. Dissemination has occurred through publication in peer-reviewed journals (Open Access where funding applications for this was successful), as well as through the researcher's participation in many national scientist–practitioner fora (e.g. the Biodiversity Planning Forum, Complexity Forum and Fynbos Forum), conferences (both local and international), science colloquia, research days, and meetings. Particular effort was made to provide feedback on the research to the majority of the participants by presenting the results at local meetings and forwarding on reports and links, especially to those who showed a particular interest in the research.

2.3. Study site

In order to better understand how issues related to the mainstreaming of ecosystem services into development planning manifest in practice, the research presented in this dissertation was conducted in the Eden District Municipality (Eden). Eden is located in the southern Cape region of South Africa and comprises a district municipality encompassing seven local municipalities (Figure 2.5). Eden occupies an area of 23 321 km^2 and more than 300 km of Indian Ocean coastline (SOER 2008).

2.3.1. Brief historical overview

In order to understand the complex social-ecological challenges in Eden, it is important to reflect upon the history of the region. Although the origin of humans is still a source of much scientific debate, compelling evidence exists that the Eden district was home to early humans between 150,000 and 200,000 years ago (Marean et al. 2007), and it is hypothesised that the rich biodiversity of the region assisted with their survival during an ice age which saw drastic population declines elsewhere in the world (Marean 2010). Ample evidence also exists of early San and *Khoikhoi* settlements in the region which date back to several centuries ago (Van der Merwe 2002), while in the 18th century agro-pastoralists from the iron age arrived in the region from the north-east (Tempelhoff et al. 2009).

Although Portuguese settlers reached the shores of Eden in the 15th century, it was not until after the Dutch settled in the Cape that Europeans began frequenting the region, mainly for hunting purposes. Europeans permanently colonised Eden soon afterwards, to exploit the vast indigenous forests in order to supply Cape settlements with timber (Tempelhoff et al. 2009). This soon led to the establishment of agriculture which centred on livestock farming, but later extended to cropping activities. Thereafter, economic activities intensified and there was an acceleration of economic growth based on hunting, trading, mining and carpentry-related activities (e.g. building of boats and furniture) (Tempelhoff et al. 2009). George was the first official town, being proclaimed in 1811 following the British annexure of the Cape Colony in 1806 (Tempelhoff et al., 2009), followed by the establishment of Knysna in 1881. Plettenberg Bay was the last town to be established, only becoming a formal municipality in 1961.

Any understanding of the social-ecological challenges in Eden would be incomplete without acknowledging the profound impact that apartheid – a system of racial segregation or

"state of being apart" – had on human settlements. Although only officially enacted as an official policy under National Party rule from 1948 until 1994, racial segregation arose in colonial times under Dutch and British rule. This discriminatory practice resulted in persons classified as non-white being spatially segregated (based largely on the Natives Land Act of 1913 and excluded from mainstream economic activities. Racial segregation and oppression was institutionalised in the latter half of the 20th century, which saw countless policies segregating education, medical care, public spaces (e.g. beaches) and other important services, and providing significantly inferior public services (e.g. housing, electricity and sanitation) to those classified as non-white.

The legacy of apartheid-based planning and extreme violation of basic human rights have resulted in severe development challenges for South Africa, especially in terms of poverty reduction (Adato et al. 2006; Carter & May 2001; Klasen 1997). The transition to democracy, marked by South Africa's first democratic elections in 1994, catalysed new forms of governance, planning and development (Sowman & Brown 2006), and a number of legislative and policy provisions have increased the responsibility of local government, the role of which has been transformed from mere service provider to active developmental agent (Rossouw & Wiseman 2004). Post-1994, the concept of environmental sustainability has become important in development discourse and policy in South Africa (O'Riordon et al. 2000; Oelofse et al. 2002; Sowman 2002), and has been moved onto the political agenda (Hauck & Sowman 2003). However, while the importance of the concept of sustainability to development has been acknowledged, especially at a national level, there appears to be limited evidence that it is having any influence on development planning at local levels (Cock 2007; DEAT 2003; Sowman & Brown 2006).

2.3.2. Key biophysical features

Eden has a varied topography, consisting of three distinct geophysical zones. The coastal platform, which varies in width from 5km to 40km, is cut by deeply incised river valleys terminating in estuaries and, in some places, coastal lagoons. The Outeniqua mountain range forms a natural barrier separating the coastal region from the inner Little Karoo region, with resulting difference between these two regions in terms of climate and landscape features. The Kouga, Kammanassie and Swartberg mountains form the northern boundary of Eden (SOER 2008) (Figure 2-5).

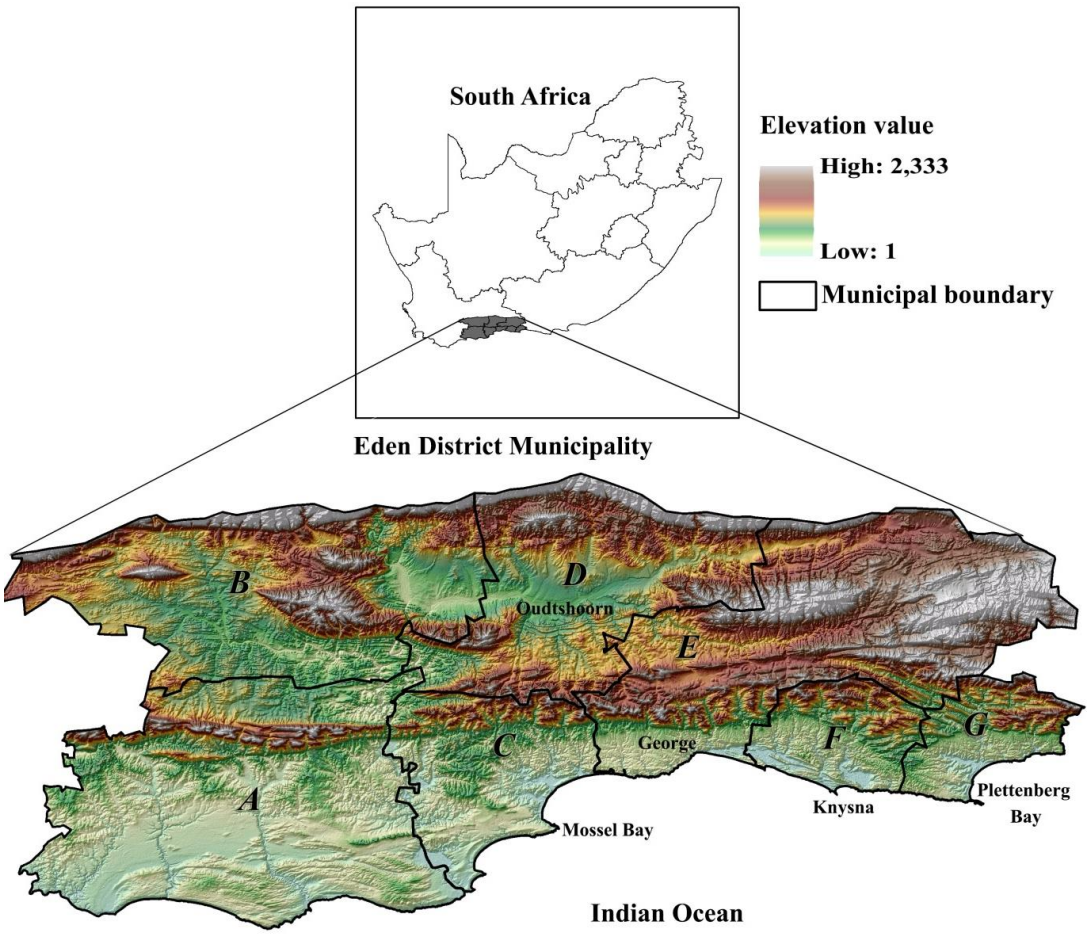


Figure 2-5: Map of Eden showing the various local municipalities (A Hessequa, B Kannaland, C Mossel Bay, D Oudtshoorn, E George, F Knysna and G Bitou) and major towns, used with permission from Sitas et al. (2014).

As Eden is located in a transition zone between a summer and winter rainfall regime, rainfall occurs throughout the year, and varies from 300mm inland to more than 1 000mm on the coast (SOER 2008). Rainfall in Eden peaks in March and October, and these peaks often coincide with cut-off low pressure systems over southern Africa (Nel et al. 2014). Cut-off low events are often associated with extreme weather occurrences, and approximately one in five cut-off low events brings flooding and associated damage to the coastal areas of Eden (Holloway et al. 2012).

Numerous factors – including the temperate climate, Outeniqua mountains and Indian Ocean – have resulted in a large floral diversity, and vegetation within Eden forms an important part of the Cape Floristic Region, a global biodiversity hotspot (Myers et al. 2000). Of the nine biomes found in southern Africa, four occur within Eden, namely the thicket, forest, succulent Karoo and fynbos biomes, with the fynbos biome covering roughly 70% of the district (Mucina & Rutherford 2006).

A diversity of land uses are found in Eden, including transformed areas such as urban and rural settlements and agricultural productive areas, as well as natural areas. Eden has 26 urban nodes, with economic activity in the coastal towns orientated towards tourism, marine resources and retail, whilst the inland towns focus more on agricultural production. A large portion of Eden is under agricultural cultivation and plantation forestry, but it is well known for its diverse natural areas, with the majority of its coastline comprising the scenic "Garden Route". While more than half of the district's vegetation remains natural, only 16.2% of Eden is formally protected, and certain natural areas have been transformed by alien plant invasions and degradation caused by development in the region (SOER 2008).

2.3.3. Population demographics

The most recent national census shows that Eden is home to approximately 574 000 people, representing almost 10% of the Western Cape's total population (Statistics South Africa 2011). In 2007, the percentage distribution of the various population or race groups in Eden was as follows: 29% African, 52.2 % coloured, 18.3% white and 0.5% Indian or Asian. Representation of these various groups in relation to each other are important, as challenges such as poverty and unemployment are associated predominantly with the African and coloured groups, and this has implications for the adaptive capacity of the region as a whole. While poverty levels decreased by almost 10% from 2001 to 2010, slightly more than 21% of the population is still considered to be living in poverty, with 19% of those actively seeking a job being unemployed (EDM 2014). Although Eden has a relatively high literacy rate, with approximately 79% of population reported as literate, the future prognosis for socio-economic development in Eden is limited, given that in 2009 only 7% of the population had a higher education qualification (EDM 2014).

2.3.4. Relevant social-ecological challenges

Of the many social-ecological challenges in Eden, the following relate specifically to this study.

The abundance of natural resources in Eden has resulted in the area being both a popular tourist destination, as well as a hub for industry and agriculture (SOER 2008). Consequently, the current social-ecological challenges relate to increasing levels of in-migration and population growth, especially in coastal regions, and associated consequences in terms of land transformation. Population increases have resulted in severe housing backlogs, with more than 35 000 households requiring public services (e.g. access to basic sanitation and

electricity) (Eden District Municipality 2014). Severe water scarcity has already resulted in negative attention being drawn to the region, and in 2009 resulted in Eden being declared a disaster area (Eden IDP 2011/2012). In some regions demand for water exceeds available resources, which has serious implications for human well-being and economic growth (Eden District Municipality 2014). As Eden is located in a transition zone (i.e. it is located between a summer and winter rainfall regime), it is increasingly susceptible to climate change, as both climatic regimes of the region are predicted to be affected by circulation changes (Nel et al. 2014).

Eden's rainfall pattern, topography and landscape features render it prone to flash floods, interspersed with periods of drought (SOER 2008). Extreme rainfall events in combination with seasonal cut-off lows result in the occurrence of large storm waves which, depending on land-use management practices (e.g. management of estuary mouths), can also contribute to coastal flooding (Nel et al. 2014). While the natural fynbos vegetation in Eden provides numerous ecosystem services, especially those related to hazard regulation (Vromans et al. 2010), transformation of the landscape, mainly due to the introduction of invasive alien species which constitute the forestry plantations, has resulted in changes in natural fire regimes, in particular an increase in wildfires (Nel et al. 2012). These extreme events have severe socio-economic impacts in the region, affecting local livelihoods at a community level, as well as private and public-sector entities (RADAR 2010; Nel et al. 2012). Understanding the impacts of extreme events is especially important, given the rapid urbanization in Eden which has led to the concentration of communities in informal settlements, often in hazard- and risk-prone areas (e.g. in flood plains), and often lacking access to basic services, making it increasingly difficult for those communities to prepare for, cope with and adapt to risks associated with extreme events such as floods (Nel et al. 2014).

2.4. The Eden project

Following an increase in the number of insurance claims resulting from the impacts of extreme weather events in Eden, Santam, South Africa's largest short term insurer embarked on a process which sought to better understand what was driving disaster risk in Eden, and whether the insurance sector could implement any measures to mitigate the risk, both through building resilience in Eden and within their own business. Following a conference entitled "The Ecocentric Journey" in 2010, institutional champions from Santam and the Council for Scientific and Industrial Research (CSIR) initiated a project to explore drivers of risk in Eden.

After an intensive stakeholder engagement process which brought together different role players from private, public, research and civil society communities, a core group of actors came together to develop and explore a 'proof of concept' project, and the 'Eden project' was born. The Eden project team was made up of multi-disciplinary experts from CSIR, Santam, World Wildlife Fund South Africa and the University of Cape Town. Together the participants explored the complex challenges associated with hazards mainly related to flood events, droughts, sea storms and wildfires, with specific interest on how these hazards impact human settlements, ecosystem dynamics and Santam business operation. The main aim of the proof of concept phase of the Eden project was to better understand the status and main drivers of social-ecological resilience in Eden, and the role of both formal and informal insurance in reducing risk and boosting resilience. The Eden project established that, although climate change is predicted to increase the severity and occurrence of extreme events (e.g. flooding), the degradation of ecosystems and their regulating services (i.e. Benefits obtained from the regulation of ecosystem processes such as the protection from high wave run up by coastal foredunes) has an equal or greater impact than climate change (Nel et al. 2014).

The Eden project demonstrated that there are important opportunities for developing interventions involving a variety of stakeholders at a landscape, and national level that can significantly reduce the risk in Eden restoring the ecosystem services provided by healthy ecosystems (e.g. restoration of foredunes and catchments) (Nel et al. 2014).

2.5. Rationale for focusing on the local level in Eden

The Municipal Systems Act No. 32 of 2000 (Republic of South Africa 2000) charges local government in South Africa with a variety of roles and responsibilities, such as regulatory functions associated with the approval of new developments and any modifications to the landscape and built environment. This act requires that ‘development’ be approached in a holistic and inter-sectoral manner, have a pro-poor bias and strong environmental dimension, and be focused on communities’ rights in terms of access to adequate housing, health care, food, water, social security, education and a healthy environment. Local municipalities are expected to contribute towards enforcing statutory regulations on behalf of other spheres of government, and play a strong role in the provision of public services, such as promotion of local tourism; electricity, sanitation, recreational facility and sewerage provision; as well as storm-water and disaster management. Thus, local government is the sphere of government situated closest to the scale at which ecosystem management and development decisions are

planned and implemented. Accordingly, it provides a suitable focus for research on the environment–development nexus and the opportunities and challenges that are associated with the integration, in current planning processes, of information on ecosystem services.

Further, Eden has been the subject of a long history of ecosystem service research conducted by numerous scientific and academic research institutions (e.g. Cowling et al. 2003; Biggs 2004; Reyers et al. 2009; Nel et al. 2011). A variety of civil-society organisations, including landscape initiatives and governmental and non-governmental organizations, provide opportunities for multi-stakeholder engagement (Table 2-1.). Despite existing research and an active network of stakeholders, there still appears to be a divergence between research and practice with regards to ecosystem services, signalling a need for the exploration of strategies to minimise or bridge this gap. The subsequent four chapters (chapters 3-6) outline empirical research that was designed in order to address this challenge.

*A note to the reader, Chapters 3-6 have been written for journal publication, and therefore there is some overlap in the introductions and study site descriptions of each chapter. Chapter 3 and 4 have already been published as multi-authored manuscripts together with the supervisors of this research, for more information see:

Sitas, N., H. Prozesky, K. J. Esler, and B. Reyers. 2014. Exploring the gap between ecosystem service research and management in development planning. Sustainability (Early view) DOI: 10.3390/su6063802.

Sitas, N., H. E. Prozesky, K. J. Esler, and B. Reyers. 2013. Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level. Landscape Ecology: (Early view) DOI: 10.1007/s10980-013-9952-3.

Table 2-1: Names and types of key stakeholder organisations engaged in ecosystem service-related work in Eden

Name of organisation	Type of organisation
Nelson Mandela Metropolitan University	Academic institution
Stellenbosch University	Academic institution
Cape Nature	Governmental organisation
South African National Biodiversity Institute	Governmental organisation
Cape Action for People and the Environment	Landscape initiative*
Gouritz Cluster Biodiversity Reserve Forum	Landscape initiative*
Succulent Karoo Ecosystem Programme	Landscape initiative*
Southern African Program on Ecosystem Change and Society	Network of researchers
Garden Route Initiative	Non-governmental organisation
Mossel Bay Environmental Partnership	Non-governmental organisation
Southern Cape Fire Protection Association	Non-governmental organisation
Wildlife and Environment Society of South Africa	Non-governmental organisation
World Wildlife Fund	Non-governmental organisation
Table Mountain Fund	Non-governmental organisation
Council for Scientific and Industrial Research	Research institution

* Partnerships between government and civil society which seek to ensure the sustainable management of a mosaic of land uses, within the natural resource limits of the landscape

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Chapter 3

Exploring the gap between ecosystem service research and management in development planning

ABSTRACT

The gap between science and practice has been highlighted in a number of scientific disciplines – including the newly developing domain of ecosystem service science –posing a challenge for the sustainable management of ecosystem services for human well-being. While methods to explore science-practice gaps are developing, testing and revisions of these methods are still needed so as to identify opportunities for mainstreaming ecosystem service science into development policies and practice. This research designed and tested an approach to explore the presence and nature of a research-management gap in order to identify ways to close the gap, using a South African case study. Combining traditional review processes with stakeholder interviews highlighted that ecosystem services are not explicitly referred to by the majority of ecosystem management related documents, processes or individuals. Nevertheless, at the local level this approach unearthed strategic opportunities for bridging the gap in the tourism, disaster management and conservation sectors. It also highlighted the current trend towards transdisciplinary learning networks seen in the region. While it found a gap between the research and management of ecosystem services, a rigorous study thereof, which transcends its mere identification, proved useful in identifying key opportunities and challenges for bridging the gap.

KEYWORDS

Land-use planning; ecosystem management; communication divide; mainstreaming; multi-stakeholder engagement; sustainable development

INTRODUCTION

The need to develop sustainably on a finite planet has become increasingly evident (Griggs et al. 2013; Sachs 2012). Sustainable development requires multi-scale policies, plans and decision making that acknowledge the importance of meeting current and future human needs without undermining the resilience of natural systems and the environment. In the past decade we have seen significant advances in our understanding of the social and biophysical aspects that determine the state and dynamics of social-ecological systems (Berkes et al. 1998; Folke et al. 2002; Folke et al. 2011). However, the translation of this knowledge into actionable strategies, designed to inform management and policy and enhance equitable sustainable development and environmental stewardship is limited (Kerr 2011; Knight et al. 2008; O'Farrell & Anderson 2010; Shanley & López 2009).

The emergence and expansion of "ecosystem service science", popularized by the Millennium Ecosystem Assessment (MA), builds towards a knowledge base of the complex interconnectedness between humans and the services nature provides (MA 2005). This research area emphasizes the importance of sustaining specific flows of ecosystem services to ensure that human development goals are met, and therefore has the potential to have a large impact on the management of ecosystems and resulting benefit flows. While there has been rapid and widespread adoption of ecosystem service-based frameworks in policy and practice, both ethical (Jax et al. 2013; Luck et al. 2012) and operational (Nahlik et al. 2012) challenges with the concept of ecosystem services remain, particularly in the developing country context (Sitas et al. 2013, Chapter 4). This signals the need to better understand ecosystem services as a contested concept (Schröter et al. 2014), especially as it relates to the design and implementation of strategies aimed to promote human well-being. However, while the term and its implementation are contested, the notion of the benefits societies and economies get from nature is not (Berkes et al. 1998) and therefore this research moves to explore the concept of the benefits, rather than the term itself.

Mainstreaming of ecosystem services requires effective knowledge exchange processes between diverse sets of stakeholders that enable the science of ecosystem services to be operationalized on the ground (Cowling et al. 2008; Fazey et al. 2013). While the science of ecosystem services is rapidly advancing, the knowledge of how decision makers

and decision-making processes at local levels are using, and implementing the science remains scarce. Understanding the current use and uptake of concept, especially as it relates to current planning processes is pivotal for effective implementation.

There has been a concerted research effort over the last few years to better understand "knowing-doing gaps" in social-ecological research (Fazey et al. 2013; Pfeffer & Sutton 1999). In the past, confirmation of the gap between science and practice was mainly achieved by assessing trends in the published literature, citation counts, and/or author intent, or by providing a theoretical overview of debates around "knowing versus doing" [see Esler et al. (2010) and Lauber et al. (2011)] . Cash et al. (2002) have suggested that in order for knowledge to be taken up into decision making processes it needs to be credible, salient and legitimate. Thus, research is now moving towards engaging with implementers or managers as key actors in the research-management divide (Evely et al. 2011; Prager et al. 2012; Reed et al. 2011; Reed et al. 2013). Here, transdisciplinary research, which acknowledges the importance of a plurality of perspectives and transcends disciplinary boundaries holds much promise (Lang et al. 2012).

While there are increasingly applications of the ecosystem services framework in practice, the majority focus on payment-based schemes and do not yet surface in the published peer reviewed literature (Favretto et al. 2014; Granek et al. 2010; Quick et al. 2013). Therefore, evidence from studies of how to operationalise ecosystem services within other contexts and in developing countries is still needed. Attempts at understanding how to translate ecosystem science into practice is complicated by issues concerning information availability and accessibility (e.g. published versus grey literature and other knowledge sources) and confusion about specific disciplinary-based terms for example, "ecosystem service". That is, implementers may be working in the realm of ecosystem services, e.g. water or land management, yet do not use the term "ecosystem service" explicitly in relation to their work.

Thus, the objective of exploring how the concept of ecosystem services manifests in ecosystem management and policy, linked to development planning, requires a flexible method that extends beyond a literature review and/or a reliance on bibliometric methods, which would only highlight the uptake of a specific scientific term. This research focuses on development planning, a process that identifies the role that different sectors of society need to play in order to improve human well-being by addressing social, economic and

environmental issues in an integrated manner (GIZ 2012; WRI 2009). In South Africa, much like other developing countries, development trajectories are based on a National Development Plan which outlines sector-specific goals to reducing poverty and plans for mechanisms to tackle cross-cutting issues that impact on South Africa's long term development (NPC 2014).

As the conservation of ecosystem services is ultimately a social process operating in a social context, this study supports other research that has shown that understanding the complexity of the research-management interface demands input from a range of stakeholders (Kenter et al. 2011; Knight et al. 2011; O'Brien et al. 2013; Raymond et al. 2010) Accordingly, methods should investigate the experiences of potential implementers of ecosystem service research. To identify the way in which ecosystem services are identified and expressed in – or indeed omitted from – management and policy linked to development planning, a method that involves engaging with multi-sectoral decision makers and their associated decision-support tools was developed and trialled. The research specifically aimed to explore 1) whether the concept of ecosystem services does or does not manifest in ecosystem-management processes; and 2) how the concept of ecosystem services is being used in these processes.

Consequently, the research uses a case study at the local level in South Africa to better understand the realities of integrating information in the development planning process, which in South Africa is specifically geared to address the injustices of the apartheid era planning, and take into account the socio-economic needs of local communities through sustainable service delivery.

In the context of this case study, management refers to purposeful activities (e.g. planning and implementation), which affect ecosystems and their resources, and include processes that range widely from conservation to disaster management. The definition of "process" is a systematic series of management actions, which include relevant policy and decision-support tools (i.e. any resource that aids in the decision-making process and that may range from documents, plans and maps to computer-based systems). Ecosystem services is defined in line with the MA definition, as referring to the benefits people obtain from ecosystems (MA 2005).

METHODS

Using a case study research design (Yin 2003), a two-phase review framework was developed which guided a content analysis of available decision-support tools identified by practitioners to be important for development planning, and of transcriptions of semi-structured interviews with decision makers at municipal level.

A focus on the local level

In South Africa, the government system is formally comprised of three spheres: national, provincial and local. There are nine provincial governments in South Africa, and the country is divided into local municipalities, of which there are three types: metropolitan (in the six biggest cities of South Africa), local (areas that fall outside the six metropolitan municipal areas) and district (an aggregation of local municipalities that fall within one district). The Municipal Systems Act No. 32 of 2000 (Republic of South Africa 2000) charges local government with a variety of roles and responsibilities such as regulatory functions associated with the approval of new developments and any modifications to the landscape and built environment. Local municipalities contribute towards enforcing statutory regulations on behalf of other spheres of government, and play a strong role in the provision of public services such as promoting local tourism, electricity delivery, sanitation and sewerage, storm-water and disaster management and recreation facilities. Local government is the sphere of government closest to the scale at which ecosystem management activities and decisions take place. Accordingly, it provides a suitable focus for this research on current ecosystem management processes and how these relate to future sustainable development in the region.

Study site

The Eden District (Eden) is located in the southern Cape region of South Africa and comprises a district municipality encompassing seven local municipalities (Figure 3-1). Eden occupies an area of 23 321km^2 and more than 300km of Indian Ocean coastline (SOER 2008).

The municipality is characterized by the “Garden Route”, a stretch of scenic coastline popular with tourists, developers and job seekers. A brief summary of the demographics of Eden can be found in Table 3-1. Complex social-ecological challenges exist in Eden and highlight the

need for a targeted approach for reconciling ecosystem services with future development trajectories, and render Eden a suitable case for this research (see Chapter 4 for a more in-depth overview of the challenges). Eden has a long history of ecosystem service research with numerous scientific and academic research institutions conducting research on ecosystem services there, including the South African Millennium Ecosystem Assessment (SAfMA) and Succulent Karoo Ecosystem Partnership (SKEP) (Biggs et al. 2004; Cowling et al. 2003; Le Maitre et al. 2007; Nel et al. 2011; O'Farrell et al. 2008; Reyers et al. 2009). A variety of landscape initiatives provide important opportunities for multi-stakeholder engagement, such as the Garden Route Initiative (GRI), Cape Action for People and the Environment (C.A.P.E), Subtropical Thicket Ecosystem Project (STEP) and the newly formed Gouritz Cluster Biodiversity Reserve Forum (GCBR).

Data collection

The first phase of research commenced with the identification of key processes, documents and individuals involved in ecosystem management, through an iterative process guided by a focused review, expert and practitioner opinion, and other sources, such as municipal websites.

Interviews

To develop an in-depth understanding of the realities experienced by implementers, interviews were conducted with municipal officials in Eden, i.e. individuals employed by local municipalities to provide technical assessments and other inputs that inform development and management processes. Respondents were purposively selected at both the local and district levels from key departments involved in, or affected by, decisions related to ecosystem management (Maxwell 2005). Nine municipal officials were interviewed, representing departments related to planning and development, environmental management, disaster management and technical services (the department of technical services deals with issues related to electro-technical services, streets and storm water, water and sewerage, sports and recreation and cleansing services). The face-to-face interviews were exploratory and semi-structured in nature. Initial questions collected background data on respondents (e.g. educational background, job priorities, etc.) and subsequent questions concerned the use of key planning documents and processes, knowledge integration and information sharing, collaboration, and environmental decision making.

Table 3-1: Table showing the biophysical and socio-economic information of Eden and associated local municipalities, namely Bitou, George, Hessequa, Kannaland, Knysna, Mossel Bay and Oudsthoorn

Municipality	**Area in km^2**	**Areas remaining natural (%)**	**Population 2011**	**Population growth (%p.a.)**	**Poverty index***	**% no income**	**Main economic development thrust (Eden District Municipality 2007)**
Bitou	992	75	49162	5.2	20.7	25.5	Tourism, retirement
George	5241	62	193672	2.6	19.6	38.1	Broad-based services, manufacturing and trade, tourism, agriculture
Hessequa	5729	51	52642	1.8	17.5	33.4	Agriculture, tourism, retirement
Kannaland	4755	76	24767	0.3	21.7	30.6	Agriculture, tourism
Knysna	1059	56	68659	2.8	22.2	33.7	Agriculture, tourism, retirement
Mossel Bay	2010	61	89430	2.2	16.5	40.6	Harbour, manufacturing, trade and tourism
Oudtshoorn	3535	66	95933	1.3	19.1	40.8	Agriculture, tourism and agri-processing
Eden	23321	64	574265	2.3	21.0	33.1	Well diversified

*The Poverty Index for the Western Cape was developed by the Department of Social Development in the Western Cape using 10 indicators. The higher the poverty index score, the higher the level of poverty (EDM 2011/2012).

Documents

A preliminary review of legislative documents at both the national and local level showed no explicit reference to ecosystem services and thus the research only focused on those documents that according to practitioners influence how land, water, resources, facilities and services are allocated within municipalities (Reyers et al. 2010b). Development and land-use planning in South Africa is regulated through the Municipal Systems Act 32 of 2000 which places the main responsibility for planning on municipalities through a compulsory process of Integrated Development Planning (IDP). The resulting plans are then expressed spatially in the form of a Spatial Development Framework (SDF) (Strydom & King 2009), therefore these two planning instruments were core to this analysis. In addition, a suite of documents including the Biodiversity Sector Plans for the region, designed by independent consultants to assist planning in accordance with the National Environmental Management: Biodiversity Act (NEMBA) Act 10 of 2004 which are currently the main environmental informants for local development planning were analysed. Available municipal budget allocations for similar periods to see how much of the yearly budget was spent on ecosystem-related activities (e.g. those activities relating to environmental protection or restoration activities) were also reviewed.

The final 46 documents selected for analysis reflect the key documents and processes that contribute, at least in theory and according to legislation, to ecosystem management (for example, conservation and land-use planning regulations), and importantly, were identified on the basis of practitioner opinion and expert advice (Table 3-2).

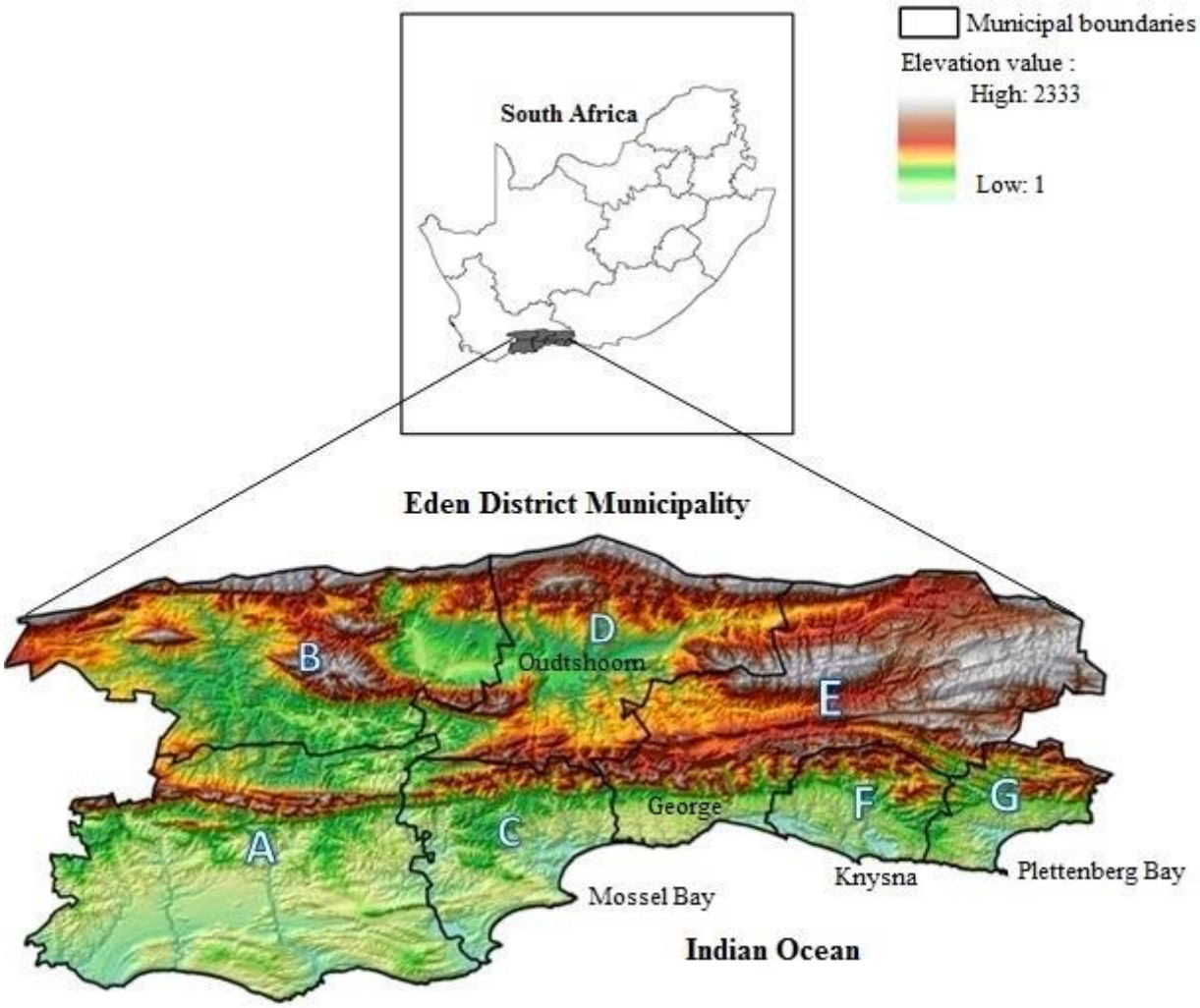

Figure 3-1: Map of Eden showing its location in South Africa, and highlighting the Eden district municipal boundary and seven local municipalities, A) Hessequa, B) Kannaland, C) Mossel Bay, D) Oudsthoorn, E) George, F) Knysna and G) Bitou and major towns, used with permission from Sitas et al. (2014).

Table 3-2: Summary of decision-support tools analysed, including the municipal scale of the documents, type of documents and number reviewed (n=46)

Scale	Type of Document	Total Number
Local	Water Services Development Plan	7
Local	Local Economic Development Plan	6
District	Growth & Development Strategy	1
District	Integrated Waste Management Plan	1
District	State of the Environment Report	1
Mixed	Integrated Development Plan	8
Mixed	Spatial Development Framework	8
Mixed	Disaster Management Plan	3
Mixed	Municipal budget	8
Regional	Biodiversity Sector Plans	3
	Total	**46**

All planning tools used to guide decision making in Eden are in the public domain and were obtained from the Eden District Municipality website (http://www.edendm.co.za/) or from key personnel in the relevant departments within municipalities. The most recent versions of planning tools were selected in preference to older ones, and the majority of documents postdate ecosystem service research interactions between research institutions/researchers and municipalities, with no document dated earlier than 2005. Each planning tool was reviewed and analyzed against the framework that was developed (Figure 3-2.).

Data analysis

During the second phase of the research an assessment framework was developed and applied (Figure 3-2.) to guide a content analysis of tools and interview responses, in order to identify 1) the extent to which the concept of ecosystem services was referred to either explicitly using terms consistent with our definition of ecosystem service), implicitly (through terms roughly synonymous with those associated with our definition of ecosystem services), or not at all; and 2) where ecosystem services had been integrated, to assess which services were mentioned, where, and how. The assessment framework was not applied to the analysis of the municipal budgets as these are not descriptive documents, but instead reviewed whether any of the budget was allocated to ecosystem related activities. Consequently this research reports on these documents separately in the results.

The assessment framework (Figure 3-2.) recognizes that the concept of "ecosystem services" includes the values, processes, benefits or services derived from nature, and therefore both manifest (explicit) and latent (implicit) content of ecosystem services were coded for (Babbie & Mouton 2001). Explicit reference to ecosystem services was whether ecosystem services were explicitly identified using the terms of the MA (e.g. food, genetic resources etc.). An implicit reference to an 'ecosystem service' was where the services can be inferred from the words used e.g. "moderates temperature" which is synonymous with climate regulation, or "ecological buffer" with natural hazard regulation. The distinction between explicit or implicit reference was made specifically to consider the degree to which the language of ecosystem service science has been taken up in the management of ecosystems. While the concept of ecosystem services (i.e. the benefits humans receive from nature) already gained popularity in the 1940s (Daily 1997), only in the last 10 years has the term has become widely used (Gómez-Baggethun et al. 2010), especially following the MA conducted in the period 2000-2005. In cases where ecosystem services were included (explicitly and implicitly), the research determined the MA category to which they belong (namely cultural, provisioning, regulating and supporting), and the depth of knowledge associated with the concept of ecosystem services. Knowledge was categorized as comprehensive if 1) reference was made to all four MA categories of ecosystem services; 2) examples of specific ecosystem services were provided; 3) links were made between ecological processes/functions and the end-benefits humans receive; and 4) information/data on ecosystem services, e.g. a map or economic valuation, was included or alluded to. If three of four of the criteria were not met, the information was categorized as "basic". Initially there

was a third category of ‘intermediate’ however none of the plans fell in this category. Selecting an ecosystem services framework upon which to guide the analysis was difficult as there are strengths and weaknesses of most proposed frameworks (TEEB 2010). Frameworks suggested by Egoh (Egoh et al. 2007) and Haines-Young and Potschin (Haines-Young & Potschin 2010) were used to develop the review framework as they cite human needs at the centre of ecosystem management and are not explicitly focused on assigning monetary valuation to ecosystem services. In acknowledging that services do not exist in isolation from humans needs, important links to the goal of development planning (i.e. improvement of human well-being through sustainable development) could be made. The Haines-Young and Potschin (Haines-Young & Potschin 2010) framework was especially useful in that it acknowledged ‘ends’ with ‘means’ and linked the two ends of a production chain. These frameworks were also used as they allow one to recognize the implicit inference of the concept of ecosystem services, i.e. not just the end services, but the ecological structures and processes that are important for producing the ‘benefits’ that humans derive from ecosystems.

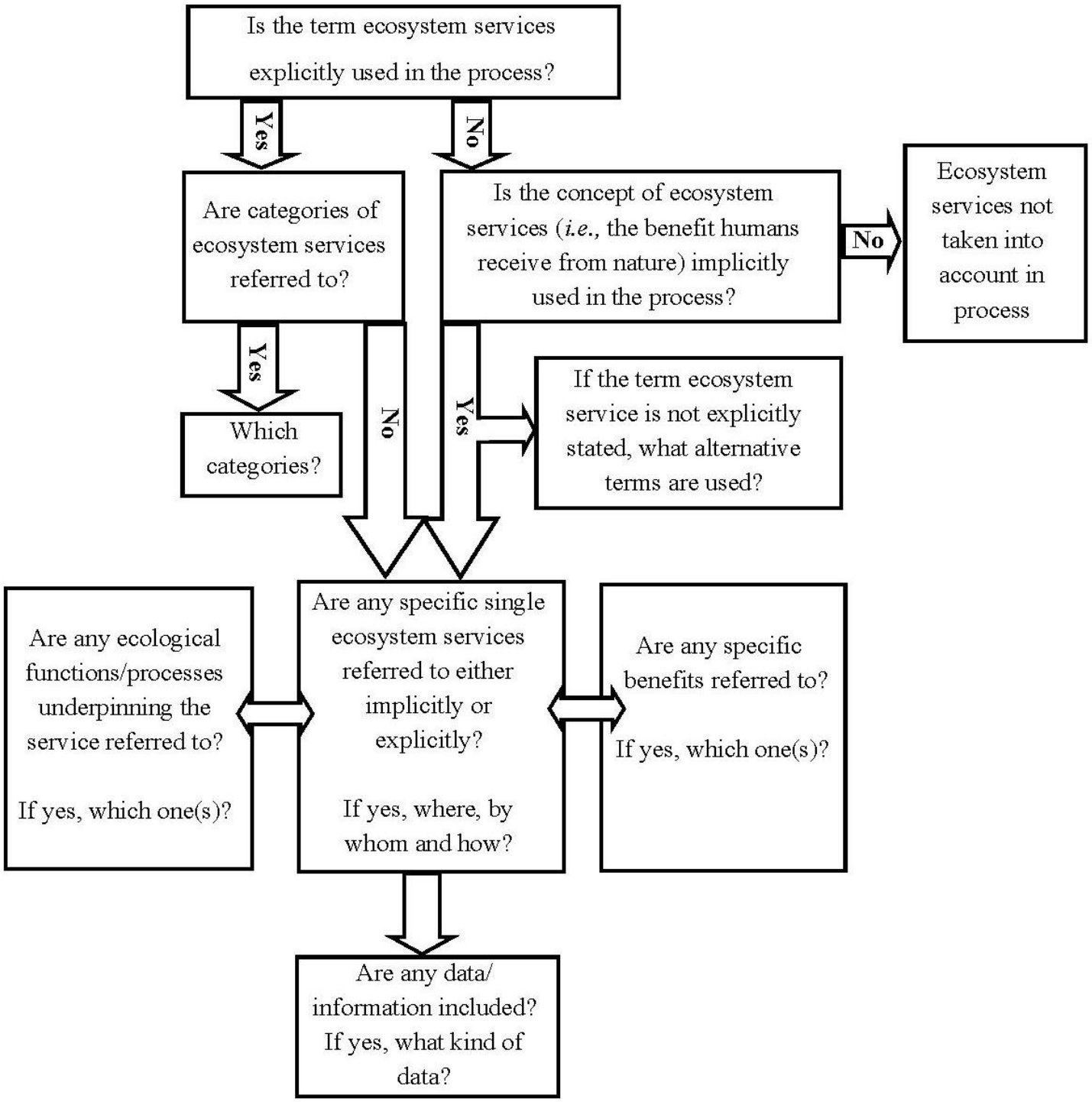

Figure 3-2: Framework based on Egoh et al. (2007) and Haines-Young and Potschin (2010) which was used to guide a content analysis of decision-support tools and interview data

RESULTS

Document analysis

Ecosystem services were explicitly and comprehensively referred to in only four (11%) documents, three of which were regional biodiversity sector plans, with the reference to ecosystem services occurring in various sections of the documents, including introductory chapters, context specific examples and integrated into management guidelines. Five documents (13%) referred explicitly to ecosystem services, but the inclusion was considered basic according to this study's criteria, and mention of ecosystem services were restricted to introductory paragraphs and/or environmental sections only and not linked to specific management guidelines or ecosystem management related activities e.g. restoration. Of the documents reviewed, 8% made no reference at all to ecosystem services, while the remaining 63% included only an implicit and basic reference to one or more ecosystem services (Figure 3-3), and the reference to ecosystem services was mostly only associated with describing the beauty of the region, and not integrated into any specific guidelines, action plans or priority projects.

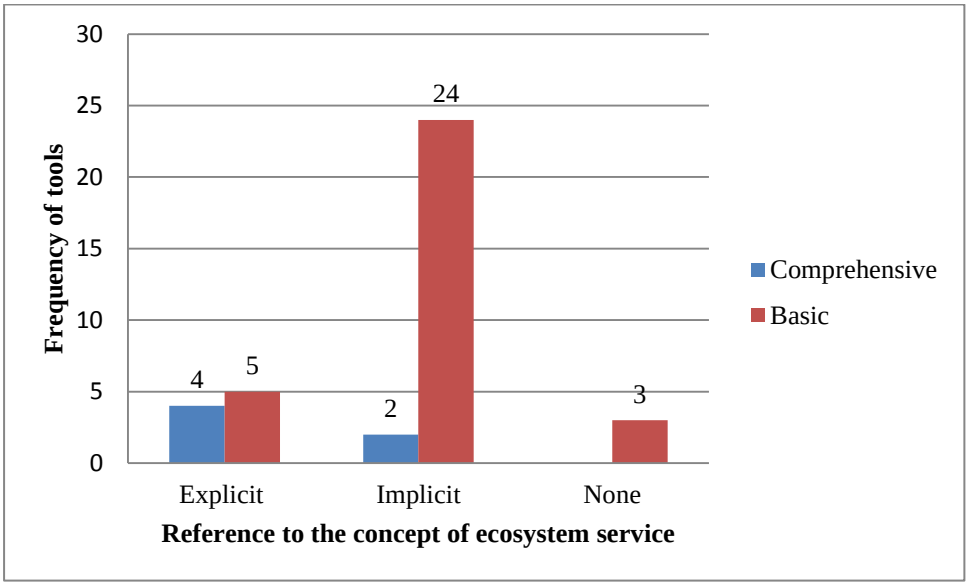

Figure 3-3: Frequency of decision-support tools that make either explicit, implicit or no reference to the term ecosystem service, and the extent to which the information is comprehensive or basic (n=38)

All four broad categories of ecosystem services (provisioning, supporting, regulating and cultural) were referred to either implicitly or explicitly (Figure. 3-4). Of those mentioned,

the cultural benefits of tourism and recreation featured most often (76%), followed by ecosystem services directly linked to food (63%), fresh water (61%) and natural hazard regulation (58%) (Figure 3-4).

In the documents analysed, the importance of ecosystems for human benefit was often mentioned, especially in relation to local economic development. Phrases such as "goldmine above the ground", "exceptional beauty", "pristine nature" and "green gold*"* of the region were used to describe how ecosystems contribute to the tourism sector, and more broadly, how, "the natural environment sustains the economy through eco-tourism, agriculture and forestry" and "nature is the backbone of our economy". Other frequently used terms related to how ecosystems provide "ecological buffers" or "storm protection" against extreme events; however, it is notable that such terms did not appear in local-level disaster-management plans. Synonyms for ecosystem service were used – such as natural capital, environmental services, and nature's benefits, services, wealth and value – but often the reference was less explicit and had to be inferred, and was found in the preambles of the documents (e.g. introductory paragraphs) linked to concepts of sustainability but not in the operational or planning sections.

District or regional-level documents (e.g. biodiversity-sector plans encompassing more than one local municipality) referred to ecosystem services more comprehensively and explicitly than plans developed at a local municipal level. In addition, documents related to the biodiversity and environmental sectors (e.g. State of Environment reporting which is a process carried out at various levels such as the municipal or national scale, and is designed to provide information to the public, industry, non-government organizations and all levels of government to inform multi-sectoral decisions which influence or are influenced by the environment) also provided more comprehensive references to ecosystem services – linking ecosystem services to the processes/functions from which they flow. In comparison, those related to water or waste focused more on built infrastructure and public services.

Only 3 municipalities allocated money towards ecosystem related activities linked to "environmental protection", "environmental management" and "protected areas", however none of these amounts were greater than 1% of the total operating budget, and no further details were provided about the activities.

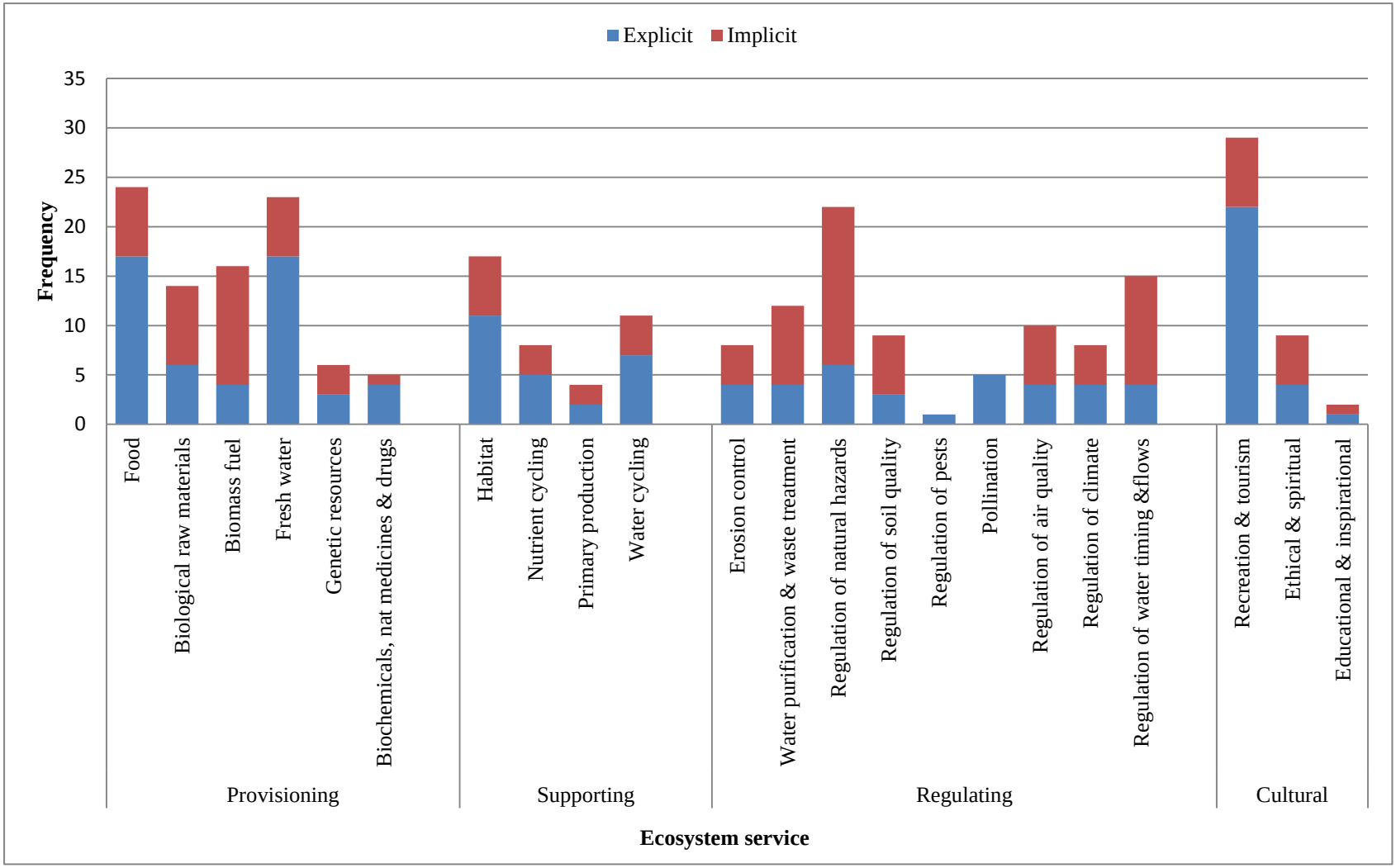

Figure 3-4: Frequency of explicit and implicit references to ecosystem services occurring within decision -support tools (n=38)

Analysis of interview data

While seeking out potential respondents, it was found that none of the eight municipalities in Eden have environmental departments or divisions, and only three of the eight have a dedicated environmental officer, located either within development and/or town-planning departments, or in the community-services directorate as part of "parks and recreation". Two municipalities employed officials mandated to deal with "environment-related work" as part of a mixed portfolio, and three municipalities lacked a person responsible for environmental issues. The age of the respondents ranged from 25 to 60 years, and all but one of the respondents had been involved in municipal planning for over 10 years. Educational backgrounds of the respondents varied from engineering, town/urban/regional planning, environmental management, military training, environmental and geographical science and urban infrastructure management and design.

During the interviews, none of the officials explicitly made reference to ecosystem services, and when the subject was raised at the end of the interview, only three of the nine officials were familiar with the specific term "ecosystem service". However, only one could provide a similar definition similar linking ecosystem services mainly to economic value and incentives (e.g. enforcing mining companies' payments for ecosystem services damaged due to mining operations, and promoting recreational hunting), while the other two respondents confused ecosystem services with public service delivery, i.e. the provision of services and infrastructure necessary to meet basic needs of communities, e.g. electricity, sanitation and water. Implicitly, however, a number of officials (none of them with a background in environmental management) did refer to the concept of ecosystem services. Three officials linked the natural-resource base to tourism opportunities and local economic development. For example, one stated: "*The Western Cape, that [nature] is our gold – we don't want to take the garden out of the Garden Route*", while another warned that development should not "*kill the goose that lays the golden egg*".

Three officials referred to the benefit of clean drinking water in relation to drought and municipal service delivery, with one of those three officials highlighting the need for better management of catchments to ensure water quality, especially in the context of flood damage of waste-water-treatment works. Three officials made implicit reference to the importance of enhancing the disaster-regulation capacity of systems; all three referred to flood regulation: one official linking it to the "*hazard absorbing capability*" of wetlands, and

the other two officials mentioning coastal erosion. Although not specific to ecosystem services, four officials spoke about the importance of biodiversity, and how it benefits Eden, with one official stating, "*Our biological heritage is so important to us in many ways*". All respondents were aware of the biodiversity-sector plans, and legislation pertaining to the consideration of biodiversity in municipal planning. However, only three of the respondents mentioned that biodiversity data actively inform their recommendations.

Engagement with people working within the environmental and/or disaster management sectors revealed that they spoke more about ecosystem services (albeit implicitly) than people working on issues related to built infrastructure or town planning. Most of the "environmental" issues raised by the latter tended to relate more to legislation and regulatory systems than specific ecosystem considerations. Similar to what emerged from the document review, scale was found to be important, as officials working at a district level seemed to have a broader understanding of the benefits that ecosystems provide and how they should be accounted for in management processes.

DISCUSSION

This study presents a snapshot of the gap between ecosystem service research and the management of those services at a local level in South Africa. It demonstrates that, even for a region with a history of ecosystem service research and multi-stakeholder engagement between scientists, landscape initiatives, municipalities and governmental and non-governmental organizations, there still appears to be a gap between research and management. The extent of the gap differs across scales and sectors, and between what is written and what is known. The following section discusses results and present some future research opportunities based on these findings.

Exploring the gap

The method outlined and tested in this research provides a nuanced understanding of the gap between ecosystem service research and management at a local level. It was found that substantial differences in the understanding of the concept of ecosystem service across sectors, which has not been reported in other studies. By identifying both explicit and implicit mentioning of ecosystem services, this study moved beyond searching for uptake of a specific scientific term, which can often take time to enter into the operational language of both

practitioners and planning documents (Bradshaw & Borchers 2000), to how a concept may manifest more implicitly.

The analysis shows that particular links between ecosystems and the benefits they provide are recognized by certain ecosystem management processes and respondents, i.e. those focusing on services fundamental for human survival (food, water and security), and those contributing to the local economy (tourism). However, few management processes (outside of the conservation sector) provided information on how ecosystem integrity can be maintained, other than referring to sustainable development and acknowledging that development options should not impact negatively on nature. Despite the emphasis on sustainable development through ecosystem management processes, the region is experiencing rapid urban development at the expense of natural ecosystems (SOER 2008), signalling the difference between 'rules on paper, rules in use' that what is stated in ecosystem management processes, does not necessarily reflect what is happening on the ground (Lebel 2005). While it appears that there are insufficient sustainable ecosystem management activities being implemented in Eden, it is important to acknowledge the intense pressure that decision makers, planners and municipal officials are under largely due to limited resources and multiple interests and expectations regarding service delivery (Pasquini et al. 2013; Sitas et al. 2013, Chapter 4).

Accordingly, ecosystem services were best represented in the biodiversity sector plans and mentioned by those individuals more familiar with the biodiversity sector (i.e. environmental and district-level-planning officials). This is perhaps due to several factors including the strength of the biodiversity planning sector and its often dominant engagement in land use and other planning processes (Reyers et al. 2010a), as well as the long history of conservation planning and engagement in this region (Driver & Maze 2002; Knight et al. 2006). As biodiversity underpins a variety of ecosystem services (MA 2005) and ecosystem services can help make the case for biodiversity conservation (Reyers et al. 2012), the biodiversity sector has been aware and engaged with these concepts for perhaps the longest. Further, the majority of respondents involved in biodiversity or conservation-related activities hold tertiary qualifications related to the environmental sciences (e.g. ecology or botany).

While this uptake by the well-capacitated biodiversity sector is positive, for ecosystem services to truly inform development planning, there is a need to move into more powerful sectors of decision making e.g. water management, mining, land use planning,

which often take precedence over biodiversity sector inputs (Reyers et al. 2010a). In this regard it is promising to note that ecosystem services were referred to in numerous documents in relation to disaster management. Disaster management is often better resourced and higher up the sectoral hierarchy of decision making; however, at the same time two of the three decision-support tools that made no reference to ecosystem services were local municipality disaster management plans. Increasingly, healthy ecosystems are recognized globally by scientists as essential for providing services for disaster management (Emerton & Bos 2004; Folke et al. 2002; Sathirathai & Barbier 2001), While they may be recognized in higher level planning documents, the failure of these decision tools to make room for ecosystem services highlights the need for intervention strategies that enable ecosystem-based risk-reduction initiatives (Sudmeier-Rieux et al. 2006). The opportunities for this appear good as the results show that the officials involved in disaster management were among the best informed in terms of the role of regulating services in risk management. Thus, the co-development, by researchers and disaster managers of tools and frameworks that mainstream data and approaches for regulating ecosystem services into disaster-management appear to offer possible future directions.

Operational challenges

Despite the potential benefits that an ecosystem service based approach holds in theory, numerous debates continue in the literature around its potential legitimacy, risks and benefits (Goldman & Tallis 2009; Jax et al. 2013; Lele et al. in press; Nahlik et al. 2012; Norgaard 2010; Redford & Adams 2009). Without addressing some of these shortcomings, it will be difficult to move the science of ecosystem services into practice at a local level.

Capacity

It became apparent across all local municipalities in this study site that capacity and resources were insufficient to carry out ecosystem management activities, especially in terms of conducting research and compiling information on the current status and trends of ecosystem services in the region, and for drafting appropriate management action plans. Although all municipalities are mandated to implement sustainable development activities, currently local authorities are not bound by any specific national legislation for employing municipal officials to oversee environmental management, nor is there any national standard which relates to the requirements for appointing environmental management officials. There are requirements to have officials who are involved with air quality and waste management -

which are often seen as environmental management – but the prevailing perception is that environmental conservation is not a municipal function and should therefore be left to the conservation sector (Sitas et al. 2013, Chapter 4). Having specific and dedicated environmental officials are important in order to ensure that environmental concerns have a 'voice' within decision-making processes. However, in order to mainstream environmental concerns into decision making more broadly, it is also important to have environmental 'champions' in positions across the sectors e.g. in departments related to infrastructure and disaster management.

The vast majority of decision-support systems included in this analysis were compiled by independent consultants, and exhibited a large variance in terms of quality and content, rendering it difficult to align ecosystem management objectives across municipal boundaries. As consultancies are hired through independent tender processes to compile specific decision-support systems, it was difficult to determine the individual capacities of each of the consultants that compiled the reports as a team, and what the terms of reference for the outputs specified. Opportunities exist here for integrating the concept of ecosystem services into the terms of reference of these decision-support systems, which would require consultants to work across sectoral and disciplinary boundaries in order to accommodate ecosystem service information into these land-use planning processes. Having ecosystem service consideration explicitly stated in the terms of reference for developing decision support tools would also assist with the review process of these documents by establishing review criteria at a provincial and sector level.

There is clearly a need to strengthen capacity, fill vacancies and support skills development in Eden. However, many traditional approaches often fail due to a variety of causes such as high staff turnover, party politics (Pasquini et al. 2013) and corruption (Smith et al. 2003). Thus, there is a need for the development of new ways of boosting capacity and competency in Eden which builds on existing strength, capacities and importantly, mutual interest. Novel partnerships between business, researchers, civil society and local government are currently being forged in Eden in the form of "Business Adopt a Municipality" whereby business plays a strong role in providing municipalities with resources to improve social-ecological governance (UNEP FI 2012). Building on existing toolkits and training developed for mandatory local climate change adaption and mitigation provides additional opportunities for developing local level capacities and capabilities for improved ecosystem management (GIZ et al. 2012).

The capacity of researchers also needs to be improved in terms of communicating their research in ways that resonate best with their intended audience(s), which requires careful consideration of the language frames and fora to be used. A unique level of cooperation and collaboration is needed among policy, implementation, public and scientific communities, and combinations thereof, to act on the combined threats facing ecosystem service delivery. (Cundill & Fabricius 2008).

Tools

A large range of "tools" and heuristics exist in support of an ecosystem service based approaches, including maps, databases, conceptual frameworks, valuation methods and computer programs (e.g. see (Daily et al. 2009; MA 2005; Smith et al. 2013; TEEB 2010; World Resources Institute 2009; WRI 2010)). However, while many of the tools can be extremely useful from an advocacy standpoint, few tools incorporate the kind of information necessary (which is also often absent) to make meaningful recommendations for local-level ecosystem-management activities geared for implementation. According to Primmer and Furman (Primmer & Furman 2012) the mismatch between ecosystem management needs and ecosystem service approaches can be addressed only if tools build on existing knowledge systems and governance arrangements and aim at communicating across ecosystem and sector boundaries within specific social, economic and institutional contexts. This is especially important given the pressure municipal officials are under to provide basic public services with limited resources and capacity (Sitas et al. 2013, Chapter 4). Many municipalities are currently struggling to achieve their developmental mandate (Pasquini et al. 2013), therefore, unless links are established between ecosystem services and municipal service delivery, mainstreaming of ecosystem services will remain a comparatively low municipal priority.

Tools that strengthen the evidence of how ecosystem services specifically contribute to different aspects of human well-being, with a focus on major sectors in the region (e.g. tourism, agriculture and disaster management), could provide an effective vehicle for engaging with decision makers in the region (Reyers et al. 2009; TEEB 2010). This would facilitate acknowledgement of, and proactive planning for, the protection of key ecosystems, and presents a strategic opportunity for promoting more socially relevant ecosystem-service research. However, decision support tools that deal with inter-sectoral, dynamic ecosystem services are scarce. New multi-sectoral networks to explore risk management within the

context of climate change are emerging between Eden municipalities, provincial government, business, researchers and civil society and are helping to identify informational needs, and integrate available data in existing decision support tools. Here, local level climate change adaptation offers new research avenues and tools that can be built upon.

Opportunities for bridging the gap

While acknowledging the challenges for integrating an ecosystem service based approach for ecosystem management, the engagement with ecosystem management processes in Eden did enable the identification of some key opportunities for integrating information on ecosystem services.

Transdisciplinary approach

The sustainable management of ecosystem services requires cross-sectoral engagement that moves beyond the conservation sector; however, this requires careful navigation across discipline-entrenched thinking. A transdisciplinary approach, which views practitioners as active and equal participants in defining the problem and research agenda, can ensure that research outputs are sufficiently user-inspired and user-appropriate for tackling the specific social-ecological problem at hand (Reyers et al. 2010a). Further, following a transdisciplinary approach can assist with on-going mainstreaming of certain concepts (e.g. ecosystem services), as all affected stakeholders should be included in the decision making / research process. Thus less effort and resources would need to be invested into gaining stakeholder buy-in and uptake of a resulting product, thereby minimizing the strain on municipalities' already limited capacity and resources. While there are still considerable challenges with undertaking a transdisciplinary approach (Brandt et al. 2013), there are numerous opportunities for conducting transdisciplinary research in South Africa especially in light of new initiatives such as the Southern African Programme on Ecosystem Change and Society (see www.sapecs.org) and Transdisciplinary, Sustainability, Analysis, Modelling and Assessment Hub (see www.tsama.org.za) which promote, use and share transdisciplinary approaches for addressing complex social-ecological problems. For a transdisciplinary approach to work, issues related to power, participation and politics need to be addressed (Pohl et al. 2007) which is especially challenging in South Africa given history and the need to address the lingering legacy of apartheid planning (Sowman & Brown 2006). Such

complex challenges require extensive resources and facilitation expertise and time which few local governments have. Yet, some pilot projects are emerging within the South African context such as The Project for Ecosystem Services (ProEcoServ 2010), ASSET Research (Blignaut et al. 2010) and The Food and Energy, Water, Land, Environment Nexus project (FEWLE 2014), which could provide excellent learning opportunities to build upon.

Language

The assumption that various stakeholders, e.g. governmental/municipal agencies, businesses and the public, easily grasp what experts or scientists may consider to be rudimentary concepts or relationships, can create barriers to defining common problems. When engaging with stakeholders, researchers should be more aware of how they present their results, and take note of the terminology they use. Knowledge is highly context-specific, as is the way in which humans think about, name and manage resources. Through these practices, but particularly through language, shared versions of knowledge are constructed (Burr 2003). By exploring stakeholders' perceptions of ecosystems and associated benefits in their own terms, it may be possible to unearth opportunities for translating the science of ecosystem services into more user-useful contexts, especially for undertaking research with a strong implementation focus. Raymond et al. (2013) provide some useful suggestions on the role that multiple metaphors can play in communicating human-environment relationships which address some of the ethical concerns related to ecosystem service framings raised by Luck et al. (2012). Multiple metaphors are especially important for communicating the concept of ecosystem services to wider society and how to establish awareness of the role of ecosystems in sustaining life. Based on the interactions during this study, framing ecosystem services in line with current development priorities of the region, for example as contributing to risk management (e.g. flood mitigation), poverty alleviation (e.g. tourism growth) and public service delivery (e.g. water quality), could serve as potential strategies or entry points to enhance the societal relevance of ecosystem service research. By stressing the importance of ecosystem services for municipal service delivery (e.g. provision of clean water), municipal officials would not have to decide between investing resources in one or the other.

Biodiversity-sector plans

As all land-use planning decisions are legally mandated to adhere to policy (NEMBA Act 10 of 2004), strengthening the representation and acknowledgement of ecosystem services

within biodiversity-sector plans at appropriate scales can provide important opportunities for safeguarding those processes necessary for delivering essential services in the region. However, debates associated with the relationship between biodiversity and ecosystem services caution one to carefully consider how particular ecosystem services trade-off against biodiversity (e.g. natural vegetation vs. agricultural land) (Reyers et al. 2012). It is therefore important that future research explores the evidence base of the assumption that critical biodiversity areas and/or ecological support areas overlap with ecosystem services (Vromans et al. 2010), thereby assisting in rendering ecosystem service trade-off more explicit for decision making. Further, enhancing the utility of biodiversity sector plans in land-use planning processes through, for example, the establishment of bioregional plans, could give ecosystem services more prominence in ecosystem management.

Ecosystem service learning networks

Efforts are needed to build the capacity, networks and resources necessary to communicate research more effectively, and to improve understanding of the realities of decision makers (Roux et al. 2006). This requires the establishment of problem-driven learning organizations aimed at facilitating information flows and knowledge sharing, guided by a transdisciplinary approach that nurtures social learning (Cowling et al. 2008; Cundill et al. 2012; O'Farrell & Anderson 2010). Convincing commercially driven landholders that they should engage in such processes is challenging, however, there is some early evidence of this in Eden in the form of an evolving private-public cooperation in restoring regulating services for flood and coastal storm surge mitigation with the insurance sector and water security related work with the food and beverage industry (WWF SA 2011; Nel et al. 2011), as well as in developing guidelines for the game-based tourism industry (Forsyth et al. 2008). Here, using risk as a boundary concept to mainstream ecosystem concerns into business operations seems to have had success and presents opportunities for further research (Chapter 5). Additional lessons could be learnt from projects such as the water-fund projects in South America which link multiple users (e.g. business, local government and land-owners) through investing in conservation activities aimed at ensuring clean water supply for all (GIZ 2012).

The establishment of an Ecosystem Services forum as part of the South African National Biodiversity Institute's (SANBI) Biodiversity Planning Forum in 2013 will facilitate knowledge exchange and debate concerning the role of ecosystem service science in local and national planning processes. However, in order for the science of ecosystem services to

influence cross-sectoral development planning, engagement needs to extend beyond the biodiversity sector and associated ecosystem managers and planning professionals, to those sectors actively altering the state and flow of ecosystem services (e.g. agriculture, mining, infrastructure development). Given the importance of independent consultants in ecosystem management processes, initiating discussions and co-learning opportunities with these stakeholders through the South Africa affiliate of the International Association for Impact Assessment (IAIA) holds promise for future integration of information on ecosystem services.

CONCLUSION

The safeguarding of ecosystem services can only be achieved if they are accounted for in processes that direct ecosystem management. Mainstreaming ecosystem services into policy and decision making requires an enhanced understanding of a suite of complex decision-making processes across various institutions involved in managing ecosystems. The method developed and applied in this paper establishes a more in-depth understanding of research–management gaps with regards to ecosystem services, and has identified key opportunities within ecosystem management processes where targeted interventions could have the most traction. The method presented in this paper which explores how the concept of ecosystem services manifests in policy and practice allows for the continued monitoring and evaluation of changes in perceptions and policy related to ecosystem services in the future as stakeholder engagement in the region continues. By better understanding how the concept of ecosystem services manifests in decision making processes over time, more targeted ecosystem management interventions can be designed.

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Chapter 4

Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level

ABSTRACT

Despite much progress in ecosystem services research, a gap still appears to exist between this research and the implementation of landscape management and development activities on the ground, especially within a developing country context. If ecosystem service science is to be operationalised and used by decision-makers directing local development, an in-depth understanding of the implementation context for landscape planning and management, and of the opportunities and challenges for ecosystem services in this context are needed. Very little is known about these opportunities and constraints, largely because of the absence of methods to explore the complexity of the landscape planning, management and implementation context and the possibilities of integrating scientific information into these processes within a real-world setting. This study aims to address this need for information and methods, by focusing on a region in South Africa with a long history of ecosystem service research and stakeholder engagement, and testing a social science approach to explore opportunities and challenges for integrating ecosystem services in landscape planning processes and policies. The methodological approach used for this study recognises the importance of social processes and legitimacy in decision-making, emphasizing the need to engage with the potential end-users of ecosystem service research in order to ensure the relevance of the research. While challenges for mainstreaming ecosystem service at a local level were discovered, strong opportunities in the multi-sectoral planning processes driving development and in how the concept of ecosystem services is framed and aligned with development priorities, especially those relating to disaster risk reduction were also found.

KEYWORDS: Landscape management, land-use planning, local, South Africa, stakeholders, sustainability

INTRODUCTION

Today it is widely accepted that sustained flows of ecosystem services (i.e. the benefits humans receive from ecosystems) are critical for human well-being and development (Butler & Oluoch-Kosura 2006; MA 2005; Tallis et al. 2008). Development – defined here as those actions that seek to improve human well-being by addressing social, economic, and environmental issues (WRI 2009) – and the natural environment are mutually dependent, and therefore require an integrated approach. However, in many countries environmental and developmental institutions and decisions still tend to operate in silos, and many ecosystem-relevant decisions continue to be taken in a variety of policy domains with little coordination among them (e.g. local economic development, infrastructure development and disaster management), and with little or no regard to ecosystem services.

Several initiatives exist which attempt to capture or include ecosystem services into decision making (e.g. (Ash et al. 2010; Daily et al. 2009; TEEB 2014), however despite the pronouncement by Burkhard et al. (2012) that the concept of ecosystem services is "*truly coming of age"*, a gap still appears to exist between ecosystem service research and implementation of ecosystem service management activities on the ground, especially beyond the conservation sector (Nahlik et al. 2012; Schäffler & Swilling 2012; Sitas et al. *2014*).

This gap between research and landscape management could be due to a number of reasons, such as the failure to embed research within a social process (Cowling et al. 2008); challenges associated with structurally integrating ecosystems into landscape planning, scale mismatches and issues related to valuing ecosystem services (Daily et al. 2009; de Groot et al. 2010); lack of effective and enduring institutions to govern ecosystem services (Daily et al 2009) and inconsistent conceptualisations and classifications of "ecosystems services" (Nahlik et al. 2012).

If the science of ecosystem services is to be operationalized and used by decision-makers directing development on the ground, an in-depth understanding of the potential promises and pitfalls of the application of an ecosystem service based approach needs to be enhanced. However, in current ecosystem service related literature few pragmatic methods exist that allow empirical exploration of the complexity of integrating scientific information

in decision-making processes (Nassauer & Opdam 2008). Research on improving the understanding of real-world challenges associated with ecosystem governance could greatly benefit from the learning and methodologies emerging from transdisciplinary research (Lang et al. 2012). Transdisciplinary research transcends disciplinary boundaries and focuses on developing enhanced understanding of complex social-ecological challenges by exploring different knowledge forms in an attempt to transform existing conditions (Pohl et al. 2007).

The above challenge was addressed by focusing on a region with a long history of ecosystem service research and stakeholder engagement. A social science approach that acknowledges multi-stakeholder perspectives was tested, with the aim to explore the opportunities and challenges for mainstreaming ecosystem services in local development processes and policies. Mainstreaming is considered to be "the informed inclusion of relevant ecosystem service concerns into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action" (Dalal-Clayton & Bass 2009). The possibilities for increasing the scope of current policy and planning processes that influence local land and water allocation and use are explored by providing user-inspired opportunities (i.e. those highlighted by relevant institutions commenting on and steering development activities on the ground) for mainstreaming ecosystem services. The focus on mainstreaming is intentionally aimed at the land and water-use planning sectors and associated landscape management processes which are mandated to drive development at a local level (hereafter referred to as development planning).

By presenting insights that are sensitive to challenges particular to the global South, where environmental issues and pressing economic goals tend to constitute polarised agendas in the political realm (Le Maitre et al. 2007; Reyers et al. 2010), this study aims to address the marginal scholarly engagement with perceptions and operational definitions of ecosystem services within a developing country context.

METHOD

The empirical research presented in this chapter forms part of a longer term multi-institutional, interdisciplinary sustainability science program in Eden (O'Farrell et al. 2011; Reyers et al. 2009) which has built up a large stakeholder network in the region. This program is now moving towards implementation of ecosystem service frameworks in the area (Cowling et al. 2008; Project for Ecosystem Services (ProEcoServ) see www.proecoserv.org). The research was exploratory and the operational framework

proposed by Cowling et al. (2008) was used to help guide research on identifying the opportunities and challenges for mainstreaming ecosystem services in order to feed into the next phase of the program in the region, however, the promotion of mainstreaming was not part of the research process presented in this chapter.

Introduction to Eden case study

In South Africa, the government system is formally comprised of three spheres: national, provincial and local (see (Pasquini et al. 2013) for an overview of the structure of local government in South Africa). Following South Africa's transition towards democracy in 1994, a number of legislative and policy provisions have increased the responsibility of local government from service provider to active developmental agent (Rossouw & Wiseman 2004). Local government is therefore the appropriate scale at which landscape management activities and natural resource use decisions are implemented (Pierce et al. 2005).

This research involved a case study conducted in the Eden District Municipality (Eden), located in the southern Cape region of South Africa. Eden comprises seven local municipalities nested within a district municipality (Figure 4-1), and occupies an area of +/- 23 000km^2. Emerging social-ecological problems in Eden suggest the need for a more targeted approach for reconciling ecosystem services with future development trajectories. Firstly, Eden's economic growth has been strong, especially within the tourism and agricultural sectors (Eden District Municipality 2014, and is predicted to continue, placing increased pressure on sensitive ecosystems {Gallo, 2009 #587). Future climate change however, has the potential to undermine Eden's economic growth opportunities, particularly in relation to climate-sensitive sectors, such as agriculture and tourism. As these sectors contribute significantly to local livelihoods and regional development, degradation of the ecosystems supporting these sectors has the potential to negatively impact socio-ecological well-being (Archer et al. 2010; O'Farrell et al. 2008). Increasing population growth and changing migration patterns have, and will continue to affect key ecosystems, especially those related to water availability. Existing demands for water in some regions of Eden already exceed available resources, resulting in the declaration of the region as a drought disaster area in 2009 (2011/2012). Eight extreme weather events associated with cut-off low events between 2003 and 2008 (causing unusually heavy rainfall) resulted in approximately $210 million worth of direct damage in Eden, with damage per capita in rural areas around 3.5 times the annual household income (Nel et al. 2011a). Lastly, the rich biodiversity of the region (Eden falls within the Cape Floristic Region, a global biodiversity hotspot) presents

both a major challenge with regards to its safeguarding, but also presents significant opportunities for sustainable local development, if based on comprehensive planning and management (Egoh et al. 2009; O'Farrell et al. 2010). Such potential for sustainable development has not yet been recognised in current management processes that direct development in the region, as environmental assets (ecosystem services) are not yet fully acknowledged in local development decisions (Sitas et al. *2014*), Chapter 3).

The social-ecological problems outlined above echo challenges facing rapidly urbanising and urban regions elsewhere in the world, and suggest the need for a more targeted approach for reconciling ecosystem service provision with future development trajectories (2011/2012; Archer et al. 2010).

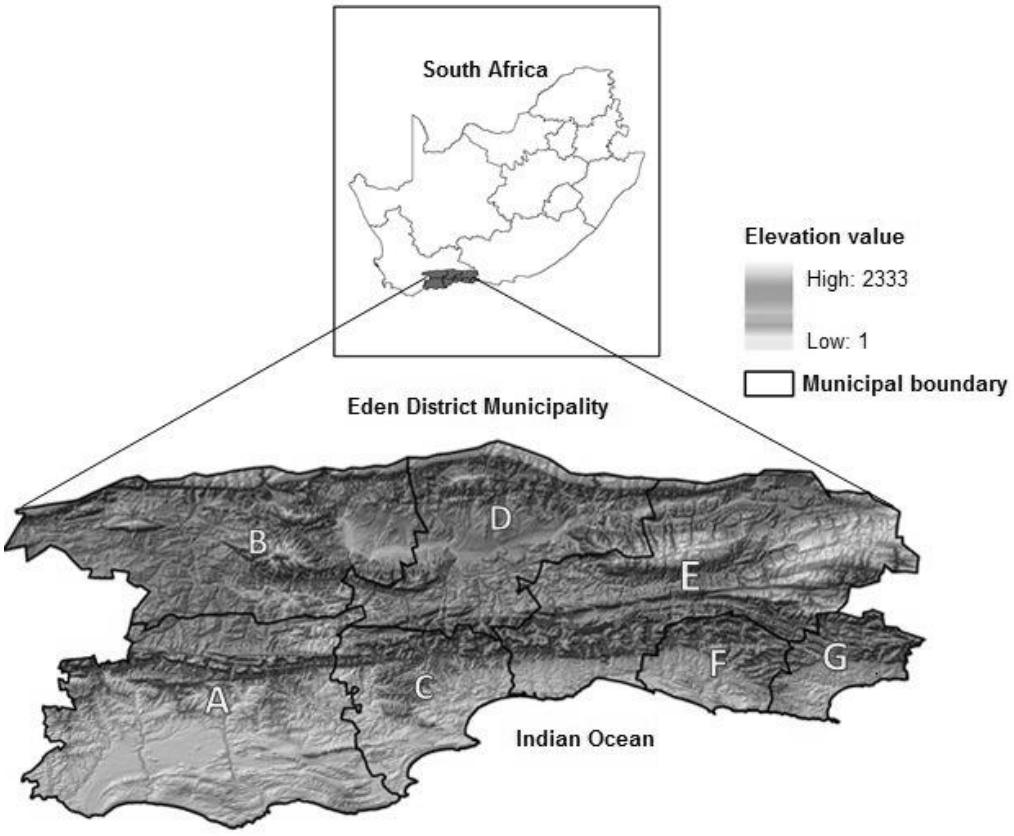

Figure 4-1: Map of Eden showing its location in South Africa, and highlighting the Eden district municipal boundary and seven local municipalities, A) Hessequa, B) Kannaland, C) Mossel Bay, D) Oudtshoorn, E) George, F) Knysna and G) Bitou

Eden has been the subject of a long history of ecosystem service research conducted by numerous scientific and academic research institutions (Biggs et al. 2004; Cowling et al. 2003; Nel et al. 2011b; Reyers et al. 2009). A variety of civil society organisations, including

landscape initiatives and governmental and non-governmental organizations, provide opportunities for multi-stakeholder engagement. Despite existing research and an active network of stakeholders, there still appears to be a divergence between research and practice with regards to ecosystem services (Sitas et al. *2014*),Chapter 3), signalling a need for the exploration of options to minimise or bridge this gap.

METHODOLOGY

Exploring the challenges and opportunities for mainstreaming ecosystem services requires methods that move beyond a simple review-based or bibliometric approach, to methods that acknowledge the complexity of navigating different value systems, mental models and research traditions – aspects which quantitative methods alone cannot address (Cowling et al. 2008). This research therefore used a participatory and qualitative approach, as this provides a holistic perspective of the complexities of operationalising ecosystem services within a real-world setting. Using a quantitative approach alone would be unlikely to fully accommodate the complex and dynamic nature of opportunities and challenges for mainstreaming ecosystem services and their contexts, and quantification could result in a loss of richness in the data collected. This exploratory study used an instrumental case study design (Stake 2003) to develop insights into the challenges associated with, and opportunities for, integrating relevant ecosystem service 'information' in development planning at a local level. This 'information' includes both conceptual links of the importance of ecosystems and their resulting benefits, and actual existing information in the region, e.g. maps on the location of storm surge mitigation.

Data collection

An iterative and staged approach to data collection was followed (Figure 4-2). Typical of case study research within the qualitative paradigm, data was collected from multiple sources (Creswell 2012), such as interviews, participant observations, *in situ* conversations and key documents, including research reports, government policy documents and decision-support tools (which were defined as resources that aid in the decision-making process and that range from documents, plans and maps to computer-based systems, see Table 4-1). These multiple sources assisted in enhancing the trustworthiness of the results primarily through triangulation (Babbie & Mouton 2001).

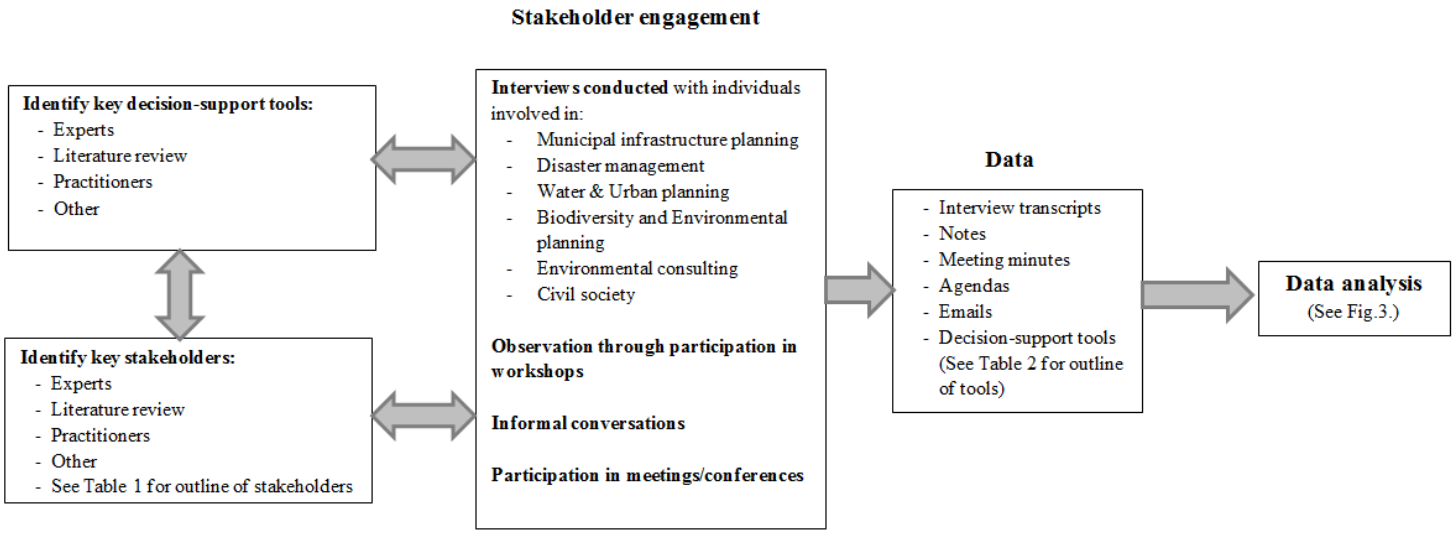

Figure 4-2: Diagrammatic representation of the stakeholder engagement process

The focus of stakeholder engagement was to develop an in-depth understanding of the lived realities of development planning in Eden, and to illuminate the extent to which environmental information is used in development planning processes at a local level. While the specific focus of this research was on ecosystem services, the concept encompasses the environment thus, when engaging with stakeholders, the use of the term 'ecosystem service' was purposefully avoided so as to not exclude potentially relevant responses from individuals unfamiliar with the term. Instead questions were framed around broader issues related to the environment (e.g. biodiversity loss, flooding, etc.), asked what information informed decisions regarding development (e.g. land-use zoning schemes) and what information informants perceived could contribute to more sustainable development. Detailed field notes were taken and the majority of the interactions were recorded and transcribed while adhering to confidentiality protocols and full ethical clearance was obtained prior to research commencement.

Table 4-1: Summary of the decision-support tools reviewed, indicating the municipal scale of the documents, type of document and number reviewed (n=46)

Municipal Scale	Type of Document	Total Number
District	Growth & Development Strategy	1
District	Integrated Waste Management Plan	1
District	State of the Environment Report	1
Local	Water Services Development Plan	7
Local	Local Economic Development Plan	6
Mixed	Municipal Budget Review	8
Mixed	Integrated Development Plan	8
Mixed	Spatial Development Framework	8
Mixed	Disaster Management Plan	3
Regional	Biodiversity Sector Plans	3
Total		46

Data analysis

All transcriptions and notes were analysed using applied thematic analysis (Guest et al. 2011). The analytic process is outlined in Figure 4-3, which comprised a series of iterative steps exploring the topics and items of interest embedded within the textual data. Resulting themes were then grouped into: a) challenges; and/or b) opportunities (Table 4-2 and Table 4-3). For the purpose of this research, a challenge relates to an issue that has the potential to undermine or hamper integration of a mainstreaming effort unless it is specifically addressed and improved upon. An opportunity relates to those aspects that facilitate or encourage the achievement of the goals of mainstreaming and offer a chance for progress or advancement.

This chapter focuses on those issues that emerged on numerous occasions during a variety of stakeholder engagement sessions, and those on which the most agreement or consensus was recorded. The level of the latter was grouped in terms of the average number of stakeholders identifying a specific issue as a challenge or an opportunity. Consensus was ranked as high

(+++) if more than two thirds of the stakeholders highlighted the issue as a major challenge or opportunity, medium (++) if between one- and two-thirds identified it as a challenge or opportunity, and low (+) if less than one-third of the stakeholders mentioned it as a challenge or opportunity. This assessment was triangulated with a deductive content analysis of key documents to explore whether similar themes (see Table 4-2 and Table 4-3) emerged.

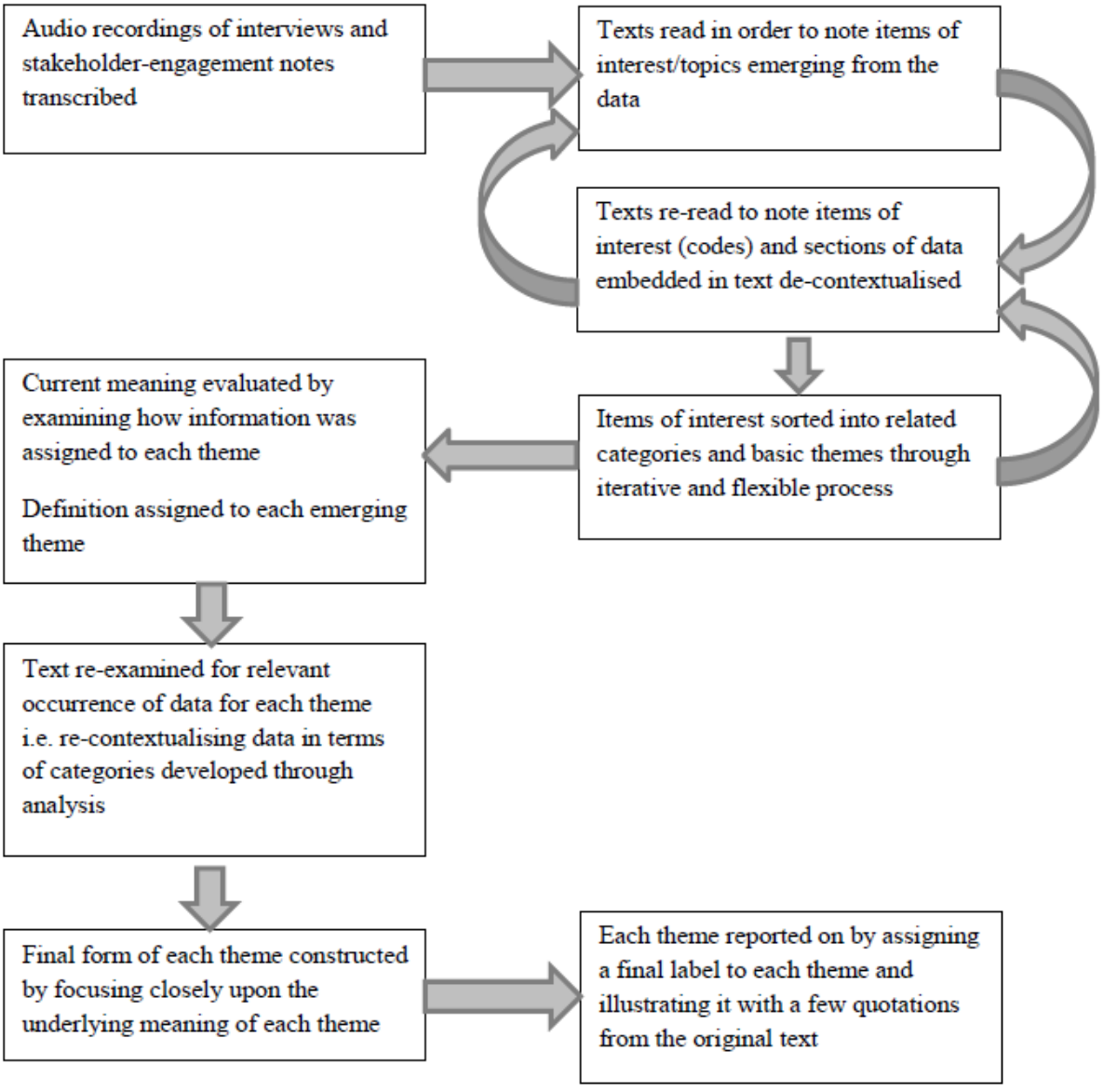

Figure 4-3: Diagrammatic representation of the process of thematic analysis, adapted from Whitelock (2010)

Stakeholder engagement

Stakeholder engagement was focussed mainly at the district and local municipal level. The format of the engagement for this research varied, with some interactions entailing formal, semi-structured interviews and workshops, while others could be described as more informal information-gathering sessions during conversations and in meetings. Stakeholders were defined as "anyone with an interest in a particular decision" (Gardner et al. 2009) regarding landscape management and development planning. This interest can stem from the potential to influence a decision, and/or from the potential to be influenced by that decision, including being affected by the outcomes of the decisions made by others. Approximately 200 stakeholders were selected primarily through a snowball-sampling approach, as well as a combination of criterion sampling and opportunistic and convenience sampling (Creswell 2012). Most represented sectors linked to infrastructure, land-use planning, disaster management, water and urban planning, and biodiversity and the environment. These sectors continually impact on and are directly impacted by environmental change in Eden (e.g. climate change) and activities within these sectors would thus need to consider ecosystem services and related multiple-sector linkages in their design and implementation (e.g. road infrastructure damaged by floods). Other informants included individuals and groups in civil society (e.g. non-governmental organisations and community collectives). Given the diversity and inherent power dynamics (e.g. senior versus junior officials) of informants, individual interviews were conducted to encourage honesty and openness. The majority of interviews were conducted *in situ* at the workplaces of the respondents. This allowed observation of the lived realities of respondents (e.g. availability of resources) and enabled respondents to share information (e.g. documents and maps) and to facilitate introductions to other potential stakeholders.

In group sessions such as meetings and workshops, tensions amongst opposing groups of stakeholders were noted, as emerging opinions varied greatly; for example, those opposing or supporting the construction of a dam along a river. As the researcher was not the facilitator of the group engagement sessions, attempts were not made to resolve the tensions, but were noted as potential challenges.

RESULTS

Challenges for mainstreaming ecosystem services

The engagement with local decision makers revealed a number of challenges for mainstreaming ecosystem services, which are summarized in Table 4-2.

Table 2-2: Main challenges for mainstreaming ecosystem services for development planning as identified by local stakeholders. Level of consensus: +++ High, ++ Medium, + Low. Source: Stakeholder consultation

Challenges for mainstreaming ecosystem services	Level of consensus
Confusion concerning the concept of ecosystem services†	+++
Insufficient resources*	+++
Environment-versus-development tension	+++
Weak alignment of policies and legislation*	++
Minimal proactive planning*	+

*denotes that these challenges were supported by our content analysis

†denotes challenge specific to mainstreaming ecosystem services

Confusion concerning the concept of ecosystem services

While most of the stakeholders engaged within the environmental sector exhibited a sound understanding of the *concept* of ecosystem services that is consistent with widely accepted definitions found in literature, the majority of individuals from other sectors (and some from environmental sectors) revealed a measure of confusion related to the concept of ecosystem services. This confusion mainly concerned a) the relationship between biodiversity and ecosystem services, more specifically whether, and how, biodiversity underpins ecosystem services, and if focusing on conserving biodiversity, especially in threatened regions would encompass ecosystem service conservation ; b) valuation, i.e. the perception that ecosystem services equate to only the benefits from the environment one can economically valuate, and that the concept of 'ecosystem services' is equivalent to payment for ecosystem services (PES); c) the assumption that ecosystem services originate only from pristine ecosystems, excluding agricultural land and urban areas; d) the question whether ecosystem services are

only the end services/benefits that humans receive that are more 'visible', for example, water quality and quantity, or whether they include the processes and functions that generate the services (i.e. upper watershed processes) ; and e) the equating of ecosystem services to public services provided by local authorities, e.g. water and sanitation services, or services provided by conservation authorities e.g. issuing of permits for recreational sports (e.g. fishing or mountain biking) in protected areas or the issuing of fines for environmental offences.

Insufficient resources

The scarcity of financial, human and information related resources were identified by stakeholders as important barriers, preventing them from executing their present daily tasks effectively, and from initiating new activities related to mainstreaming ecosystem services. Less than half of the municipalities involved in our study had staff positions dedicated to environmental management functions, and where these dedicated positions existed, they were not filled. Those few officials working within municipalities with environmental officers in place highlighted how their impact is constrained by a lack of financial resources. Again, this is supported by the fact that none of the municipalities allocated more than 1% of their total budget to environmental activities (such as restoration, environmental awareness, or alien invasive species control), with six of the eight municipalities reporting an environmental budget of zero (Municipal budget reviews: see Table 4-1). A municipal official expressed his frustration with the failure of municipalities to budget for the environment thus: "*when municipalities need to save and reallocate money, the first thing to go is the environment. We have a budget of zero to act with, how are we supposed to keep the garden part of the Garden Route with nothing?"*

Insufficient human and financial capacity was also highlighted as a limiting factor for many stakeholders from other sectors, including from governmental and non-governmental agencies, where the volume of work far exceeds institutional capacity, resulting in the inability of some to extend to critical initiatives, e.g. facilitating and securing new stewardship agreements. Insufficient capacity and resources were also reported to contribute to a lack of implementation, monitoring and enforcement of environmental laws and regulations across sectors and among both public and private entities alike.

Many stakeholders also reported on insufficient informational resources, stating that existing information is inaccessible and/or inappropriate. Unless information on ecosystem services was available at an appropriate scale, it would be irrelevant to decision making at a local level. The existing coarse-scale environmental information contained in sector plans (e.g. biodiversity sector plans, which in South Africa inform various multi-sectoral planning procedures (Vromans et al 2010)) is seen as providing a guideline, but is insufficiently accurate to address the reality on the ground. The perception is also that existing data are captured in complex scientific articles, inaccessible databases or reports, and as a variety of stakeholders mentioned, "*esoteric*", "*idealistic*" and "*unrealistic*" conceptual frameworks with little relevance or linkages to "real-world" problems, e.g. poverty alleviation or livelihood security. Information on how to integrate issues of scale (e.g. how ecosystem services scale across time and space) with existing decision-making tools and management structures was highlighted as constituting a considerable challenge in mainstreaming ecosystem services.

Environment-versus-development tension

The research found that the concept of ecosystem services is still predominantly perceived as 'green' concept. Most stakeholders perceive each other as belonging in one of two conflicting camps, i.e. "*greenies*", who are perceived to be "anti-development" on the one hand, and "pro-developers", who are viewed as "anti-environment" on the other. This is illustrated particularly well by the different views on environmental impact assessments (EIAs), which the National Environmental Management Act, 1998 (Act No. 107 of 1998) requires development projects to undergo. Environmental concerns raised during the EIA process are sometimes viewed as obstructing and limiting development, while others consider EIAs insufficiently rigorous, and believe that "*rampant development is eroding our life-force*". Certain sectors are also perceived to be either "green" (e.g. the biodiversity sector) or "pro-development" (infrastructure, housing, water), with seemingly irreconcilable aims and often hostile engagement between these camps. Conflicting views on the relative importance accorded to the environment vis-à-vis development-related issues also emerged, with one stakeholder stressing that one "*cannot eat fynbos*" (the dominant vegetation type in the area), and another reporting that, even though the State of the Environment Report (SOER 2008) for the region assessed the condition of the environment quite positively, environmental considerations dominated the spatial development framework (SDF), instead of it focusing on how the region could contribute towards social upliftment. Further, the biodiversity and

environmental sectors are perceived by some as "*locking land away from the people that need it most*" and limiting access to opportunities, e.g. extending agricultural zones that could promote local development.

Local policy tools that in theory should promote sustainable development, are also perceived to 'lack teeth' in practice. Comments such as *"Disaster, disaster, disaster… [sectoral plans] have all been a disaster*" were common among a variety of stakeholders. The Integrated Development Planning (IDP) process, which all municipalities are legally required to undertake (Municipal Systems Act 32 of 2000) is considered by some as ineffective and as a box-ticking process. Likewise, stakeholders alluded to the fact that SDFs are not having the impact they should, with some perceiving them as biased towards biodiversity while neglecting social and broader land-use issues (e.g. agriculture). Others referred to the process of developing a framework as protracted, resulting in outdated information. The lack of a regional SDF was highlighted as an important factor preventing the reconciliation of developmental and environmental issues that extend beyond individual municipal boundaries.

Weak alignment of policies and legislation

The research found that stakeholders perceive current legislation and policies as weakly aligned, evidenced through a disjuncture between hierarchical (i.e. from national to local level) and vertical (i.e. between local planning tools and process) integration of policy tools and processes steering development. Even though development planning occurs at a local level, it is mandated to align with national and provincial planning processes. Therefore, integrating information on ecosystem services into these weakly aligned policies and associated processes is perceived to be, as one stakeholder mentioned, "*a waste of time*", as they are not aligned to feed into one another. It was found that as one moves down the hierarchical list of planning documents, environmental issues become "diluted" in terms of their relevance to local development, as evidenced by a lack of recognition or mention in more local-level planning tools. Stakeholders reported on weak alignment between key planning tools, for example SDF and Integrated Development Plans (IDP) which, according to legislation, should be aligned, but in reality are managed and drafted in isolation and without acknowledgement of cross-cutting issues (e.g. poverty, climate change or disaster risk). Independent spatial plans for district and local municipalities was also viewed as problematic as, according to some stakeholders, spatial plans either contradict each other, or

duplicate efforts. In local development plans, environmental considerations were often considered merely a "*nice to have*" (as stated by one stakeholder), with a common perception amongst other stakeholders that often those compiling the plans merely pay lip service to sustainable development.

The weak alignment of policies and legislation could in part be due to inadequate communication and participation across sectors. The research found poor relationships and collaboration both among municipalities, and among sectors within Eden. Tensions were especially apparent between the district- and local-level municipalities, as highlighted by the following statement: "*we never even bother to send our plans [to the municipality], because most of the times we don't get a response or a comment from them*". Sectors are perceived to operate and plan within "silos", with little integration and communication with other departments, as described by one stakeholder: "*these days it's totally separate, it's like islands – if your director doesn't feel like getting involved, there is no involvement – it's an island decision and you find that stuff separates even though it should be integrated*". Stakeholders mentioned the utility of a variety of platforms (e.g. urban planning forum, water user forum, biodiversity planning forum etc.) for the discussion of new insights, technologies and tools, and for sharing experiences and challenges. However, these fora are still perceived to be sector-specific, and many stakeholders are unaware of the fora or dismissing them as irrelevant. Additionally, many of the information resources that have been generated seem to be tied up within specific institutions, with no central "knowledge-hub" for a variety of stakeholders to access easily, often resulting in the duplication of efforts and/or misinformed decisions. It was also found that stakeholders rely on past experience, procedures and outdated frameworks to inform their decisions, which offer few integration opportunities for "new scientific knowledge".

Minimal proactive planning

Those stakeholders located predominantly in the disaster-management and built-infrastructure departments revealed that little proactive planning occurs, especially in relation to risk-reduction activities. In this regard, one stakeholder declared that "*we are spending the money and doing the maintenance [of infrastructure] in [a] Band-Aid type of way […] a plaster here, a plaster there, with no consideration of a long-term picture*". A relatively common perception was that planning mostly entails recovering from a crisis, and only thereafter the correct disaster-response strategy is put in place. Few plans exist that take

decisive steps towards minimising disaster risks, especially those related to the environment. This was supported by document analysis which found that disaster-management plans were entirely focused on disaster response and recovery. One stakeholder described the situation as follows: "*we are not getting ahead – we are doing crisis management […] year after year after year".* The development of early warning systems and user-inspired research to solve recurring environmentally linked problems (e.g. floods and droughts) were also highlighted as important gaps that needed to be addressed.

Emerging opportunities

Below are presented some of the opportunities for mainstreaming ecosystem services in development planning as they emerged through stakeholder engagement, expert consultation and document analysis.

Table 4-3: Main opportunities for mainstreaming ecosystem services in development planning, as identified by local stakeholders. Level of consensus: +++ High, ++ Medium, + Low. Source: Stakeholder consultation.

Opportunities for mainstreaming ecosystem services	Level of consensus
Communicating ecosystem services	+++
Disaster-risk reduction*	+++
Sector and spatial planning*	+++
Champions	+++
Policy tools and regulatory instruments*	++

*denotes that these opportunities were supported by our document analysis

Communicating ecosystem services

One of the greatest opportunities for mainstreaming ecosystem services is situated in how the concept is communicated to stakeholders. Framing ecosystem services in terms of their contribution to the current socio-economic development priorities of specific regions is perceived by stakeholders as ultimately determining the uptake and use of this concept. In addition, when ecosystem service benefits were communicated as core features of an ecological infrastructure that complements existing urban infrastructure, they resonated well with the terminology and mental models associated with municipal infrastructure planning, e.g. road networks and storm-water drains. The research also revealed that stakeholders

require a variety of tools to communicate ecosystem services to other stakeholders, and that maps – although extremely useful – were sometimes insufficient and needed to be complemented with conceptual frameworks, locally relevant examples based on site-specific evidence, as well as hypothetical scenarios and collaborative processes that seek to develop a common understanding and shared definition of a problem amongst stakeholders. Simple infographics and annotated presentations that could be used by decision makers were also cited as being helpful communication tools.

Disaster-risk reduction

The impacts of disasters and disaster risk were the major concern of the majority of stakeholders across all the sectors in Eden; as one stakeholder proclaimed, "*disasters are everyone's business*". The predominantly reactive response to disasters in Eden, which focuses more on disaster recovery than prevention, is seen by a large number of stakeholders – especially those involved in infrastructure and disaster management, as well as land-use planning – as a key opportunity for the development of ecosystem-based intervention strategies. Moving towards more proactive responses to disasters aligns with their mandates to provide safe and secure living conditions within their respective regions. It was noted that reference to ecosystem services in terms of how they contribute towards disaster risk reduction in the region had most traction with decision makers. Strategic restoration and conservation activities, especially those linked to wetlands, coastal fore-dunes and riparian zones, were suggested as priority actions that should be integrated by municipalities into sector plans during the integrated development planning process, as they would be of benefit to all sectors and society. Disaster-risk reduction is also viewed as providing new opportunities to engage with the private sector, as disasters in the region have had negative impacts on businesses (e.g. water risk in agriculture, both in terms of scarcity and flooding). It was found that these businesses do not benefit from relief funds and rely heavily on private insurance companies, who themselves are feeling the burden of global change (e.g. climate change) in terms of insurance pay-outs.

Sector and spatial planning

A key point of intervention, highlighted in terms of its potential for linking development with ecosystems, involved the use of an *ecosystem service lens* in the development of sector plans that each municipality is mandated by national legislation to produce. Currently, sector plans are perceived to be uncoordinated, inconsistent and often even conflicting. However,

regardless of their perceived weaknesses, multi-sectoral development plans are viewed as significant vehicles for linking ecosystem services and development, most importantly in terms of the roles they play in the allocation of municipal budgets, and in future spatial development planning. Ensuring that links to ecosystem services are reflected in all phases of a development plan –i.e. from preparation to project approval– was raised on more than one occasion as a strategy that would facilitate planning that addresses both basic humans needs (such as food and water) and specific ways (such as agriculture and trade) of satisfying those needs in a more sustainable way. This could be achieved by assisting those compiling the plans with a guide or toolkit for integrating information on ecosystem services, and/or including the integration of ecosystem services in the terms of reference in the case of external consultants carrying out the work. Building on and strengthening existing sector plans were also raised as key opportunities. For example, biodiversity-sector plans already highlight key critical biodiversity areas (CBA) and ecological support areas (ESA) that sustain ecosystem services. However, these plans do not explicitly contain information on ecosystem services, and do not indicate whether CBAs and ESAs overlap with ecosystem service hotspots- i.e. areas which provide large components of a particular service. The addition to more specific ecosystem-service data/information (on e.g. ecosystem service hotspots into these planning tools was perceived to be a strategy which could strengthen their utility and scope in current development planning).

Even though numerous challenges with regard to current spatial planning were highlighted by stakeholders, spatial plans (e.g. SDFs) were proposed as relevant tools for the integration of spatial information on ecosystem services, thereby widening their utility for decision making, and making specific environment–development links more explicit. Also reported were opportunities for drafting spatial plans that allow for the visualization of ecosystem services and overlapping demographic development needs, including socio-economic goals. As such, spatial plans are viewed as having the potential to link human and ecosystem dimensions across space and time, while acknowledging the landscape-management needs and contributions of stakeholders from both the private and public sector.

Stakeholders also asserted that, as ecosystem services exist in different regional bundles, information on how these services might trade-off under different management or land-use scenarios would be extremely beneficial for decision making.

Champions

Numerous stakeholders identified the importance of "champions", i.e. individuals or institutions that take responsibility for publicizing and garnering support for a "cause", and for reconciling the environment and development. Initiatives perceived to be making breakthroughs in terms of environmental mainstreaming were mostly associated with specific individuals or institutional 'champions". The champions identified by stakeholders emerged from a variety of sectors, and were more often than not situated within well-established social networks. The need to establish new champions was highlighted as extremely important, especially those that could work with multi-disciplinary teams, cut across and/or connect sectors, and span the science–policy and science–society interface. Independent consultants and consultancies were highlighted as key champions for mainstreaming ecosystem services, in addition to individuals based within NGOs, landscape initiatives and community groups. Consultants are the main knowledge producers in the region, playing a large role in undertaking the research and development of decision-making tools, acting as specialists on impact assessments, and collecting and compiling specific reports commissioned by local authorities.

Policy tools and regulatory instruments

Specific environmental management tools that local municipalities are required by law to develop, are viewed by some as providing strategic opportunities for the inclusion of information on ecosystem services. Two specific tools were highlighted as exhibiting the greatest potential for influencing local development, namely EIAs, which are project-specific, and Strategic Environmental Assessments (SEA), which focus on encouraging sustainable development on a strategic level for areas, regions or sectors of development.

An EIA involves a reactive process that seeks to understand the environmental impact that a proposed development may have on ecosystems. Therefore, the inclusion of information on ecosystem services (e.g. impact of a dam on water quality and quantity) throughout all stages of the process– from scoping, to specialist studies, to public participation processes, – was suggested to render ecosystem service trade-offs of the proposed developments more explicit. Moreover, if ecosystem services are included in the EIA process, they should be included in any mitigation measures that are necessary, in the form of an Environmental Management Plan (EMP) which aims to minimise the effect of the development on the biophysical and socio-economic environment.

Including ecosystem services within an SEA was suggested to provide a more proactive approach to guide development proposals. As an SEA includes information on the current *status quo*, issues that actually or potentially threaten the flow of ecosystem services from specific ecosystems (e.g. converting natural vegetation into monoculture), can be highlighted for future mitigation or prevention activities. Opportunities for integration of ecosystem information exist in the initial assessment of a study area to attain the desired state of the environment and as such, would feed down into the guidelines, processes, procedures and tools to be used in managing development in the area.

DISCUSSION

The methodology outlined in this paper provides an in-depth and systematic approach to understanding the complexities of mainstreaming ecosystem services in development planning. By being transparent about the analytical and stakeholder engagement process (Green et al. 2007), it is hoped the study will also contribute to the literature at a methodological level, by raising awareness of the need and potential for complementary and nuanced methods for, and approaches to, exploring social-ecological systems, and to dispel a common misconception that qualitative research is anecdotal and "unscientific" (Green & Britten 1998). The methods of data collection recognize the importance of social processes in decision making (Cundill et al. 2012) and emphasize the significance of engaging with the potential end-users of ecosystem-service research.

While some of the barriers identified in this research are specific to mainstreaming ecosystem services – for example, that stakeholders find the concept confusing and certain ecosystem service data inappropriate or inaccessible – the majority of challenges that emerged during the research are those common to environmental mainstreaming in general (see Dalal-Clayton and Bass 2009 and the Environmental Mainstreaming initiative found online at www.environmental-mainstreaming.org). However, in South Africa these challenges are exacerbated due to the environmental legacy of apartheid, which saw the majority of its citizens forced off their land and relocated to the least productive land, with many households still today lacking basic services such as sanitation and water (Steyn 2005).

The results suggest that there are many obstacles for integrating ecosystem-service information into decision-making processes that are driving development at a local level. The stakeholders the research engaged provided examples of multi-scale institutional barriers to

the integration of information on ecosystem services with current decision-making processes, ranging from the individual level (e.g. lack of resources and capacity) to the organisational level (e.g. inaccessible or inappropriate information) and the wider enabling environment (e.g. poorly aligned policies and legislation).

However, many of the issues identified present windows of opportunity. Specifically mainstreaming environmental concerns into development planning using an ecosystem-services lens, guided by the opportunities highlighted by stakeholders in this research, can create the basis for more comprehensive, integrated development planning. Importantly, the opportunities suggested, such as integrating ecosystem services into spatial and sectoral planning, allow for cross-sectoral engagement with a common agenda (i.e. ensuring equitable and sustainable development), without necessarily putting additional strain on already limited resources and capacity, and present potential mechanisms for aligning current planning processes. Moreover, as the opportunities highlighted are user-inspired and address on-the-ground realities related to development planning in Eden, their implementation is more likely (Cowling et al. 2008; Knight et al. 2011; Shackleton et al. 2009).

Adopting an integrative approach towards ecosystem services as common benefits to be shared across all sectors can allow for more equitable distribution of those services while enhancing their availability. A variety of tools and approaches are necessary to mainstream ecosystem services in development planning in Eden in order for ecosystem services to reflect in the policy, planning and budgeting processes. Many of the suggested opportunities align with existing municipal and regulatory mandates, thus requiring minimal additional resources.

Post-apartheid South Africa boasts progressive legislation on ecosystem services, as enshrined in its Constitution (Republic of South Africa, 1996); a plethora of regulatory and legislative environmental policies and laws exist, designed to be implemented through a variety of institutions from a local to national level. Nevertheless, the research found that financial and human resources have not yet been allocated in proportion to the rapid development of policy and, as Swilling (2010) states, "*South Africa's state's capacity to formulate policies is not matched by its capacity to implement those policies*". Consequently, key ecosystems remain under increasing threat (NSBA 2011). Timely interventions, focussing on implementing sustainable landscape management activities, are therefore

needed in order to sustain the ecological base upon which future human well-being and development is based.

Linking disaster risk reduction with restoration activities and job creation can provide mutually beneficial situations where excessive disaster-recovery costs are minimised, ecological integrity and associated bundles of ecosystem services are maintained or restored, and contributions are made towards local livelihood security (Van Wilgen et al. 1998). Here, local to national scale maps on important ecosystem service hot spots or key areas of ecological infrastructure would be useful, also to direct future national investment and action.

Currently, high-level policy decisions favouring economic growth, job creation and poverty reduction are often made without acknowledging the role that the environment plays in driving the economy, creating employment opportunities and supporting local livelihoods (Swilling and Annecke 2012). As the demand for ecosystem goods and services has grown to meet the needs of a burgeoning human population and to satisfy increasing consumption patterns, it is predominantly the poor and marginalised communities that have lost access to them (CBD 2010; Cock 2007). This highlights the importance of developing more integrated and equitable development-planning processes which balance human needs with environmental resilience. Although policy and legislation for these processes do exist in South Africa, currently they do not explicitly include ecosystem services (Sitas et al. *2014*).

Using ecosystem services as a common denominator in sectoral and spatial plans and environmental management tools (e.g. EIAs and SEAs) can help streamline the development-planning processes and produce a more coordinated and coherent development strategy that aligns sectors, planning processes and stakeholders. These processes can also help strengthen arguments around the environment for, instead of against, development (CBD 2010; Slootweg et al. 2008).

Further, strengthening proactive planning through the development of early warning systems, and moving from disaster management to disaster-risk reduction using an ecosystem-based approach, can also help bridge sectoral divides and improve understanding of how ecosystems contribute to local socio-ecological resilience (Shepherd 2004). Early action has been shown to be the most cost-effective response (Sudmeier-Rieux et al. 2006), and it has been estimated that every dollar spent on disaster-risk-reduction activities saves seven dollars in losses from natural disasters (TEEB 2010).

During the engagement with stakeholders it became apparent that they find the concept of ecosystem services confusing, especially what constitutes a 'service' arising from multifunctional landscapes (e.g. agricultural land bordering on a protected area and an urban node) and how the scale of benefits and ecosystem functions or processes do not always match. The concept of ecosystem services is also seen by some within the environmental sector as shifting important resources and focus away from biodiversity conservation (e.g. by recognising ecosystem services arising from agricultural landscapes). Another widespread view is that ecosystem services are only those services which can be valued economically, and which are predominantly the more visible provisioning services. These issues make it difficult to reach stakeholders agreement on potential management strategies that connect ecosystem services with development.

A stakeholder's engagement in decision-making processes is determined by that stakeholder's personal frames of reference and mental models (Gerger Swartling et al. 2011; Lakoff 2010; Wilhelm-Rechmann & Cowling 2011), which are linked to their belief and value systems. Changing deeply rooted belief and value systems may be difficult if new concepts, priorities or frameworks differ significantly from existing personal or cultural frames. Thus finding a frame of reference, or point of departure that resonates with decision makers is key.

Sitas et al. (2014),Chapter 3 found that the biodiversity and disaster-management sectors in this study site are most familiar with the concept of ecosystem services, and hence opportunities exist here for the integration of ecosystem-service information into the tools and processes already used in these sectors. Similarly, it was found that framing ecosystem services in ways that link to concepts of ecological infrastructure and risk (e.g. risk reduction) had the greatest traction, as they connected to real, multi-sectoral problems in the area, such as increasing environmental risk related mainly to flooding, drought and coastal storm surge (Nel et al. 2011b); Chapter 5) and built infrastructure which most sectors either rely on, or are responsible for delivering.

In order to move towards an operational definition of ecosystem services, which encompasses multi-stakeholder and multi-sector views, further understanding of how ecosystem services are currently conceptualised and utilized in research, policy and practice in both the development and conservation sector are needed. This could result in best-practice examples of how ecosystem-based interventions can provide cross-cutting benefits and

minimise costly infrastructure repairs (Rebelo et al 2012). Additionally, it could alleviate tensions associated with the perception of environmental conservation or restoration initiatives as being anti-development.

However, maximising the opportunities to mainstream ecosystem services in development planning is not without further challenges. While this research touched on the importance of the potential influence of politics and power dynamics in ecosystem-service-mainstreaming efforts, these issues warrant an entire study on their own, as they can play a crucial role in the success or failure of mainstreaming efforts (Pasquini et al. 2013). Furthermore, debates around the complexities of how to structurally integrate ecosystem services in decision continue in literature (de Groot et al. 2010; Lamarque et al. 2011; Nahlik et al. 2012), as do discussions around the utility of an ecosystem-service-based approach (Goldman & Tallis 2009; McCauley 2006; Norgaard 2010; Spash 2011) and the links between biodiversity and ecosystem services (Mace et al. 2012; Reyers et al. 2012).

CONCLUSIONS AND RECOMMENDATIONS

It has been proposed that mainstreaming the environment in development planning works well when the focus is on "real problems, in real places, facing real people" (Aongola et al. 2009). This research found that a variety of tools and approaches are necessary to mainstream ecosystem services in development planning in Eden, in order for these services to become incorporated in policy, planning and budgeting processes. Reflecting on the challenges and emerging opportunities identified by stakeholders, some of the key activities and research questions that we believe are strategic starting points to catalyse ecosystem-service-mainstreaming initiatives in Eden are outlined below, and hope that some of this learning can be theoretically generalised to other contexts (Yin 2008).

Firstly, mainstreaming ecosystem services is essentially a communications and education endeavour (Aongola et al. 2009). Attempts at mainstreaming ecosystem-service-based initiatives will not succeed if they do not consider deeply entrenched positions in the environment-versus-development debate. The research results echo findings from research on perceptions in this regard, as they exist elsewhere in South Africa (Cock 2007; Munnik & Wilson 2006) and therefore further supports investing significant effort into determining how and to whom information on ecosystem services should best be communicated.

Secondly, the evidence suggests that a large opportunity for mainstreaming exists in targeting the people, policies and processes with "teeth" that currently steer development and landscape management at a local level. Strategically targeting local champions, identifying key decision-support tools and policies perceived to influence development-planning processes, and providing accessible and user-relevant information to feed into these tools and processes, we suggest are important starting points.

Lastly, investing more research and resources into developing "disaster-proof planning" centred on disaster-risk-reduction activities, resonates strongly with decision-makers and practitioners across the sectors. Disaster-proof planning provides numerous opportunities for integrating information on ecosystem services (Shepherd 2004; Sudmeier-Rieux et al. 2006; van Riet 2008), such as incorporating the role of regulating services, for example those produced by intact wetlands, riparian zones and coastal foredunes, that mitigate flood, erosion and coastal storm risk.

Mainstreaming ecosystem services can render an important contribution towards more equitable and sustainable development; however, to realise its potential requires strong political will, active follow-up after implementation, persistence and patience. It is only by engaging with the "end-users" of the knowledge that one can understand how information on ecosystem services should best be communicated or packaged, and in order to do this, a mix of methods and approaches spanning a variety of disciplines is critical. Accordingly, a transdisciplinary approach can prove highly valuable (Cowling et al. 2008; Daily et al. 2010; Liu et al. 2010; Nahlik et al. 2012), as could recent research in the use of a soft-systems approach which acknowledges the researchers interaction with the complex world (Cundill et al. 2012), and a participatory research approach, borrowed from the field of education, to co-design interventions (Plomp 2009). Thus, in order to develop transformative interventions, the end-users of ecosystem-service information need to be actively involved in the research and design of these interventions.

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Chapter 5

Exploring risk as a boundary concept for mainstreaming ecosystem services

ABSTRACT

Engaging diverse stakeholders in collaborative processes aimed at exploring the importance of building resilient ecosystems to mitigate risk is important, but challenging. Many institutions are not fully aware of the extent of their impact, but more importantly their dependence, on ecosystems and the services they provide. Mainstreaming ecosystem services into decision making processes has been proposed as a potential solution for integrating environmental concerns into decision-making. . This study focuses on the extent to which the concept of risk is useful as a mainstreaming tool in bridging the gaps between different disciplines, and between science, policy and practice, by using a case study based in the Eden District. Through a reflective, qualitative inquiry, this research found that using a multidimensional concept of 'risk' enabled different disciplinary and knowledge communities to participate in joint activities and discussions during which information was co-produced and exchanged, facilitated by the use of boundary objects such as assessment frameworks and analytical and conceptual modelling. Through this work, new relationships were built that facilitated both learning and action with regards to the importance of ecosystem services for mitigating risk.

KEYWORDS

Boundary work, ecosystem, extreme event, hazard, knowledge exchange, risk management

INTRODUCTION

Over the last decade research in the scientific field of ecosystem services (the benefits humans derive from nature) has rapidly increased (Seppelt et al. 2011), as have calls to mainstream ecosystem service information into decision-making in order to improve human wellbeing and to support sustainable development (Cowling et al. 2008; Daily et al. 2010; Daily et al. 2009). Mainstreaming is viewed as the integration of relevant information into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action (Dalal-Clayton & Bass 2009). While there have been increasing attempts to do this (CBD 2010; GIZ 2012; TEEB 2010; WRI 2010), many challenges still exist (de Groot et al. 2010; Jax et al. 2013; Ruckelshaus et al. 2013; Sitas et al. 2013, Chapter 4). Mainstreaming requires extensive knowledge-exchange processes that enable different knowledge types (e.g. scientific research and practitioner knowledge) to be used for mobilising action and designing effective interventions (Fazey et al. 2013). This necessitates the co-production of credible, salient and legitimate knowledge amongst diverse stakeholders (Cowling et al. 2008; Cash et al. 2002; Honey-Roses and Pendleton 2013). In order to produce such knowledge, the importance of inter- or transdisciplinary work has been highlighted (Carpenter et al. 2009; Cash et al. 2006; Cash et al. 2003; Lang et al. 2012; Thompson Klein 2004). These approaches require "boundary work", i.e. working at the "boundaries" between academic disciplines and between knowledge types (e.g. scientific and traditional knowledge) (Clark et al. 2011; Guston 2001; Klein 1996; Mollinga 2010). These "boundaries" can exist in many forms including intellectual boundaries between disciplines, between research and policy and between expert and local knowledge, as well as organisational boundaries between different institutions (Mollinga 2010).

While transformative research —i.e. research that aims to transform existing practices and introduce desired ones — requires inter-and transdisciplinary work (Jahn et al. 2012; Pohl et al. 2007), working at the interface between groups of people that have different views of what constitutes reliable or useful knowledge is challenging. Some of these challenges relate to issues such as a lack of coherent problem framing; difficulty in integrating methods; appropriate design of research processes that facilitate knowledge production; multi-stakeholder engagement, especially with regards to practitioner involvement, and whether the transdisciplinary projects are indeed having the intended transformative outcomes (Brandt et al. 2013; Gieryn 1983; Guston 2001; Lang et al. 2012; Pohl & Hirsch Hadorn 2008).

In response to these challenges, Mollinga (2010) suggests that effective inter- and transdisciplinary work essentially requires three key elements: suitable boundary concepts, acceptable boundary objects and enabling boundary settings or environments.

Boundary concepts are "words that function as concepts in different disciplines or perspectives" and are considered multidimensional, referring to the same quality of an object, phenomenon or process, but carrying different meanings in those different disciplines or perspectives, they are different representations of the same entity (Mollinga 2010). For example, the concept of "resilience" is used in a variety of disciplines such as ecology, engineering, psychology and organizational management, with the different dimensions of resilience of social-ecological systems being explored by each discipline (Berkes et al. 1998; Hollnagel et al. 2007; Masten et al. 2009; Weick and Sutcliffe 2011).

Boundary objects are seen as approaches or methods to facilitate action in the context of complex systems, where information of the system is incomplete. Boundary objects are considered to be adaptable to different viewpoints and robust enough to maintain identity across them (Jahn et al. 2012; Mollinga 2010; Star & Griesemer 1989). Three different methods for inter- and transdisciplinary knowledge integration, using boundary objects to negotiate the interface between research and practice, have been identified. First, the analytical route uses modelling – i.e. the generation of a schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics – in an attempt to better understand important aspects of complex systems (Cilliers 1998; Gunderson and Holling 2001). Second, the assessment route includes practical frameworks for assessment and mapping, for example work carried out during the Millennium Ecosystem Assessment (MA) which used an assessment framework and mapping process to better understand the state of ecosystem services worldwide (Ash et al. 2010; MA 2005). Third, the participatory route acknowledges the importance of social processes in knowledge production, such as social learning processes and political mediation in natural resource governance (Berkes 2009; Lebel et al. 2006; Mollinga 2008; Mollinga 2010; Rist et al. 2007).

Boundary settings refer to the specific institutional arrangements that facilitate the development and implementation of boundary concepts and objects. Thus, boundary settings relate to both the internal organisation and dynamics of a research activity, i.e., how

institutions implement their work, as well as the broader external environment of the activity e.g. linked to issues regarding funding sources (Mollinga 2010).

Despite the challenges associated with mainstreaming ecosystem services into decision making (Cowling et al. 2008; de Groot et al. 2010; Nahlik et al. 2012; Sitas et al. 2013, Chapter 3 and 4) and undertaking inter- and transdisciplinary work in order to elicit change (Brandt et al. 2013), there appear to have been some successes (Quick et al. 2013; Roberts et al. 2012; Tallis et al 2009) including recent work on extreme events and regulating ecosystem services in the disaster management sector of South Africa (Nel et al. 2014). This recent work presents opportunities for exploring the extent to which ecosystem service information has been mainstreamed into decision-making processes that catalyse action, and the nature of that action (see Le Maitre et al. 2014; Nel et al. 2011, 2014; UNEP FI 2012). In these projects, and based on the findings of Chapter 3 and 4, the concept of risk arises multiple times as a potential mainstreaming "tool" for integrating information on ecosystem services into decision making, and as such warrants a deeper exploration.

The risk-related work carried out in Eden by Nel and others (Le Maitre et al. 2014; Nel et al. 2012, 2014; UNEP FI 2012), is the focus of the research presented in this chapter. The research explores whether and how the use of the concept of 'risk' facilitates boundary work and mainstreaming by: a) exploring in what way(s) risk was used as a boundary concept facilitating engagement across knowledge systems to mainstream ecosystem services; b) determining what types of boundary objects were used which might have helped mainstream ecosystem services; and c) understanding whether any specific boundary settings were developed and implemented that facilitate mainstreaming information of ecosystem services into decision making. Further, the research aims to investigate whether the boundary work resulted in evidence of mainstreaming including changes in policy, plans, rules, investment, and action.

While the focus of this analysis is on the concept of risk for boundary work, the challenges associated with the use of such a multidimensional concept need to be recognised (Brand & Jax 2007). Criticism levelled against the use of concepts that are multidimensional relate mainly to their role in advancing science, in that they can be pressed into service by different disciplines to justify their particular interests, potentially hiding conflicts and power relations (Brand & Jax 2007). Thus, some researchers suggest that concepts should have clear definitions with limited ambiguity, restricted extension and specified intensions (Kates et al.

2005). However, prescribing definitions of concepts to diverse stakeholder groups without acknowledging the variation in perspectives that might exist can limit whose voice gets heard. In bringing stakeholders together to clarify the meaning ascribed to certain concepts from different perspectives, confronting potential conflicts and power relations, can allow for the generation of a common understanding.

Numerous definitions for risk exist, developed within an array of disciplines including sociology, political science, anthropology, geography, law, economics and engineering (Ekberg 2007). Cardona (2004) suggests that all conceptions of risk have a common element: a distinction between reality and possibility. Ulrich Beck (2000) and Anthony Giddens (1998) have made important contributions to our understanding of "risk", particularly in terms of developing the critical theory of the "risk society". Research on a "risk society" seeks to understand how modern society organises in response to risk, thus focusing mostly on manufactured risks which are the product of human activities. The focus of the work presented in this chapter is on 'real' or 'actual' risks associated with the threats of extreme weather events, which are defined as "the occurrence of a value of a weather or climate variable above or below a threshold value near the upper or lower ends of the range of observed values of the variable" including the consequential physical impacts, e.g. flooding (CDKN 2012). While realists argue that risks are real, and can be identified, measured, classified and predicted by quantitative sciences using reproducible, "reliable" methods (Ekberg 2007), cultural relativists argue that "nothing is a risk in itself; there is no risk in reality. But on the other hand, anything can be a risk; it all depends on how one analyses danger, considers the event" (Ewald, 1991). The approach taken in this study lies between these two extremes where risks are perceived to be real in that they exist and have the potential to cause harm, and are socially constructed as they can be "changed magnified, dramatized or minimized within knowledge, and to that extent they are particularly open to social definition and construction" (Beck 1992).

This chapter focuses on the extent to which the concept of risk is useful as a mainstreaming tool in bridging the gaps between different disciplines, and science, policy and practice (Cash et al. 2003). This exploratory study used an instrumental case study design to explore the ways in which the concept of risk facilitated boundary work and the mainstreaming of ecosystem services into decision making process, and whether any evidence for a change in practice exists (Stake 2003). An outline of data collection and analysis is provided in Figure 5-2.

METHODS

Study site

The Eden District Municipality (Eden) is one of six District Municipalities in the Western Cape province of South Africa. Eden accounts for 18% of the area of the Western Cape and is comprised of seven local municipalities (Figure 5-1.). Similar to many rapidly urbanising regions in the world, complex social-ecological challenges have merged in Eden associated with interrelated issues of population growth; rapid development and loss of biodiversity have become more pronounced (EDM 2014; O'Farrell et al. 2008; Reyers et al. 2009; Sitas et al. 2014, Chapter 4). The most recent national census shows that Eden is home to approximately 574 000 people, representing almost 10% of the Western Cape's total population (Statistics South Africa 2011). While poverty levels decreased by almost 10% from 2001-2010, slightly more than 21% of the population are still considered to be living in poverty, with 19% of those actively looking for a job recorded as unemployed (EDM 2014). The economy of Eden is rooted in the agriculture, manufacturing, tourism, trade and business sectors (SOER 2008). Over the last two decades, numerous high-cost housing developments and recreation facilities (e.g. golf courses) have been built along the scenic coastline and around estuaries (often in flood-prone regions) in order to accommodate wealthy retirees and tourists. In addition, there has been rapid in-migration to Eden of people seeking employment opportunities which has resulted in severe low-cost housing backlogs, with more than 35 000 households requiring public services (e.g. access to basic sanitation and electricity) (EDM 2014). This rapid urbanization has led to the concentration of communities in informal settlements, often in hazard-and risk-prone areas (e.g. in flood plains), and often without access to basic services which makes it increasingly difficult for communities to prepare, cope and adapt to increasing risks such those risks associated with extreme events such as floods (Nel et al. 2014) .

In the last decade these challenges have been exacerbated by the impacts of climate change, especially related to the increase and intensity of extreme weather events, which in Eden have manifested as alternating periods of drought and flooding from rivers, lakes and sea-storms, as well as wildfires (Nel et al. 2014; Tempelhoff et al. 2009). Between 2003 and 2008 the Western Cape provincial government incurred direct damages exceeding USD234 million in eight severe weather incidents associated with cut-off low events. Eden incurred 70% of this damage indicating its vulnerability. Damage per capita in rural areas was 3.5

times the annual household income in some instances, indicating social vulnerability of households in those areas (RADAR 2010). The private sector also suffered large financial losses, with local insurance agencies having to disburse around R16million in the last 15 years, with more than 78% of the claims having been made between 2005 and for insured assets (Nel et al. 2011). In response, a partnership between public- and private-sector entities and researchers and decision makers was forged in order to better understand the causes of the risks associated with extreme events and their impacts in Eden, and identify possible leverage points in the system where interventions could be implemented to reduce risk (Nel et al. 2014)

This partnership (hereafter referred to as the Eden project), established that, although climate change is predicted to increase the severity and occurrence of extreme events (e.g. flooding), the degradation of ecosystems and their regulating services (i.e. Benefits obtained from the regulation of ecosystem processes such as the protection from high wave run up by coastal foredunes) has an equal or greater impact than climate change (Nel et al. 2014). By using a communities of practice model of engagement, which promotes social learning and facilitates the production of knowledge that takes place in the context of its application, a sense of shared risk and shared responsibility was generated (Chapter 6). The Eden project demonstrated that there are important opportunities for developing interventions involving a variety of stakeholders at a landscape, and national level that can significantly reduce the risk in Eden restoring the ecosystem services provided by healthy ecosystems (e.g. restoration of foredunes and catchments) (Nel et al. 2014).

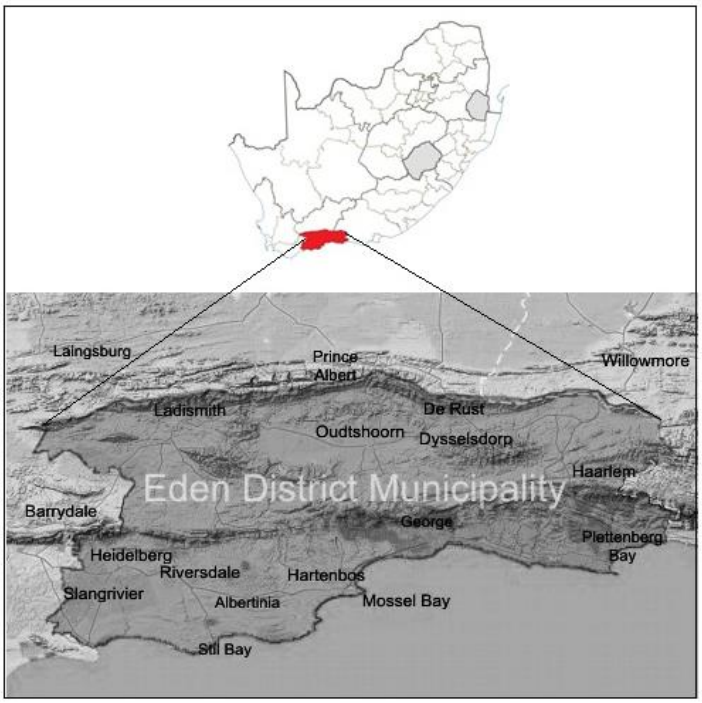

Figure 5-1: Map of Eden showing its location in South Africa and major towns

Data collection

Data were collected from multiple sources, such as semi-structured interviews, participant observations, *in situ* conversations, presentations and key documents, including project reports (n=7), peer reviewed papers (n=2) stemming from the research, minutes from meetings (n=4), meeting agendas (n=7) and over 30 news and media reports. In addition, presentations linked to the project were either downloaded from the internet (public domain), or copied with permission from the presenter (n=13). Semi-structured interviews were conducted with 19 individuals involved in the Eden project who had been purposively selected due to their involvement as core members of the project, or in mainstreaming activities related to the project. During the interviews, participants were asked whether they were prepared to share any documents, and presentations that they felt were important to the study. These documents were included in the analysis and sourced directly from participants, either as email attachments, internet links or printed copies given to the lead author. All interviews were recorded with permission of the respondents based on a principle of informed consent and were conducted in person, or over the phone, and transcribed by the lead author. All news and media reports were sourced online from the public domain. Data was collected and analysed iteratively, i.e. there was a constant process of collecting data, carrying out a preliminary analysis and using that analysis to guide further data collection.

This pattern was continued until saturation was reached. An iterative approach was used to facilitate flexibility in order to align with the research design, data requirements and analysis of methods in response to new information that is collected.

Data analysis

Data (see Figure 5-2) were analysed qualitatively using applied thematic analysis which involved a close examination of the data in order to identify themes that emerged as being important for understanding how the concept of risk might have facilitated boundary work that enabled ecosystem services to be mainstreamed into decision making processes (Guest et al. 2011). A hybrid approach was used, outlined by Fereday and Muir-Cochrane (Fereday & Muir-Cochrane 2006), which included both a data-driven inductive approach —whereby coding of the data occurred without trying to fit the data into a pre-existing model or frame— and a deductive approach using a predetermined template of codes. Memos, annotations and a combination of structural, provisional and process coding were used in order to identify and collate important themes in order to address the aims of this study (Saldaña 2012).

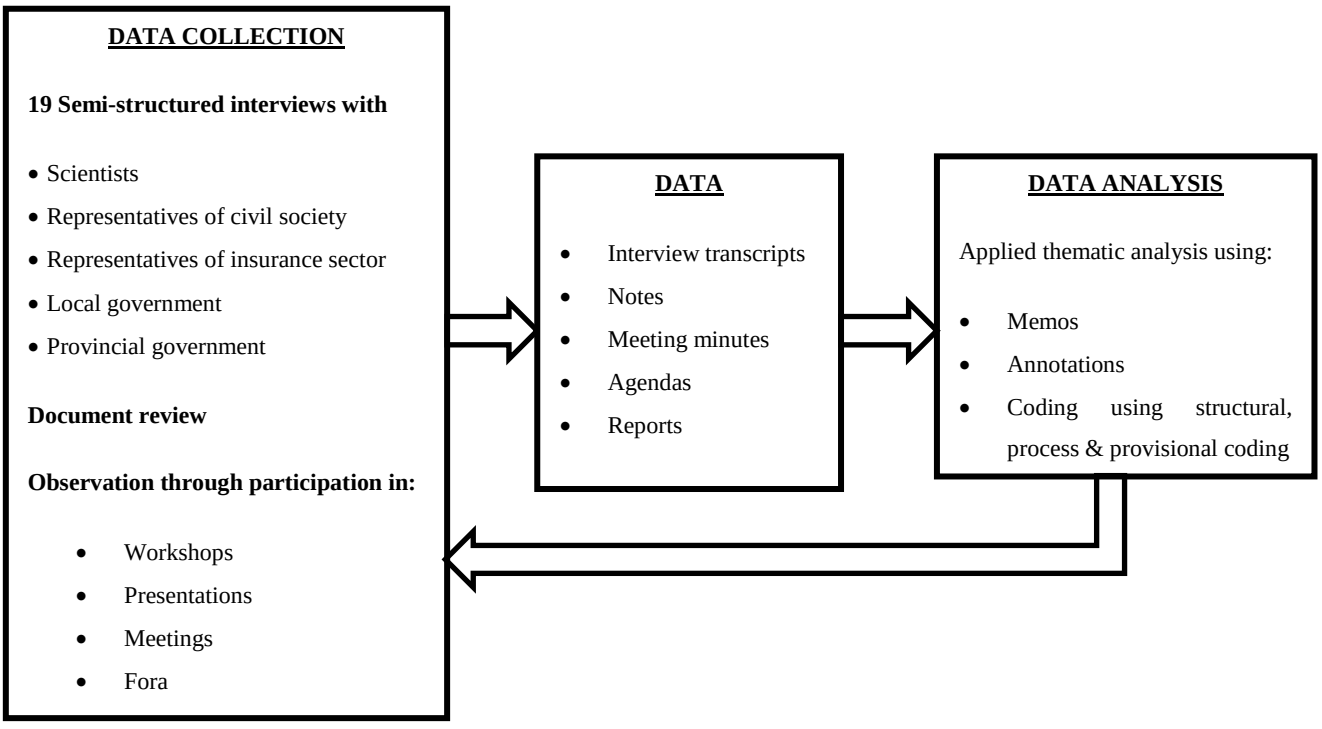

Figure 5-2: Diagrammatic representation of the data collection and analysis process

Development of codes

Due to the nature of this study, three coding methods were required to manage the complexity of the processes and phenomena in the data (Saldaña 2012). Structural coding was used in order to organise the data according to the aims of exploring how the concept of risk might facilitate boundary work and investigating whether the boundary work resulted in any action according to the goals of mainstreaming. Process coding was used to connote action in the data and highlight ongoing interaction or perspectives in response to situations or problems, with the purpose of reaching a goal or handling a challenge. Provisional coding was used which involved the use of a predetermined list of codes, developed on the basis of our conceptual framework and literature review, *e.g.* codes linked to boundary objects such as assessments for frameworks (Saldaña 2012). By using this combination of coding methods we were able to explore whether specific themes emerged which addressed the aims of this study.

RESULTS

The concept of risk as a boundary concept

The interviews revealed that there was a general understanding amongst participants that risk is essentially the probability of an event occurring and the related impact it would have should it occur. Within this shared understanding it was found that the concept of risk carried different dimensions according to the diverse disciplines, perspectives and interests of the participants. These were then grouped according to technical, social-ecological and socio-economic/political categories (Table 5-1).

Table 5-1: Table showing examples of the different dimensions of risk and which risk dimension project participants fit into. Source: Participants interviews and project documents.

Dimension of risk	Participants	Examples
Technical	Insurance underwriters, coastal engineers, hydrologists	Measuring and quantifying risk e.g. establishing flood lines
Social-ecological	Conservation, ecology, representatives from civil society	Understanding interconnection of social and ecological factors linked to extreme events
Socio-economic/political	Individuals from insurance sector responsible for sustainability and stakeholder issues, social scientists, disaster management, climate change and land-use planning from local and provincial government	Governance aspect of risk e.g. how disaster recover funding is allocated

The technical dimension was linked mostly to individuals from the insurance agency and some of the specialist scientists from engineering and hydrology-related disciplines who focused mostly on measuring and quantifying risk in a linear and often univariate way aimed at determining fixed flood lines and coastal set back lines. The social-ecological dimension was linked to scientists and individuals from civil society with a background in conservation or ecology-related disciplines and was associated with understanding that the impacts and potential for extreme events were linked to ecological as well as social factors in Eden (e.g. the timing and intensity of clear-felling activities in forestry plantations); and the socio-economic/political dimension was linked to individuals from the insurance sector, as well as local and provincial governments and was associated with how risk relates to issues of the governance, socio-economics, and/or economic impacts of risk (e.g. identifying who or what is at risk and how disaster risk recovery funding is allocated)

Some participants from the business sector had initial perspectives of scientists as "*just these tree huggers*", while another argued, "*if you use ecosystem services it means something: nature, bunnies; that is not what we do*". Thus, it was initially perceived by many individuals from the business sector that scientific knowledge produced by the more generalist scientists was irrelevant. However, by using the language of risk as a common denominator, it emerged as a functional way of talking across the disciplines, thus facilitating knowledge exchange. Framing the loss of ecosystem services in terms of how such losses increase societal or private-sector risk provided a starting point for further discussions and facilitated conceptual communication and engagement; as an NGO worker highlighted, "*risk is just such a powerful motivator*. Further, 'risk' was perceived to be "*everyone's business*", as elucidated by a municipal official, and the use of 'risk' as a common frame was perceived by the majority of the participants as being useful. Scientists engaging with the private sector, in particular, found it useful, as one explained: "*it's almost a negative way of engaging with business, but in a way, because they are so driven by their margins and bottom line and profit, if you can link the risk to that, it is a very powerful tool in engaging with business".*

The concept of risk for configuring boundary objects

All three of the integration strategies (i.e. the analytical route, the assessment route, and the participatory route) outlined by Mollinga (2010) were used by participants in the study in order to facilitate knowledge exchange (Table 5-2).

Table 5-2: Table showing the various risk related boundary objects and integration strategies used in the Eden project based on criteria outlines in Mollinga (2010). Sources: Interviews, project documents and observation.

Integration strategy	**Evidence**
Analytical-risk models as mediators	Process-based and statistical models used to develop risk analysis framework (Nel et al. 2012; Nel et al. 2014)
Assessment- risk based frameworks as learning and decision tools	Development of a social-ecological systems based conceptual framework for understanding risk (Reyers et al. in prep)
Participatory- processes and people to negotiate boundaries using frame of risk	Variety of participatory engagement techniques employed e.g. workshops, fieldtrips/site visits, participatory mapping

First, the analysis found that an analytical route using process-based and statistical models, linked to expert analyses of function responses (e.g. to calculate flood risk) was used to inform the development of a risk analysis framework which was then used to explore how land cover and climate change influenced the risk of floods, fires, and storm-waves. The technical modelling was undertaken by scientists with an engineering or hydrology background, and by those individuals from the insurance sector involved in underwriting- or assessing risk. It was found that these individuals mostly had a perception of risk that was aligned with a technical dimension of risk. In order to develop the risk analysis framework and produce maps and graphs which were used to communicate the results, a deliberative multi-stakeholder process was carried out involving additional participants, i.e. those participants with a more social-ecological and socio-economic/political perspective of risk. This deliberative process required participants to spend sufficient time exchanging knowledge until a common understanding was reached, as elucidated by a scientist who said "*I don't know her field and she doesn't know mine, so there was quite a process to get onto the same page*". Participants had to dedicate a significant amount of time to consider how to message the quite technical and specialised model outputs in ways that would be more broadly understandable, user-useful and linked to social-ecological problems in Eden, and this required multi-stakeholder input.

Second, evidence was found of an assessment approach that used a social-ecological systems based conceptual framework for understanding risk. This approach combined social and ecological elements of the system in order to clarify the interacting social and biophysical processes for understanding why some people or places were at risk, and what interventions might be possible the mitigate the risk. This approach was mainly used by more generalist

scientists and individuals from civil society with a background in conservation or ecology-related disciplines, whose perception of risk was linked to a social-ecological dimension. The development of the framework necessitated that different pieces of knowledge were brought together in order to get an integrated picture and was considered to be very beneficial, in the words of an insurer, "*if you keep looking at something and you only have natural sciences, then what you find is natural sciences insights – it's valuable, but nature is not like that: nature is diverse; it's always different, so the insurers brought in the difference"*.

Third, it was established that a participatory route of knowledge integration was used. Various participatory methods of stakeholder engagement were employed (e.g. participatory workshops and simple mapping and modelling using symbols and simple diagrams) and there was a high level of perceived participation across the various forms of stakeholder engagement. The perceived importance of a participatory route was captured by one of the insurers who said *"for me the whole Eden [project] is not so much practically what happened, its more that it changed the way we thought about the way things can be done",* which highlighted that the process of knowledge exchange and co-production was considered as important as the products (e.g. maps and models) the project generated.

In terms of enabling participation, the use of a risk lens was very useful for mobilising participation, as all stakeholders were interested in cooperating and collaborating to find a joint solution specifically for reducing risk in the region, which would have mutual benefits. The Eden project was perceived by most participants to be sensitive of the social processes underpinning risk management, as elucidated by a scientist: "*it's a human project: it's about people, it's not about some idea someone tried to prove; it's not a pet interest, it's about people who want to solve a problem and then had a human approach to solving a problem".*

Issues related to learning were also mentioned by many participants in relation to the research process with an NGO worker saying *"I think [integrating the findings] was a huge learning curve",* while a scientist said *"I think that [participants] perspectives on ecosystem based interventions have been forever changed".*

It was also found that using the concept of risk facilitated knowledge exchange with regard to the development, and use of specific communication tools. In this regard, the way data were expressed in the form of graphs, maps and/or photographs enabled the majority of participants to think about how the results of the study could be used to generate awareness,

and what potential end-user requirements were. For example, simple, annotated presentations were designed for municipal officials to use in municipal planning meetings highlighting the role that healthy ecosystems play in hazard mitigation, while short one-pager summaries were used to engage with high level strategic managers in the private sector.

Developing enabling boundary settings

It was found that the problem-driven nature of the research was a critical aspect that facilitated a participatory research environment within the Eden project. Work within the project was divided according to how it addressed the problem of understanding risk in Eden, and how to identify possible leverage points in the system where interventions could be implemented to reduce the risk. Consultation with both the private and public sector institutions identified important extreme events in the region, and identified the associated governance arrangements to manage, and mitigate the impacts of the extreme events. These 'work packages' or issues dictated the expertise and resources required for improving the understanding of the phenomena, for example bringing in a coastal engineer in order to model coastal dynamics or engaging with NGO workers who could implement ecosystem management activities on the ground. An in depth analysis of the factors which supported the effective co-production and exchange of knowledge is presented in Chapter 6.

As the project was designed to be problem-oriented in order to address complex social-ecological challenges in Eden related to extreme events, the broader institutional context within which the project was situated was mostly supportive of the research, which was evidenced by the co-funding of the work by the four core institutions, and both financial, and strategic high-level institutional support for follow-on activities. However, all participants commented on the limited resources and time they had to their disposal in order to conduct the work. In addition, we identified some challenges posed by working with such different interest groups, especially those related to intellectual property issues, e.g. how, and whether, data should be made publically available.

Evidence of impact

It was found that the concept of risk appears to have facilitated the integration of ecosystem-based concerns into particular decision-making processes in Eden, as well as in national and international policy contexts (e.g. district-level integrated development plans, amendments to the Disaster Management Act (Act 57 of 2002) and Principles for Sustainable Insurance). All

participants that were interviewed (n=19) commented on the success of various aspects of project, and how most of them were pleased with the outcomes of the project.

	A	B	C	D
Insurance Agency	X	X	X	X
National Science Council	X		X	X
NGO	X			X
University	X			
South African Insurance Association (SAIA)		X		
UNEP Finance Initiative		X		
Department of Cooperative Governance and Traditional Affairs (COGTA)			X	
Municipalities			X	
South African Local Government Association			X	
District Municipality			X	X
Provincial Government				X
Local Municipality				X
Conservation Authority				X

	Key
A	Core institutions who initiated the Eden project
B	Insurance Learning Network
C	Business Adopt A Municipality (BAAM)
D	Disaster Risk Learning Network

Figure 5-3: Multi-stakeholder participation stemming from the Eden project. Source: Interviews, project documents and observation

Using a frame of 'risk', the Eden project has catalysed new institutional collaborations and networks, and brought a diverse set of actors together to work towards understanding, and addressing key drivers of risk in Eden, South Africa and internationally, thus changing the 'normal rules' of engagement around risk management (Figure 5-3.). As a result of the Eden project, and previous work in the region, three new networks have been established (A in Figure 5-3) centred on improving risk management and implementing response options.

The first network comprises institutions involved in an insurance learning-network (which spans both the national scale, through the South African Insurance Association, and international scale, through the United Nations Environmental Programme Finance Initiative) (B in Figure 5-3). An individual from the Eden Project's core team now sits on the steering Committee for the Principles for Sustainable Insurance (PSI) Global Resilience Project, and the Eden project has been used as a case study in Advancing Adaptation through Climate Information for Financial Institutions (AACIFI) published through the UNEP FI and Sustainable Business Institute (SBI). Although only limited evidence of changes in risk assessment processes within the insurer have been implemented, there is evidence that the insurance agency (and by virtue of this new learning network, South African insurers [B in Figure 5-3]), are acknowledging the importance of advancing risk assessments to include

future predictions, new data and different methods of data analysis (e.g. including drivers of landscape change). This change in learning around risk assessment methods also acknowledges the importance of collaborating with other institutions in order to pool resources and information. Collaboration is especially vital as there are substantial gaps in the current data needed in order to undertake more reliable risk assessments. Engagement with SAIA following the Eden project has resulted in a first dialogue on the Principles for Sustainable Insurance draft as part of the UNEP FI global consultation process (UNEP FI 2012), and the establishment of a Strategic Risk Forum which is a partnership between the SAIA and the Financial Intermediaries Association (FIA) of South Africa.

The second network comprises institutions working at a local level to improve municipal risk management through the Business Adopt A Municipality initiative (BAAM), which works with local development agencies (Department of Cooperative Governance and Traditional Affairs and the South African Local Government Association, (SALGA), an autonomous association of all municipalities which seeks to assist local government with its developmental mandate by building capacity and facilitating participation) in order to build capacity and resource local municipalities using public and private sector funding (C in Figure 5-3).

The third network is made up of a new disaster management learning-network—comprised of private and public sector institutions including representatives from provincial government, local and district municipalities, provincial and district disaster management units, local NGOs, state owned conservation authorities, national research institutions and private companies (D in Figure 5-3) — that collaborate around further data collection and research on ecosystem-based disaster risk reduction, and plan, as well as implement ecosystem-based interventions in Eden.

Through these new institutional arrangements and collaborations such as BAAM, disaster risk and insurance learning networks (Figure 5-3), positive changes have been observed in the way ecosystem concerns have been integrated into plans, policy, investment and action. For example, work financed by an insurance agency and implemented through a local NGO is underway in Eden to restore coastal foredunes and catchments, which were identified as important buffers against storm-waves and floods. Recommendations have been made to integrate the importance of ecosystem services for disaster risk reduction into the Disaster Management Act (Act 57 of 2002), where Eden project members were asked to

comment on possible revisions of the Act and its budget allocation. Further, while the research has not changed the way in which the insurance agency assesses risk, as some project participants hoped would be the case, risk underwriters have been relocated to work at a more local level, which suggests that some of the learning around systems-based, landscape-level risk assessments has influenced the organisational operations.

DISCUSSION

This study produced evidence that the concept of 'risk' facilitated boundary work that enabled information on ecosystem services to be integrated into various decision making contexts in Eden. Using the concept of 'risk' in order to frame the research, assisted the configuration of boundary objects and participatory approaches that were instrumental in establishing and nurturing novel multi-stakeholder and multi-institutional knowledge-exchange processes and networks i.e., enabling boundary settings which facilitated integrating different knowledge 'types'. Additionally, it was found that, compelling evidence exists that certain processes are underway that hold promise for future mainstreaming of ecosystem services into decision making in Eden.

Linking risk and ecosystem services

The concept of ecosystem services can be said to have the potential for enabling different actors and/or disciplines to undertake integrated research (Abson et al. 2014; Lang et al. 2012; Maass et al. 2005; Reyers et al. 2010). However, challenges associated with operationalising the concept in practice remain significant (de Groot et al. 2010; Jax et al. 2013; McCauley 2006; Nahlik et al. 2012; Norgaard 2010; Raymond et al. 2013; Sitas et al. 2014, Chapter 3*;* Sitas et al. 2013, Chapter 4). One of these challenges relates to stakeholder perceptions that the concept of ecosystem services is a 'green' concept and as such, "anti-development"(Scott & Sutherland 2011; Sitas et al. 2013, Chapter 4), which is a perception that we also found in our study. The multidimensionality of the concept of risk avoids this limitation (Fischhoff et al. 1993; Slovic 2001) assisting stakeholders to contemplate the role of ecosystems services in relation to aspects of risk of extreme events. As 'risk' was perceived to be "*everyone's business*", as elucidated by a municipal official, participants framed their knowledge within the context of risk, and in doing so, produced knowledge with greater societal appeal and accessibility. By linking the benefits of ecosystem services to the way in which they reduce risk, knowledge of a technical nature could be exchanged in a more

meaningful and multi-sectoral way, as the knowledge was framed using a common reference concept.

Although there are different dimensions of risk depending on an individual's mental models, the different dimensions are not independent, but interrelated. Changes in one dimension, (e.g. policy on land-use) can trigger or require changes in the others, (e.g., restoration activities); that is, they are connected in a complex social-ecological system (Berkes et al. 1998; Mollinga 2010). Transdisciplinary knowledge exchange necessitates improved understanding of the interrelation of these different dimensions (Jahn et al. 2012). Using risk as a lens with which to explore the relationships between environmental, social and governance concerns facilitated dialogue amongst the different stakeholders. Based on participant interviews and an examination of associated project documents, we found that while it was not necessarily important that the Eden project prescribe a specific definition of risk, or develop a method of how risk should be calculated, what did seem to be important was that the role of ecosystems in mitigating risk was brought to the fore, and this was facilitated by using a frame of risk.

Risk-based boundary objects for facilitating knowledge integration

In addition to the finding that the concept of risk was a useful boundary concept, it was discovered that using a frame of risk also facilitated the configuration of boundary objects which promoted knowledge integration. While the social-ecological problems in Eden that are related to increasing risk are complex (Nel et al. 2014) – involving uncertainty, unpredictability and divergent stakeholder interests – the development of boundary objects necessitated participants to collaborate, and enabled decisions to be made in conditions of incomplete knowledge (Folke et al. 2005; Mollinga 2010). Thus, the boundary objects assisted with cooperation between diverse stakeholder groups by facilitating the production of shared understanding amongst stakeholders from different "social worlds": the private-and public sectors, and science (Brand & Jax 2007; Clarke & Star 2008).

It was found that the boundary objects developed in the Eden project spanned the three approaches for knowledge integration identified by Mollinga (Mollinga 2010): an analytical route which used risk models and maps as mediators; an assessment route which used social-ecological based conceptual framework to facilitate learning and decision support

for better risk management; and a participatory route which supported the development of new social networks and knowledge-exchange processes to work across boundaries.

Process-based and statistical models were used as mediation tools to facilitate dialogue amongst diverse stakeholders in that they combined expert knowledge from academic disciplines and practitioners, together with policy objectives (e.g. reducing disaster risk according to the National Disaster Management Act of [No. 57 of 2002]) and other normative claims (e.g. the need to restore ecosystems in order to boost social-ecological resilience) (Boumans 1999; Mollinga 2010). Facilitating multi-stakeholder dialogue in the creation of decision-support systems (e.g. risk models) is an important factor in attempting to balance issues related to credibility, salience and legitimacy (Cash et al. 2002; Clark et al. 2011). It appears that the Eden project succeeded in producing both credible and salient knowledge, highlighted by the methods undergoing an extensive peer-review process (see Nel et al. 2014) and that the knowledge produced was problem driven in an attempt to better understand social-ecological challenges relating to risk in Eden. However, although the project was legitimate in terms of inclusion of project participants, the project did not include local community members (i.e. members of the 'lay-public' residing in Eden) in the initial design of the project, thus the broad legitimacy of the knowledge produced remains to be seen.

The social-ecological systems based framework was used to draw together different knowledge types in order to gain a more holistic understanding of role of ecosystems in mitigating the impacts of extreme events in the region. By co-developing a systems-based risk-assessment framework based on the practical problems stakeholders were experiencing in Eden, locally relevant response options and interventions were identified (Nel et al. 2014). As the framework was based on both the ecological and social components that drive risk in the region, it integrated the varied concerns of multiple stakeholders, and thus facilitated dialogue and learning between different knowledge domains, while building practical connections between research and policy (Berkes et al. 2000; Cornell et al. 2013).

Further, the social-ecological systems based framework, as a boundary object, enabled policy links to be forged, which is important considering that it is the responsibility of government to reduce risk to communities (Disaster Management Act of [No. 57 of 2002]). By linking ecosystem concerns to the need for risk reduction, interventions became a development mandate, instead of what is often construed as a mere "green concern". This is

important, as environmental issues are often side-lined by development concerns that are constructed as more pressing and as independent of the environment (Pasquini et al. 2013; Scott & Sutherland 2011; Sitas et al. 2013; Wilhelm-Rechmann & Cowling 2011). Providing evidence of how healthy ecosystems mitigate risk by buffering the impacts of extreme events showcases the relevance of resilient ecosystems for development (Jones et al. 2012; Munang et al. 2013; Nel et al. 2014; Sudmeier-Rieux et al. 2006). Further, using a risk-based framing provided conceptual connections which highlights the various contributing factors driving risk in Eden, thereby allowing different sectors to develop an appreciation for the way in which systems are intricately connected. The promotion of systems-based thinking enabled the different sectors to consider other factors beyond their individual interests (e.g. insured asset, scientific model or housing project) and to recognise how landscape drivers are connected, and as such, require a shared, multi-institutional response (Nel et al. 2014). Exposing different stakeholders to new types of knowledge and perspectives provides opportunities for learning and collaborative action (Cundill et al. 2012).

Although it was not the deliberate, intended goal of the project, it was found that an important, latent outcome of the project was the development of strategies to navigate the challenges posed by inter- and trans-disciplinary work (Merton 1968). In addition to the important role that knowledge brokers play in boundary work (Sitas et al. in prep; Michaels 2009), and akin to many other scholars, we found that a participatory approach to knowledge production and exchange was critical for ensuring the integration of different knowledge types (Armitage et al. 2008; Hage et al. 2010; Hessels & Van Lente 2008).

While numerous boundary objects were identified that enabled cross-boundary work, in order for that work to catalyse action, certain of the boundary objects (e.g. frameworks and maps) needed to become "boundary objects-in-use". Thomas et al. (Thomas et al. 2007) suggest that this occurs through a process of 'processual plasticity', when participation is distributed and a range of participants contribute to the co-construction of meaning. Processual plasticity is highly influenced by issues related to power, particularly stakeholders exercising power to influence the negotiation of meaning (Thomas et al. 2007). While the boundary objects were co-produced during the Eden project, the majority of the design was carried out by knowledge brokers or institutional project leaders (Chapter 6). Thus, in order for the boundary objects to be rendered more useful within a decision-making context, the end users, i.e. practitioners and decision makers, needed to be involved in their design to improve their saliency and legitimacy (Cash et al. 2002; Cowling et al. 2008; Honey-Rosés &

Pendleton 2013; Knight et al. 2006). In this regard, we have provided evidence of some promising developments of new multi-institutional networks that are being established in Eden.

In addition to the role that the concept of risk played in providing knowledge for understanding as well as for the development of boundary objects for instrumental work, evidence was found suggesting that the concept of risk and associated concepts (e.g. risk management, risk reduction and risk assessment) facilitated new conversations and collaborations between organisations and institutions that were previously not collaborating. These new cooperative arrangements provided both the internal and external support structures for participatory engagement around ecosystem contributions to risk reduction and are outlined in detail in Chapter 6. While it appears that the boundary settings developed as part of the Eden project were conducive for knowledge-exchange, with regards to the co-production of knowledge, establishing such 'nurturing' environments is not easy and requires dedicated efforts by knowledge brokers (Chapter 6).

Concept of risk for generating impact

According to the definition of mainstreaming outlined by Dalal-Clayton and Bass (Dalal-Clayton & Bass 2009), successful mainstreaming results in the integration of environmental information into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action. Sitas et al. (2013, 2014), Chapters 3 and 4 of this dissertation, suggest that using a discourse of risk presents opportunities for mainstreaming ecosystem services. While the analysis found that mainstreaming had been not been successful in achieving integration of environmental concerns into all decision making processes involved in development planning activities, strong evidence was found that the Eden project has already initiated some promising movement towards mainstreaming and has started to mobilise action in Eden including the establishment of new learning networks, and initiation of restoration activities and investments. Considering the short period since the start of the Eden Project (2009) this progress is promising as there is no 'fast track' to mainstreaming, and integrating environment and development agendas is a long-term process (Aongola et al. 2009).

Issues related to 'satisfaction' (i.e. the extent which participants develop positive feelings about the knowledge-exchange process and outcomes) have been suggested by Fazey

et al., (Fazey et al. 2013) as an important consideration when evaluating knowledge-exchange effectiveness. A reasonable level of satisfaction may mean that participants are willing to continue to share and exchange knowledge, which is vital for viable, longer-term sustainability. Mainstreaming should also not be viewed as a once-off event, but should be a conversation over time (Bass et al. 2010), and as such, momentum for such research and action needs to be maintained. However, the continued resources necessary for the kinds of longer term engagement and cooperation that are needed, e.g., finances, capacity and capabilities, are already limited, especially within in a developing country context (Sitas et al. 2013, Chapter 4). Here, understanding the roles that both formal and informal boundary organisations (Carr & Wilkinson 2005; Clark et al. 2011; Guston 2001; McNie et al. 2008) can play is becoming increasingly important.

CONCLUSION

This study has helped to highlight the important role that multidimensional concepts can play in ecosystem mainstreaming efforts, especially in assisting with boundary work. It has shown that using a multidimensional concept like risk was helpful in mainstreaming ecosystem services (which are often perceived as being uni-sectoral and uni-dimensional) into decision making where evidence of early impacts on institutions, processes and investments exist. The prevalence of extreme events and a large insured asset base in Eden facilitated the multi-sectoral and multi-institutional work presented here and it is not clear whether 'risk' would be as useful a boundary concept in the absence of these characteristics. It is possible that in other contexts, other boundary concepts might emerge that assist with mainstreaming ecosystem services into decision making. Related multidimensional concepts of vulnerability or resilience may provide useful frames beyond Eden, and are already being used to understand challenges associated with disaster risk management (Fekete et al. 2014) and climate change adaptation (Lynch et al. 2008).

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Chapter 6

Fostering communities of practice to promote ecosystem service mainstreaming

ABSTRACT

Over the last decade, increasing efforts have been made to integrate ecosystem services into decision making. Mainstreaming the environment into decision making requires multi-stakeholder engagement processes that facilitate the co-production and exchange of knowledge. This requires insight into the social conditions and processes that facilitate or impede knowledge production and exchange in ways that support action. These conditions and processes were explored using an ongoing collaborative project in South Africa where the critical factors that facilitate and/or hamper the mainstreaming of environmental concerns were investigated. It was found that issues related to a lack of communication, including preconceived assumptions; entrenched disciplinary thinking and language have the potential to derail mainstreaming efforts. Evidence was also found that highlighted the importance of effective knowledge brokering amongst communities of practice within multi-stakeholder engagement processes. In particular, the promotion of systems thinking, grounded in practice, emerged as important. Perceived power dynamics were found to play important roles in enabling and promoting, but also potentially limiting inter-and transdisciplinary knowledge exchange.

KEYWORDS

Communities of practice, decision making, ecosystem management, environmental sustainability, knowledge brokers, knowledge exchange.

INTRODUCTION

Over the last decade, the notion of ecosystem services has become increasingly central in environmental science and policy. This is evident in the rising number of journal publications (Fisher et al. 2009; Seppelt et al. 2011), reports (Gómez-Baggethun et al. 2010) and policy interest illustrated by numerous international agreements and research initiatives [e.g. Conservation of Biological Diversity (CBD) Aichi Targets (CBD 2014), Millennium Ecosystem Assessment (MA) (MA 2005) and Intergovernmental Platform of Biodiversity and Ecosystem Services (IPBES) (IPBES 2014)]. Research on ecosystem services continues to play a critical role, firstly by highlighting the need for enhanced ecosystem management and secondly, by generating public awareness of the impacts of ecosystem degradation on society. However, generating awareness alone is insufficient. Generating actions to meet the challenges associated with the social-ecological impacts of ecosystem degradation is an important next step, but this requires confronting the real-world complexities involved in harnessing research more effectively for action (van Kerkhoff & Lebel 2006).

Although there has been significant expansion of the knowledge base as well as awareness of the political and socio-economic importance of ecosystem services over the last decade, actual integration and implementation of the concept of ecosystem services in practical planning and decision making is still in its early stages (Cowling et al. 2008; de Groot et al. 2010; Ruckelshaus et al. 2013; Sitas et al. 2013, Chapter 4; von Haaren & Albert 2011). A multitude of tools and approaches exist for measuring, mapping, valuing and understanding ecosystem services (Crossman et al. 2013; Maes et al. 2012), but many of these approaches still need to be tested in practice (Nahlik et al. 2012). Thus, while the more technical aspects of ecosystem service research are rapidly advancing, evidence of the actual mainstreaming of ecosystem services – i.e. the informed inclusion of relevant information on ecosystem services into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action (Dalal-Clayton & Bass 2009) – appears to be emerging more slowly (Ruckelshaus et al. 2013).

Environmental mainstreaming in general is hindered by several constraints, including a lack of capacity; a lack of information and skills regarding how the environment is linked to development; the prevailing development paradigm which treats ecosystem services as economic ‘externalities’; and competing priorities for which there is either greater political

will or stronger institutional support (Bass et al. 2010). Mainstreaming of ecosystem services has been hampered by the following: failure to embed research within a social processes (Cowling et al. 2008; Sitas et al. 2014, Chapter 3; Sitas et al. 2013, Chapter 4); challenges associated with structurally integrating ecosystems into landscape planning (de Groot et al. 2010); scale mismatches and issues related to the valuing of ecosystem services (Daily et al. 2009; de Groot et al. 2010); and inconsistent conceptualisations and classifications of "ecosystems services" (Nahlik et al. 2012).

While issues related to the more technical aspects of integrating ecosystem service information into decision making processes (e.g. quantification, modelling and valuing ecosystem services) have been explored (Burkhard et al. 2012; Crossman et al. 2013), few examples exist in the published literature of how research on ecosystem services has translated into action on the ground (Honey-Rosés & Pendleton 2013; Laurans et al. 2013).

Critical factors in any mainstreaming process relate as to how knowledge is produced and exchanged, i.e. processes that generate and facilitate the sharing and use of knowledge through various methods appropriate to the context, purpose, and participants involved (Fazey et al. 2013). According to van Kerkhoff and Lebel (2006) knowledge is defined as "justifiable belief", which includes the information and skills acquired through experience, or through theoretical or practical understanding of a subject. Knowledge exchange is increasingly key to facilitating the social, environmental and economic impact of research (Fazey et al. 2013).

Questions still remain, however, as to how knowledge can best be produced, exchanged and mobilized to encourage transitions towards desired sustainability outcomes, particularly using linear, mechanistic models of behaviour change. (Cash et al. 2003; Scott & Sutherland 2011). These models of behaviour change use simple "cause and effect" models, where information (the independent variable) impacts on human behaviour (the dependent variable), which then alters attitudes, actions and behaviour in in a linear, one-way direction (Scott & Sutherland 2011). However, there is limited evidence that these "one-way" relationships between knowledge and action exist in practice. Thus, linear models are not useful for understanding the social conditions and processes that facilitate or impede knowledge production and exchange in ways that support action, and a deeper understanding of the complex processes and conditions is required (Scott & Sutherland 2011).

Accordingly, the objective of this research is to explore the critical factors that have the potential to facilitate and/or hamper the mainstreaming of environmental information into decision making contexts. This aim is carried out by reflecting on an existing collaborative process of knowledge production and exchange in South Africa that is widely considered by local actors to have had some success in terms of moving from research to action (Nel et al. 2014; Chapter 5).

Study area

The Eden District (hereafter referred to as Eden) is located in the southern Cape region of South Africa. Eden has a district municipality comprising seven local municipalities (Figure 6-1) and occupies an area of +/-23 000km^2. Emerging social-ecological problems in Eden relate to rapid economic growth; climate change; biodiversity loss; population growth and changing migration patterns; water security; and increased frequency of extreme weather events (Sitas et al. 2013, Chapter 4; Eden IDP 2011/2012; Nel et al. 2014). These echo challenges facing rapidly urbanising and already urbanised regions elsewhere in the world. This suggests the need for a more targeted approach for reconciling ecosystem service provision within future development trajectories and a move towards more adaptive governance strategies (Archer et al. 2010; Bolund & Hunhammar 1999; Carpenter et al. 2009; Olsson et al. 2006).

A recent increase in hazards mainly related to flood events, droughts, sea storms and wildfires in Eden has increased the urgency to explore new approaches to addressing these complex challenges (Nel et al. 2014). A unique partnership between national research institutes, a national insurer, a non-governmental organisation, and local and provincial government in the Western Cape region of South Africa was initiated in 2008 in order to gain a better understanding of the causes of extreme events in Eden, and identify possible management strategies.

Figure 6-1: Location of Eden and its seven local municipalities in South Africa

This multi-stakeholder project (hereafter referred to as "The Eden project") was intended as a "proof of concept" for longer-term engagement between the various institutions and sectors aimed at understanding risk and resilience in the context of climate change. The purpose of the Eden project was to explore how issues related to land cover and climate change might affect floods, droughts, wildfires and storm waves in Eden, with the intention of influencing how multi-institutional stakeholders manage and respond to increasing risk in the region (Nel et al. 2014).

The Eden project found that, although climate changes are increasing the risks of these extreme events, human-induced changes to land cover and the resulting loss in the buffering capacity of ecosystems increase risk to an equal or even greater extent. Importantly, it was found that actual risk to any individual asset is an emergent property of complex (non-linear) interactions between the different drivers of risk, which cannot be managed in isolation (Nel et al. 2014).

These findings illustrate that, although little can be done to mitigate local-scale climate change, human-induced impacts on the ability of ecosystems to regulate and reduce the risk associated with extreme events can be offset by proactive management and restoration of key ecosystem features and processes, e.g. removing invasive alien plant species and restoring degraded coastal areas and foredunes (Nel et al. 2014).

The results of the project outlined by Nel et al. (2014) are extremely relevant for advancing understanding of ecosystem management, both in theory and practice. It also appears that the research process adopted by the Eden project proved critical for its perceived success in terms of mainstreaming ecosystem services in decision making; and therefore the focus of this chapter is the process itself.

METHODS

A qualitative, inductive approach influenced by grounded theory methodology (Glaser and Strauss 1968) was used in this research. The research involved an iterative process of moving back and forth between data collection and analysis. Applied thematic analysis (Guest 2012) was used to analyse: (1) the transcriptions of semi-structured interviews with key stakeholders involved in the knowledge-exchange process; and (2) project outputs (e.g. presentations on the findings of the research by project participants at workshops/meetings and institutional project reports published by the different institutions involved in the project).

Data collection

To explore the nature of the knowledge-exchange process that occurred during the Eden project, the research commenced with an engagement of key individuals involved in the collaborative project, i.e. those individuals from national research institutes, a national insurer, a non-governmental organisation, and local and provincial government in the Western Cape region of South Africa (Nel et al. 2012, UNEP FI 2012).

Accordingly, all of these individuals were purposively selected as key participants with whom a first round of semi-structured interviews was conducted. These key participants were then requested to identify additional actors who became involved in the research process as it unfolded, and were therefore also interviewed. A total of 19 participants took part in the research outlined in this chapter, with the interviews taking place between May

2013 and April 2014. Two of the participants were interviewed twice as some information collected towards the end of the data collection process required further input and clarification from two key participants. The interview questions focused on the different roles of individuals in the project, as well as on how, and to what extent, knowledge was exchanged during the Eden project (Table 6-1). To complement the interviews, key project documents (such as reports and presentations given by the project participants) and related information (such as institutional websites and other information supplied by the participants, e.g. meeting minutes and plans) were collected and analysed. The interviews were conducted and recorded (with participants' permission) with a digital voice recorder, mainly on site, but some telephonic interviews also took place. Interviews lasted on average 45 minutes each, and were all conducted and transcribed by the author. All participants completed a process of informed consent, which included being provided with an overview of the nature of the study, and were assured full confidentiality.

Table 6-1: Broad topics for discussion in the interview guide (some topics have been omitted from this table as they fall outside the scope of this chapter)

Broad topic	Main question categories
The respondent's role in the project	The way in which they became involved The ways in which different roles emerged Other role players with whom they closely collaborated
The respondent's perception of how knowledge was exchanged in the project	Role players with whom information was shared Means of sharing information Perceived barriers, if any, to knowledge exchange
The respondent's perception of learning, if any, that had occurred during the project	Whether they learnt anything new in terms of knowledge, skills or networks Their opinion on whether others had learnt anything new in terms of knowledge, skills or networks
The respondent's perception on whether they perceive the project to have been a 'success'	Their definition of indicators of success Their views on what important outcomes of the research should be Satisfaction with the outcomes

Data analysis

Although presented separately here, the data analysis process progressed in tandem with data collection (see Figure 6-2). All data were analysed qualitatively: using applied thematic analysis (Guest et al. 2011), annotations, memos, and open and axial coding were employed

in order to identify key topics and to collate information on each topic (Newing et al. 2011). The analytic process comprised a series of iterative steps exploring the topics and items of interest embedded within the textual data. The analysis method draws on grounded theory, according to which sense is made of data through a process known as "conceptual ordering", whereby data are organized into discrete categories depending on their properties and dimensions (Strauss & Corbin 1998). The emerging categories were then grouped into category sets/ themes, resulting in a coherent, well-connected set of themes that describe and explain the phenomena under study, and analysis continued until no new themes emerged.

In order to interpret the findings, but also to ensure participant anonymity, participants were grouped according to their emerging roles in the project. The "scientists" (n=8) comprise a group of specialists with expertise in coastal engineering, climatology, marine ecology, hydrology, fire ecology, biodiversity, climate change and ecosystem services. The second group are termed "knowledge brokers" who, according to (Fazey et al. 2013), "absorb complex ambivalent messages from diverse sources including technical, commercial and legislative developments and translate them into terms that can be understood and acted upon". In this research they include the 3 initiators of the research who are affiliated with an NGO, a research institute and an insurer, respectively, as well as 2 additional scientists who assumed responsibility when one of the knowledge brokers acquired a job with a new institution (n=5). Thirdly, the "insurers" consisted of a risk underwriter, and individuals from the sustainability and stakeholder-relations section of the insurance company (n=3). Finally, the "public sector officials" (n=4) included individuals from local and provincial government, specifically from departments related to climate change adaptation, environmental management and disaster risk reduction.

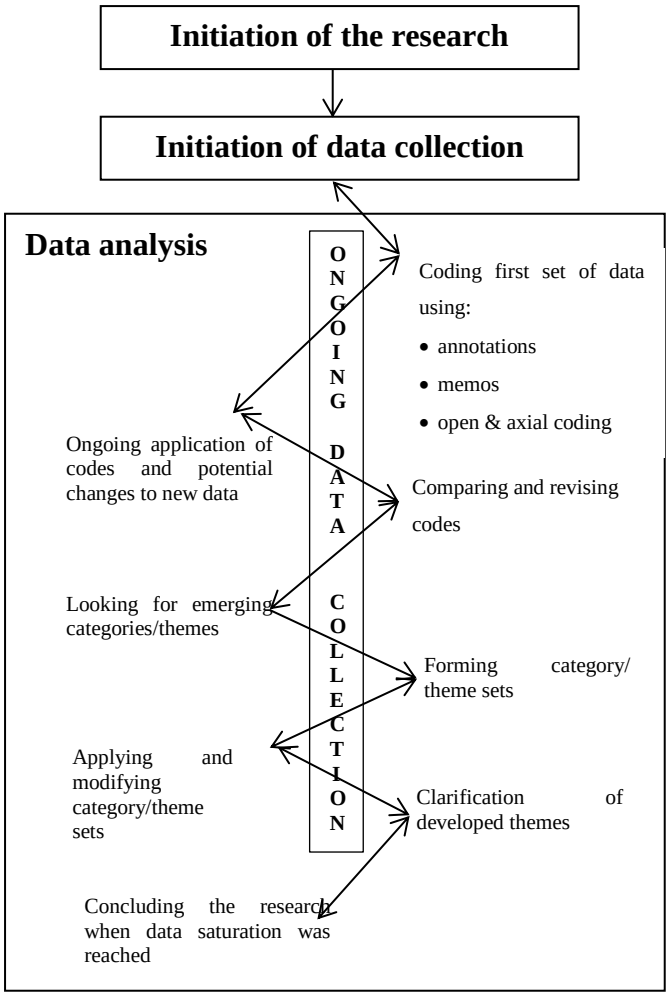

Figure 6-2: Figure depicting the research process, adapted from Egan (2002).

RESULTS

A number of barriers to knowledge production and exchange were identified in the Eden project. These barriers tended to be related to (interlinked) aspects of communication, specifically: preconceived assumptions, language and associated entrenched thinking. However, a number of factors enabled the project to transcend these barriers, which emerged primarily at the outset of the project, towards a more integrated knowledge-exchange process. First, the barriers are explored, before reflecting on the factors that enabled the project to overcome these.

Barriers to knowledge production and exchange

Preconceived notions or assumptions concerning the motivations of other participants and institutions for embarking on the research emerged as a key challenge to knowledge exchange. Initially there were many misconceptions among participants about how others

hoped to benefit from the project. Some of the scientists assumed that business was engaging in the research merely to determine how it could recoup losses caused by extreme events in Eden by increasing clients' premiums. Other scientists were of the opinion that the insurance company was engaging because of their corporate social responsibility mandate, and thus that there was no intention to change the company's business practice in any concrete manner. Some insurers perceived scientists' involvement in the research as motivated by "*self-serving interests*" of publishing papers and/or advancing their research careers, and therefore also not by a real concern with how the work impacts on natural resource governance decisions on the ground.

Linked to the preconceived assumptions of different participants was the role that language played as the project unfolded. At first, the different 'languages' used by the various participants, and which were entrenched in their respective disciplines or organisations, were regarded as an impediment to the project's progression. "*We all need almost like a Rosetta stone where we can come together*", stated one of the knowledge brokers, whose view was supported by a scientist who pronounced, "*we were totally talking past each other in beginning*". Participants were using both sector-specific language, and consequently even the same words, for example 'risk', carried very different meanings for the different participants (elaborated in Chapter 5). Certain discipline-specific language such as "ecological buffer" and "hydrological regime", was also cited as being problematic. At the same time, the operational language of business was not well understood by some of the scientists, and data were presented in ways that did not necessarily reconcile with the organisational language of business, e.g. business strategy development or risk underwriting.

Entrenched thinking, both in terms of discipline-embedded thinking and an initial resistance to new practices (e.g. the use of a particular assessment framework), emerged as an important barrier to knowledge exchange in the Eden project. It became apparent that, at the onset of the project, participants' mental models differed regarding, for example, the concept of risk. Some scientists were perceived to be prepared to accept risk and uncertainty within their worldview, while on the other hand, the private sector was seen to understand risk as something one could delimit and manage, without much uncertainty. Numerous participants stated that one of the most significant adaptations that was required in order for the project to progress, involved scientists and the way in which they exchange and produce knowledge. Specifically, there was a need for scientists to consider more flexible and adaptive ways in which they could apply their skills to address the issues at hand. This was raised not only by

insurers, but also by scientists performing the knowledge-brokering roles, as illustrated by a scientist who, in his/her own words "*found it very difficult with some scientists for them to actually step out of their strict methodological approach...in the end we got there, but it was difficult"*. Scientists were often perceived as being "*blinkered*", and in the beginning of the project there was very little interaction amongst the specialist scientists, who were perceived to have little interest in what others had found. However, when some of the scientists were asked about issues related to knowledge exchange, there was no mention of any of the difficulties mentioned above. This resulted in an impression that some of the scientists were content with remaining within their specialist field(s), thus fulfilling a narrow role in the project, i.e. producing a result which then needed to be translated by other participants in terms of how it contributed to the overall findings of the project.

Factors facilitating knowledge exchange

Despite these apparent barriers, which emerged mainly within the first few months of the engagement, a number of positive factors came in to play during the process to result in a mainstreaming project that is generally regarded by most participants and a range of stakeholders as having had some success.

Co-creating the project

Four broad 'formal' types of engagement were identified during the Eden project, all of which contributed toward a perception among participants that – although time-consuming, as the participants met numerous times within a particular meeting 'type' – the project was co-created by those involved. The first, partnership, meetings were strategic ones held primarily between the "knowledge brokers" and "scientists", and where higher-level issues (e.g. strategic direction of the project or key outcomes) were discussed. Second, technical meetings, comprising of the scientists, knowledge brokers and insurers, involved establishing operational leads for the modelling/expert components of the research (e.g. flood or fire models), which required knowledge brokers to integrate the expert reports and present the integrated research at the partnership meetings, and then to report back to the scientists. Third, participant meetings included all participants and provided a space for them to meet and present/discuss their findings. This type of engagement focused on mainstreaming, occurred once the research component of the project had been completed, and involved engaging with potential implementers of the response options outlined by the research, with

decision makers in local and provincial government, and with other interested and affected individuals and institutions. Engagement took the form of meetings and presentations at, for example, the 17th Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCC), as well as stakeholder fora. Fourth, 'informal' meetings, such as field trips during which scientists, insurers and representatives from local government drove around the region visiting specific sites of interest (e.g. for the risk underwriters and disaster managers to show the scientists and knowledge brokers direct flood damage).

Information was shared using diverse methods, including face-to-face meetings, workshops, field trips, online video meetings, telephone calls or reports attached to email correspondence. Engagement was structured through formal, planned meetings that were recorded, as well as informal 'drop-in' meetings where specific issues (e.g. model components, data sharing, etc.) were discussed, mainly in the offices of the scientists. The knowledge brokers also spent substantial time together, especially near the end of the project, when they dedicated a weekend away to interpreting the results and designing ways to strategically message the project. Engagement with those individuals and institutions that did not form part of the core project team were face-to-face in nature, and occurred at conferences, meetings and workshops.

Many participants mentioned that they had not engaged in this type of multi-stakeholder research before, and that they were using insights derived from this mode of engagement in their subsequent work, especially as regards the development of new research partnerships. The value for business of engaging with research institutions was articulated as follows by an insurer: "*when you have academic evidence it is so much easier to position yourself…we found that we could bring substance to particular issues*".

Joint activities and co-learning together were regarded as crucial to knowledge exchange. This was highlighted by a knowledge broker who said, "*I think the success of Eden is that we spent enough time to get to the final point; the social scientists, natural scientists, business people took enough time getting to know each other being together, working together, struggling together to get to something – but it took a lot of time*". There was a general sense that the results and insights that emanated from the project were co-created through collaborative problem solving.

Knowledge brokers, mavericks and champions

A frequently cited reason for the perceived success of the project was the presence of individuals who served as vital facilitators, integrators, champions, energisers and agents of change: the knowledge brokers. Knowledge brokers had flexible roles which depended on the phase of the project. For example, some were more active in integrating the individual result components (e.g. results of the flood-risk model and coastal risk models) into a coherent narrative, while others worked at a more strategic level to interpret the implication of the findings for decision making at local, provincial, national and even international levels.

Knowledge brokers ensured dialogue amongst participants, and provided structures that 'contained the learning', thus facilitating processes whereby the broader problem could be translated into researchable components, and then synthesised to tell a coherent and compelling story. The coherence was viewed as an important part of joint problem solving, in that all the research activities needed to be bound or directed by the broader research question, rather than merely addressing research sub questions in isolation.

The analysis identified certain perceptions of knowledge brokers which seem to have influenced their ability to facilitate knowledge exchange. Knowledge brokers were regarded as big-picture thinkers; innovative experts in their fields; and, importantly, passionate individuals who are committed to eliciting change. In describing the knowledge brokers, the label "champion" was also used by a variety of participants. These "champions" were considered critical for ensuring institutional buy-in, as well as garnering support for the research beyond the core institutions, by presenting the findings at multiple fora, both locally and internationally. It was pointed out that another term for the champions could be "*mavericks*", as suggested by an NGO worker, as the knowledge brokers were perceived to be traversing new or unconventional territory by facilitating engagement among institutions that had not collaborated before, and had seemingly irreconcilable aims (e.g. those from business and conservation). Despite the vital role that champions played in driving the research and garnering support for it, one of the knowledge brokers cautioned that, while it is important to involve champions, they themselves are somewhat more sceptical about their role, and question the motivation for championing a cause, because "*almost by definition one wants to be the champion and so can hold one's cards very closely to one's chest*".

Another critical factor that emerged relates to the role that dialogue played in facilitating a plurality of perspectives. The constant dialogue was actively and –as often reported – painstakingly facilitated by the knowledge brokers who played a vital role in ensuring that the historically isolated "silos" (e.g. the private sector and scientists) and their associated "monologues" of entrenched disciplinary/sectoral language became a dialogue. This enabled a two-way process of communication through which assumptions and agendas could be addressed.

For the most part, the project was also deliberately exploratory and 'document-free' in nature because the type of work had not been undertaken before, and therefore no one had previous experience to draw on. While the engagement processes were not pre-designed and formulated on paper, the co-learning process was documented, especially in the final phases of the project. Facilitating dialogue was especially important for the scientists to gain a better understanding of how business operates, in order to find a common language with which to communicate. Maintaining a constant dialogue also assisted with finding new ways of engaging and sharing knowledge amongst participants, and allowed for a co-ownership, or mainstreaming, of the research, as indicated by a knowledge broker for whom the project *"wasn't about control; we allowed something to emerge – it was a very creative process and we co-created something that had multiple meanings so [X] can go on and do something with it, and I can go and do something with it".*

Power as an enabler of knowledge exchange

Power emerged strongly as an enabler of knowledge exchange. Power was mentioned explicitly with reference to the power the insurance sector is perceived to hold in Eden. Participants were of the opinion that partnering with the insurance sector allowed access to various stakeholders and decision-making processes that scientists and NGOs alone would not have been able to access. Power was also linked to the scientific knowledge that was produced during the Eden project, the legitimacy of which, in most instances, remained unquestioned by non-scientists. More implicitly, power emerged in relation to who was included in, and excluded from the project, and the different roles and responsibilities allocated to, or assumed by, the participants. The 'power' of individuals which derives from their positions within their institutions was also cited as being important, as it translated into the ability to leverage inter-and intra- institutional support for the project and elevate the strategic relevance of the research.

Finding common frames of reference

While we found evidence of language functioning initially as a barrier to communication within the project, the way in which issues were subsequently both framed and phrased enabled participants to find a common language in which to communicate their knowledge. This was especially important to allow for the communication of the science in a way that private-sector individuals could understand, but also to provide a common frame for the results of the scientific research, and for generating and/or maintaining participants' interest in the science.

Framing the findings in terms of the how the research contributed to addressing the societal and development needs of the region expressed in development plans, greatly assisted in ensuring the uptake and impact of the research on various scales. In Eden, framing the research in terms of how it reduced risk and by referring to the value of ecosystems, both in economic and instrumental terms, provided important starting points for further discussion and interest. However, it is interesting to note that, although at the beginning individuals were keen to develop their understanding of the economic value of ecosystems, towards the end of the project the specific monetary amounts ceased to carry much significance. The fact that functioning ecosystems 'are of value' and have the potential to financially impact organisations, whether they be public (e.g. municipalities) or private (e.g. insurance agency), emerged as an important frame for communicating the findings.

Trust

Participants' mutual trust in each other's abilities and the research process emerged as an important enabling factor of the knowledge-exchange process. Trust was referred to explicitly either in relation to the specific technical aspects of research being conducted, or more generally in relation to the research process as a whole. Competence-based trust also emerged, although more implicitly, as evinced by the use of terms synonymous with trust, such as confidence or belief in each other's capabilities. However, it is interesting to note than one of the scientists referred to the "*blind faith*" that other participants had in the science component of the work, in particular *business* which *"has a scary trust in scientists"* and that therefore, as scientists, they "*have a big responsibility to not abuse the trust and to be upfront*

about the limitations and assumptions". References were also made to participants creating a "safe space" where they trusted one another sufficiently to be honest and truthful, even though they did not always agree with each other.

Systems thinking grounded in practice

Another key factor that emerged during the analysis was the way in which the process compelled participants to conceptualise risk in a more holistic and systemic way. This was evinced by a respondent who stated that "*everybody was so focused on the science and so focused on specific slices of the problem, and this was the first systemic look at it – how you can actually do it in an area – and it was quite real, because it was linked to an area and was not just theoretical*". Illustrating practical connections between social and ecological phenomena and how they impact business in an interrelated and often reinforcing way, assisted with communicating the importance of the benefits healthy ecosystems can play in mitigating risk. Further, the project was perceived as "live", as opposed to merely a science experiment, as articulated by a knowledge broker, according to whom "*it's live people running around thinking about stuff and then making decisions in the real world, and it's messy".*

For participants, the project provided new ways to think about or understand the challenges they faced in their work or 'practice', for example, challenges associated with integrating different disciplines, choosing between ecosystem management options, using science to inform or alter current risk management practices, or communicating science in user-useful and user-driven ways.

DISCUSSION

This study aimed to explore the key factors that might facilitate and/or hamper the mainstreaming of environmental concerns into decision-making contexts. A significant finding was that in terms of knowledge exchange, the research process was identified as important, in addition to the results or products generated by the project. During the multi-stakeholder process various participants who historically have worked in isolation – e.g. municipal disaster-management authorities, land-use planners, conservation groups, scientists, implementing agencies, local government and business – were able to share knowledge and experience. Therefore, by engaging in that process a sense of shared risk and

shared responsibility was generated. Although all participants attributed much of the project's success to the fact that the work was carried out in multi-disciplinary and multi-institutional teams, most of them also commented on how difficult it was to work with such a diverse set of participants. A key constraint identified by participants included the time-consuming nature of the intensive engagement processes required to overcome language barriers and preconceived assumptions, and to build trust and share frames of reference.

Enhancing communication

The central role of communication in improving knowledge exchange within the science–practice interface is well documented in the literature (see Vogel et al. 2007; Karner et al. 2011). What seems to be lacking in the existing body of knowledge, however, are examples of how diverse groups of participants within a knowledge-exchange process overcome communication issues in practice, to arrive at a shared understanding of an issue, especially one pertaining to ecosystem management (Fazey et al. 2012). We found that issues arising from a lack of communication in the beginning of the project, namely preconceived assumptions, the specific language used and entrenched thinking, emerged as the most important barriers to the co-production and exchange of knowledge.

Facilitating dialogue has been shown to be important in communicating science to decision makers (Cornell et al. 2013), and maintaining continuous dialogue throughout a research process improves the likelihood of its uptake (Godfrey et al. 2010). In the Eden project, dialogue did not merely involve individuals talking to each other; rather, it was an active process of knowledge sharing, exchange and co-production, which aimed to shed light on the importance of ecosystems for managing risk through the use of context-specific examples. This required all participants to actively participate, thereby ensuring the incorporation of a variety of different knowledge types, arguments and preferences in the findings. By the end of the project there was a sense of a shared or common understanding of the role of ecosystems for mitigating risk, and a joint commitment to mobilising future action.

Although risk emerged as a common language frame with which to communicate across boundaries, definitions of risk varied among participants and sufficient time had to be dedicated to the negotiation of a mutual understanding of risk in order to design appropriate response strategies (Scholz et al. 2000; Chapter 5). Individuals from the public and private sector, scientists and NGO workers all have differing perspectives on the world around them, and as such they belong to different epistemological communities (Hoppe 2009). This renders

it vital to acknowledge, early on in the research process, the perceptions, assumptions and world views of participants in relation to the research problem. Facilitating dialogue is important in this regard, especially when conducted in a way that does not alienate dissenting voices (Karner et al., 2011).

Facilitating boundary work

Managing the boundaries between disciplines and institutions, and between different types of knowledge (e.g. technical versus experiential) is vital for knowledge exchange (Cash et al. 2002; Fazey et al. 2012), and a breakdown in communication across the boundaries can hinder effective knowledge exchange (Ziervogel & Taylor 2008). In this regard, the role that the knowledge brokers played was found to be extremely important in assisting with communication across and within disciplinary, institutional and knowledge boundaries. By creating safe spaces where participants felt they trusted one another, knowledge brokers in our research moved beyond the mere brokerage of abstract scientific knowledge generated by research towards a more common understanding (Fazey et al. 2012), thus enabling participants to engage in mutually beneficial problem-solving activities.

It was found that knowledge brokers were considered champions and, similar to the findings of (Fazey et al. 2014), are regarded as important for driving knowledge-exchange processes. However, a danger associated with collaborating only with champions is that, once they move into a different role or institution, momentum for the research could fall away. Thus, while it is important to have individual champions, wider institutional engagement and buy-in is critical for eliciting change in the long term.

Akin to Sitas et al. (2013) (Chapter 4) and Wilhelm-Rechman and Cowling (2011), the way research is framed was found to influence whether it will be integrated into decisions. Framing and phrasing the research in terms of how it addresses the different public- and private-sector need for reducing risk enabled the research to have strategic relevance for both sectors. This emphasises the need for sufficient time to be allocated within project frameworks for communicating the results in order to establish suitable policy or practice ‘hooks’ (Dalal-Clayton & Bass 2009).

Strong evidence also emerged suggesting that scientists were perceived to be the most resistant to widening the scope of their work, in terms of crossing disciplinary divides and embracing new frameworks, which has also been reported elsewhere (Bruce et al. 2004;

Hirsch Hadorn et al. 2008; Ziervogel & Taylor 2008). In this regard, the promotion of systems thinking assisted scientists to recognise how their individual research components contribute to understanding the interrelationship between various drivers of risk (e.g. ecosystem degradation and unplanned urban development). Systems thinking also aided in changing insurers' perception of the role the insurance industry can play in mobilising change, both in terms of the way it underwrites risk, and supporting risk reduction programmes in other sectors, e.g. capacitating municipalities in partnership with local government initiatives (Chapter 5).

Although there were many different motives for undertaking research in the Eden project – e.g. insurance interest in reducing the risk of insured assets in the landscape, ecologist interest in producing evidence of the role healthy ecosystems play in mitigating risk, implementing-agency interest in mobilising action – all participants shared the goal of reducing disaster risk in the region. Thus, there was multi-stakeholder demand for the research. As such, and similar to (Honey-Rosés & Pendleton 2013), it was found that by acknowledging the practical demand for the research, as well as focusing on joint problem development (Jahn et al. 2012), mainstreaming and knowledge-exchange activities were facilitated.

Towards a communities of practice model of engagement for mainstreaming ecosystem services

The operational model for mainstreaming ecosystem services developed by Cowling et al. (2008) outlines the benefits of social-learning organisations that enable a learning-by-doing approach. Wenger (2000) argues that communities of practice are the most basic building blocks of a social learning system and thus the concept of communities of practice holds particular promise in understanding, and designing for, learning in multi-disciplinary processes.

What emerged clearly from this research was that a flexible structure or community is required to contain the learning, i.e. a "community of practice", and in many ways the Eden project was exactly that: a community of researchers, private and public sector individuals and NGO workers working and learning together. According to Wenger (2007), in order to constitute a community of practice, three elements are essential. The first key feature of a community of practice is a shared *domain of interest*, which in Eden consisted of participants interested in learning together to gain an improved understanding of the social-ecological

drivers of risk. Membership of the community of practice thus suggests a "commitment to the domain, and therefore a shared competence that distinguishes members from other people" (Wenger 2007). Secondly, a community of practice must be comprised of a *community*, the members of which engage in joint activities and discussions, share information and assist each other in order to build relationships that facilitate learning from one another. In Eden, several communities of practice existed at any given time, with participants engaged in various problem-solving activities, e.g. Developing flood models, or designing response options to proactively mitigate risk (Nel et al. 2014; Chapter 5). Lastly, a community of practice must *practice*, i.e. be practitioners that develop shared "repertoires of resources: experiences, stories, tools, ways of addressing recurring problems" (Wenger 2007). Members of communities of practice are usually also members of another community of practice. Several communities of practice emerged during the Eden project with different levels of participation. The core group, constituted primarily of the knowledge brokers, were very active in the sense of meeting regularly, spending time together away, and engaging with various other stakeholders at multiple governance levels in order to garner interest and support and, importantly, link the research to potential action. Other communities of practice were comprised of scientists researching specific technical aspects of the project (e.g. conducting organisational analysis or constructing fire models), connecting with each other through boundary objects (e.g. documents, maps or models) (Mollinga 2010) around which communities of practice could organise their research linkages, and also brokering activities at the level of participation and interpersonal relations (Chapter 5).

Communities of practice need leadership to be effective, and this is where the knowledge brokers in the Eden project played a significant role. Boundaries between the communities of practice became important 'spaces' for learning opportunities as, according to Wenger (2000), *"they connect communities and they offer learning opportunities in their own right. […] Yet, they can also be areas of unusual learning, places where perspectives meet and new possibilities arise"*. Communities of practice are important because they allow for the transfer of both tacit and experiential knowledge, which are both critical for understanding ecosystem management (Cowling et al. 2008; Cash et al. 2003; Fabricius et al. 2006). However, nurturing communities of practice is challenging due to the extensive resources and time needed for this kind of engagement and intrinsic issues related to power dynamics (Roberts 2006).

Ecosystem service science has produced very useful products or boundary objects (e.g. ecosystem service maps and models) that are of value for decision makers. However, as these are often not co-developed with their end users, the objects cannot act as connectors between different communities of practice (e.g. ecosystem scientists, land-use planners and decision makers), and as such cannot effectively contribute to closing science–action gaps (Cowling et al. 2008). Using a communities-of-practice model of engagement facilitates the production of knowledge that takes place in the context of its application and results in "socially robust" knowledge which is critical for action-orientated research (Gibbons et al. 1994; Nowotny et al. 2001).

By highlighting where successful knowledge exchange has occurred, and how, our case study has the potential to inform future research of a similar nature. Reducing risk and vulnerability, and building communities that are resilient through ecosystem-based disaster-risk reduction, are multi-sectoral, cross-cutting activities that require multi-stakeholder and multi-institutional action. Mainstreaming activities can be implemented by nurturing communities of practice as organisational models for shared innovation and learning. However, careful attention should be paid to the significant role that power can play in shaping legitimate participatory processes (Stringer et al. 2006).

Navigating power dynamics

Acknowledging power dynamics in knowledge-exchange processes is important (Fazey et al. 2012). Power dynamics influence whose voices are heard in decision making (Reed et al., 2008), as well as the information and actors that are involved in knowledge-exchange processes (Barnes 1988). While unequal power dynamics are often associated in the literature with the negative effects they have on decision making and knowledge exchange (Agrawal & Gibson 1999; Reed et al. 2010) , they can also have some positive effects, as the research presented in this chapter shows. Due to the perceived power that the insurance sector wields, which is linked to the number of insured assets in Eden (including municipal assets), ecological concerns that previously may not have been given a platform could be raised, and decision makers (e.g. local government) appeared to be more engaged and interested in engaging in the research. However, only people who were part of the project were interviewed, and those participants would probably be more likely to refer to power in a positive light (Babbie and Mouton 2001).

Successful transfer of knowledge between stakeholders requires the co-production of knowledge through collaborative learning (Roux et al. 2006). This requires a shift in the way knowledge is produced, from a mere transfer of information to a process of relating that acknowledges and negotiates meaning among stakeholders (Roux et al. 2006). Our research showed that, in order to produce knowledge for ecosystem-based risk reduction, process is as important as product, and if processes are well designed, the sharing of knowledge from different backgrounds, disciplines or institutions can result in more profound trans-disciplinary insights (Tress et al. 2005).

CONCLUSION

A critical step in integrating environmental concerns into the decisions that drive development is to identify important factors that facilitate and/or hamper knowledge-production and -exchange processes that are geared for action. The methodology outlined in this paper provided an in-depth and systematic approach to exploring emerging factors that enabled but also those that obstructed, environmental knowledge exchange during a multi-disciplinary and multi-stakeholder engagement process that was designed in order to mainstream the importance of ecosystem-based risk reduction. By selecting a qualitative approach, which acknowledged the context-specific nature of the perceptions of the participants, a deeper understanding of the complex social conditions that facilitated knowledge production was developed, which a quantitative approach would not have allowed for (Newing 2011). We found that knowledge brokers played a critical role in facilitating processes of knowledge co-production and exchange, and were important for assiting with nurturing new relationships between stakeholders and navigating complex power dynamics. Such an understanding is crucial, as the final uptake of findings in policy and practice is often more dependent on the context of scientists and users, and on relationships and mutual understanding, than on the attributes of the research results (Karner et al. 2011; Landry et al. 2001).

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Chapter 7:

Synthesis and recommendations

7.1 Synthesis

According to population projections, by 2050 approximately 9.6 billion people will inhabit the earth, with the majority of that population growth occurring in developing regions (UN 2013). Ensuring the future well-being of the growing population necessitates that we make fundamental changes to the way society manages ecosystems and uses natural resources. Despite numerous international agreements (e.g. Convention on Biological Diversity and Framework Convention on Climate Change) and national policies (e.g. National Environmental Management Act 107 of 1998) recognising the detrimental impact that humans have on ecosystems, progress in terms of the mainstreaming of the environment into the decisions that drive development has been slow (Sowman & Brown 2006). Mainstreaming environmental knowledge, data and tools into development decisions is central to supporting sustainable development and human well-being, and amongst other things, requires effective knowledge-exchange processes that are geared for action (Cowling et al. 2008).

The development of the concept of ecosystem services within environmental and conservation sciences offers hope for a more integrated and anthropocentric focus for including environmental concerns into decision making. Despite some progress (e.g. the development of IPBES which is a global, independent and intergovernmental body established in order to assess the state of the planet's biodiversity and ecosystem services), theoretical, ethical and practical challenges appear to be hampering the mainstreaming of ecosystem services (Jax et al. 2013; Nahlik et al. 2012).

While this research is based on the premise that a lack of acknowledgement of ecosystem services in decision making would result in unsustainable development planning and the erosion of the resilience of social-ecological systrems, I recognise that this is just one problem amidst notable challenges for improving human well-being. Central to the underlying realities at hand as well as to the concerns for future social-ecological resilience are political features of social orders, i.e. "who gets what, when and how" (Choucri 1999).

This research has focused strongly on stakeholder perceptions, and while the politics did not come out as a strong issue, the potental for politics and issues related to power to alter stakeholder preferences, especially related to develoment planning are important to acknowledge (Pasquini et al. 2013). Power, defined here as both a relationship, and an attribute, has its essence in the exercise of influence in order to persuade others to behave in particular ways which that they may or may not have wished. Politics, or "the authoritative allocation of values in a society" (Choucri 1999) links to mechanisms of "allocation", i.e. the policial processes and institutions of governance. Thus the allocation, or restriction of who benefits from ecosystem services is an important issue, and one which is highly politicized (Bene et al. 2009; Shackleton et al. 2008). Further, the assumption that human well-being will improve with increased access to, or enhanced delivery of ecosystem services is highly simplistic (Daw et al. 2011). Access to ecosystem services relies on policy and processes linked to a multitude of decisions regarding development trajectories (e.g. building a dam or gazetting a new protected area) and there will inevitably be tradeoffs associated with different management actions resulting in winners and losers. Thus, more research is needed into the distributional issues related to the governance of natural resources.

The overall goal of this dissertation was to explore development-planning policies and processes at the local level in South Africa in order to identify the opportunities and challenges for mainstreaming ecosystem services, and to improve understanding of the ways in which ecosystem service research can be harnessed more effectively for action. This goal was approached in a stepwise manner, with results from each empirical data chapter informing the research approach and subsequent data collection and analysis of later chapters. Furthermore, the research was conducted using a transdisciplinary, mixed method approach which acknowledged a plurality of perspectives among diverse stakeholders within a “real-world” setting in Eden.

Combining traditional analysis processes with stakeholder interviews, in Chapter 3 I found that despite a long history of research, and multi-stakeholder engagement spanning various sectors in the past, the concept of ecosystem services was not explicitly referred to by the majority of individuals involved in the management of ecosystems, or in ecosystem management-related documents and processes. However, several strategic opportunities for bridging the research–management gap in the tourism, disaster-management and conservation sectors were identified in Chapter 3. It was also found that potential exists for bridging the gap between ecosystem service research and management in Eden, using a transdisciplinary

approach which nurtures ecosystem-service learning networks between local actors involved in development-planning processes, such as local government officials from diverse sectors, researchers, NGO workers and private sector employees.

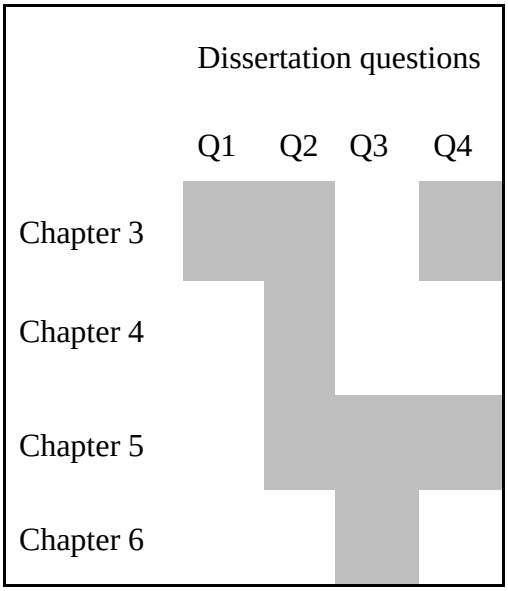
Next, an in-depth exploration of the opportunities and challenges associated with the mainstreaming of ecosystem services in development planning at a local level in Eden (Chapter 4) led to the identification of challenges, including confusion concerning the concept of ecosystem services; insufficient resources; environment-versus-development tensions; weak alignment of policies and legislation; and minimal proactive planning. Opportunities for the mainstreaming of ecosystem services were identified in the following: the way the concept of ecosystem services is communicated; disaster-risk reduction initiatives; sector and spatial planning processes; champions; as well as policy tools and regulatory instruments. In these opportunities, the critical influence of social processes and legitimacy (including the consideration of multiple perspectives) in decision-making was recognised.

Building upon the opportunities for the mainstreaming of information on ecosystem services in disaster risk reduction reported in Chapter 3, as well as increasing impacts of extreme events in Eden outlined in the same chapter, the last two chapters of this dissertation focused on improving our understanding of how risk-based approaches that use a communities-of-practice model of engagement might facilitate the mainstreaming of ecosystem services. These chapters were based on a case study of a multi-stakeholder, multi-disciplinary and multi-sectoral project in Eden ("the Eden project"), which aimed to explore how issues related to land cover and climate change might affect floods, droughts, wildfires and storm waves in Eden, with the intention of influencing how multi-institutional stakeholders manage and respond to increasing risk in the region (Nel et al. 2014).

In Chapter 5 I investigated whether, and how, the concept of 'risk' might facilitate the mainstreaming of ecosystem services. This was carried out by analysing data collected during the Eden project and subsequent interviews. Through this exploration it was found that the concept of risk can be considered a boundary concept, as it enabled effective knowledge-exchange processes by facilitating boundary work between diverse interest groups. This was achieved using boundary objects, such as process-based and statistical models to calculate risks, as well as social-ecological-systems-based conceptual frameworks for understanding risk, facilitated through multi-stakeholder participation. New evidence was provided that this project has initiated a promising movement towards achieving the aims of mainstreaming, and has started to mobilise action in Eden.

In order to better understand how research has been translated into action, an exploration of the important factors, which appear to have assisted in integrating environmental concerns into decision-making, was undertaken (Chapter 6). I found that interlinked aspects of communication – specifically preconceived assumptions, language and entrenched thinking – emerged as important barriers to knowledge exchange. Despite these barriers, a number of facilitative factors were also identified, including the co-creation of the project; the important role that knowledge brokers, champions and mavericks played; harnessing perceived institutional power as an enabler of knowledge exchange; finding common frames of reference; and promoting systems thinking that is grounded in practice. Further, additional insights were developed on the potential benefits of using a communities of practice model of enagement in order to link research with action.

The results generated during the different study phases assisted with answering the main research questions underlying this dissertation (Figure 7-1):



Q 1: How does the concept of ecosystem services manifest in development-planning processes at a local level in South Africa?

Q 2: What opportunities and challenges exist for mainstreaming ecosystem services in decision making at a local level in South Africa?

Q 3: What strategies facilitate the mainstreaming of ecosystem services into decision-making processes in South Africa?

Q 4: What evidence exists that ecosystem services-based research has catalysed action in South Africa?

Figure 7-1: Outline of research questions addressed by the different chapters of this dissertation

Upon reflection on the research conducted for this dissertation, the following tentative framework is presented outlining the factors and processes that the study found to be critical in mainstreaming ecosystem services. I propose that it is these factors that have the potential to overcome some of the challenges hampering environmental mainstreaming. This framework outlines a conceptual and practical approach to mainstreaming. I consider mainstreaming to be the outcome of extensive co-production of knowledge, and exchange processes mediated through transdisciplinary engagement (centre of Figure 7-2). The knowledge-exchange processes should recognise the perspectives of various stakeholders, integrating knowledge originating from science, policy and practice. Knowledge exchange is facilitated by knowledge brokers (organisations or individuals) who link different stakeholders and assist with interaction and engagement across disciplinary or institutional boundaries.

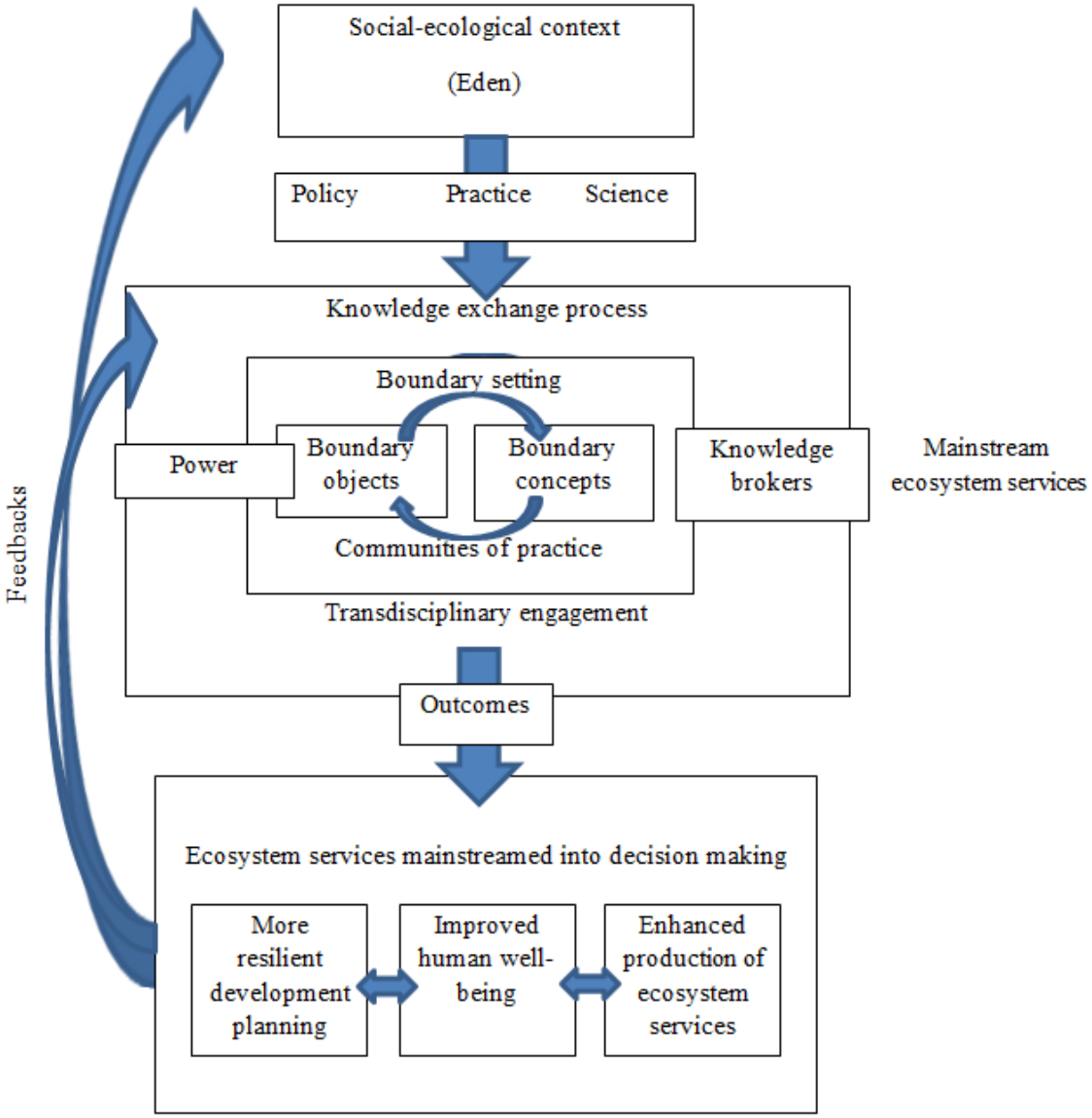


Figure 7-2: Framework for mainstreaming ecosystem services into decision making

Knowledge exchange is also facilitated by the development of conducive boundary settings (e.g. how data are shared and/or funding is allocated) wherein multidimensional boundary concepts (e.g. risk) can be used to enhance dialogue amongst stakeholders, in order to assist with communication of the benefits of healthy ecosystems. The co-development and use of boundary objects (e.g. frameworks and/or models) further aid mainstreaming efforts by generating knowledge that is geared for action. A communities-of-practice model of engagement, which is comprised of communities of practitioners with a shared domain of interest, greatly assists with ongoing problem solving and knowledge sharing. Further, working within communities of practice facilitates the development of decision-support tools that are user-inspired and user-useful. The role of power inherent in such knowledge-

exchange processes – where different knowledge holders can influence both the ways in which knowledge is produced and exchanged – and the results that are possible, should be acknowledged and carefully balanced. The outcomes of a transdisciplinary knowledge-exchange process designed to mainstream ecosystem services into decision making can result in interrelated issues associated with more resilient development planning, improved human well-being and the enhanced production of ecosystem services.

While presented linearly, the processes illustrated in Figure 7-2 are ongoing and non-linear, with feedbacks between the knowledge-exchange processes, social-ecological context and outcomes of such processes

7.2 Insights

While each chapter highlights the insights garnered from a specific study, these can be synthesised into general insights outlined below, which are considered important for forging ahead with conversations on environmental mainstreaming.

Process is as important as product

Maps and graphs are useful as mainstreaming tools, but the process of co-developing these products through repeated transdisciplinary engagement is itself imperative, especially from a mainstreaming point of view. Stakeholders in Eden indicated that they are often inundated with sets of maps, but because they are not included in the development of the maps, the information they contain is sometimes irrelevant to their needs and not well understood, especially in terms of how it relates to their daily work. Designing processes that involve demand-driven research and joint problem solving, as well as facilitate mutual learning opportunities that consider a multiplicity of voices, will improve the salience and legitimacy of the knowledge produced.

Situated learning

Research needs to occur through engagement of stakeholders in joint activities and discussions, sharing information and assisting each other, in order to build relationships that facilitate learning from one another. Roles need to be flexible and depend on the issue at hand – i.e. applied researchers, integrators, communicators, negotiators and visionaries – and sufficient time needs to be allocated for regular, sustained interaction and reflection.

Institutions or individuals acting as knowledge brokers are important for linking stakeholders and facilitating boundary setting that is conducive for learning and engagement around natural resource governance issues. The development of 'tools' based on theory alone runs the risk of those tools not being designed optimally for influencing ecosystem management on the ground. New tools and concepts need to be tested in practice and refined, based on their utility in terms of addressing real-world problems. By means of continuous reflection and refinement of tools through inclusive stakeholder engagement, tools can be generated that are context specific and more likely to be utilised by decision makers.

Risk as an engager

Using the language of risk is perceived by participants to be an effective and powerful way of engaging with each other, as well as a broader set of stakeholders about the benefits of ecosystem services (especially regulating services). Framing the benefits of healthy ecosystems in terms of how they contribute to risk reduction resonates well with both the public and private sectors, but especially the latter. While 'ecosystem services' has recently become a business buzz word, it is still viewed as a 'green' initiative that is not easily operationalised or linked to core business goals. Connecting the benefits of healthy ecosystems to business operations by using the language of risk speaks more directly to the organisational models of business. By linking issues related to ecosystem governance with risk to the insurance industry, response options were generated in Eden that are beneficial not only to the insurance sector, but also to local communities and the environment. In addition, providing examples of how risk can be reduced by investing in ecosystem service restoration can enable cross-sectoral support for ecosystem management.

Individual and institutional engagement

Champions are important for initiating and driving the research process forward, but it is equally important not to rely solely on champions (as they might leave, change roles or lose interest), and to ensure that a variety of individuals within and among institutions are included in research activities. In this regard, the development of communities of practice around a shared domain of interest is important so that practitioners can take collective responsibility for managing the knowledge they need, and be well placed to access institutions that have the required knowledge.

Finding the 'hook' and making the case

Mainstreaming often necessitates opportunism, which means that one needs to take advantage of new opportunities that might arise. These opportunities can include converting disasters, such as those caused by extreme events, into opportunities for knowledge exchange and communication on the role of ecosystem-based disaster risk reduction, or responding to calls for commenting on existing or new policies or plans (e.g. national development plans, or amendments to legislation such as disaster management acts). It is also important to focus mainstreaming activities on the people, processes and policies 'with teeth', i.e. those that are central to decision making. This requires engagement with decision-making processes (which include both the people and the plans), so as to identify the processes that are considered important or used in practice. Once 'hooks' have been identified (e.g. person, event and/or process), adequate time needs to be set aside for developing communication material which should be user-inspired, and tailor-made for specific audiences, using 'real-world' examples. In this regard, demystifying environmental jargon and using the operational language of institutions or individuals to outline how ecosystems are of benefit to them, is essential.

Transdisciplinary engagement

Underpinning many of the above suggestions is the need for stakeholder engagement to be inclusive, and to recognise input from researchers, end-users and business equally, in order to ensure that research is 'co-owned', context specific, and relevant to the local decision-making processes. Transdisciplinary engagement poses many challenges, but my research shows that engaging with these is worthwhile. Following a transdisciplinary approach facilitates the 'mainstreaming' of certain concepts (e.g. benefits of regulating ecosystem services), as affected and interested stakeholders are included in the research process, and uncertainty can be addressed as the research process progresses. This minimises the necessity to embark on post-hoc and separate mainstreaming efforts, as stakeholders are active participants and do not have to 'buy into' the aims of the project/process. As the outcomes of the research are geared towards being user-useful, response options stemming from the research will be well supported, and a transdisciplinary approach should therefore be continued in future decision-support and implementation activities on the ground.

7.3 Challenges and limitations to the research

This study has largely explored new terrain, and challenges and limitations associated with embarking on this type of research were experienced, which are outlined below.

This research was undertaken in Eden which, compared with many other municipalities in South Africa, is fairly well resourced and capacitated. Had this research been conducted elsewhere, the results would probably have been significantly different, which highlights the need for multiple-case-study comparisons across the socio-economic spectrum, ranging from under-resourced municipalities to well-resourced metropoles.

As this research focused on the development-planning process, individuals from various institutions responsible for, or contributing to, development decisions in the region were identified as participants in this research. Thus, this research did not engage with local community members in Eden. Consideration of the needs and understandings of community members in relation to the concept of ecosystem services is important in order for decision making to be inclusive and legitimate. Engaging with community members was beyond the scope of this PhD research. However, future stakeholder engagement and research on ecosystem services should extend participation and engagement to these key role players.

Even though substantial stakeholder engagement took place in various phases of this research, access to participants was often a challenge. Consequently, stakeholder engagement was sometimes opportunistic, i.e. chance encounters were taken advantage of when the opportunity for engagement arose or presented itself. In such cases the time to conduct in-depth interviews could be limited. Some decision makers, while keen to be involved in the research in theory, turned out to be ‘no-shows’ (Bryman 2012) on the day an interview was scheduled (and also for re-scheduled interviews), and thus some potentially novel responses were lost.

Although respondents always seemed to be frank and open during interviews and other engagement activities, it is important to acknowledge the potential impact that personal differences can have on interview dynamics. Issues related to race, language, gender and education can all have an impact on responses, and in particular the likelihood of social desirability bias. The fact that I am a young, white, English-speaking, female scientist, interviewing participants of whom the majority are older, Afrikaans-speaking males of various races could have had an influence on the types of responses I received (Babbie & Mouton 2001). While all interviews were conducted in English, the option of interviewing

respondents in their home language/mother tongue might have provided more nuanced results.

7.4. Transdisicplinary PhDs

Much has been said about the benefits of undertaking trandisciplinary research, both within this dissertation and in literature. However, limited literature is available on how to operationalise transdisicplinary research as an individual researcher, especially for degree purposes. Given the need for the continual epistemological and disciplinary border crossing that is required in order to conduct 'authentic' transdiciplinary research, it can be asked whether an individual transdisicplinary PhD is at all possible. While it was my intention to position this research within a transdisciplinary approach, the practical requirements of doing so according to "ideal" models of transdisciplinary research were restrictive. I outline some of the main challenges and potential solutions that I encountered with conducting my doctoral research using a transdisicplinary approach below:

a. Problem framing

Jahn et al. (2012) outline an "ideal" model of the transdisciplinary research process, according to which a common research object/problem should be formulated jointly with all stakeholders. While my research has suggested solutions to solving very 'real' problems associated with knowing-doing gaps, and has provided decision makers in Eden with context-specific recommendations for mainstreaming ecosystem services in decision-making processes associated with development planning, the research object/problem underpinning this research was essentially formulated by the researcher, and thus it resembled action research more than its 'true' participatory version (Babbie & Mouton 2001). This was unavoidable, given the (1) restricted time period for completion of a PhD with strict bursary-related deadlines, as extensive time is required for legitimate stakeholder engagement in order to define the common research problem, and to develop expert facilitation skills to negotiate such a process; and (2) academic requirement of developing a PhD proposal with a clear problem statement in the first few months of registering for the degree. In addition, transdisciplinary work requires substantial financial resources which are rarely available to students. In light of this, O'Brien et al. (2014) suggest an overhaul of academic programmes which seek to co-produce solutions to the complex challenges associated with global change. In some respects the research outlined in this dissertation and the extensive stakeholder

engagement that took place throughout the duration of the study can be seem as a joint problem framing process with which to base future ecosystem service mainstreaming research on.

b. Impact

The intention of this research was to elicit change in the way ecosystems are aknowledged and managed in Eden, especially in relation to development planning processes. Through prolonged stakeholder engagement and interaction it is hoped that not only the policy/management discourse and local narrative in Eden has been changed regarding the benefits of mainstreaming ecosystem services into land-use planning and management, but that the changes have resulted in changed behaviour and actions. Due to the limited duration of the study, questions still remain as to whether the research and stakeholder engagement was of sufficient duration to anchor the concept of ecosystem services into planning and management processes related to natural resource governance. However, a mitigating factor to this potential challenge was that my research was embdedded within a larger inter- and transdisciplinary project on mainstreaming ecosystem services in decision making, the Project for Ecosystem Services (www. proecoserv.org). This alignment with a larger project not only assisted with the sustinability of the work, but also enabled to work to be scaled up and integrated with mainstreaming work being carried out at regional and national scales.

c. Access to knowledge

Understanding the complex issues raised during the stakeholder engagement processes as well as from interviews and litertaure requires a certain degree of epistemological flexibility which is extremely challenging as a single researcher. While much of the 'sense-making' happeneded within diverse mutil-stakeholder groups, it was my responsibility to consolidate and package the research in ways which were publishable and considered credible by academic standards. Having a multi-disicplinary supervisory team, being involved in a larger, aligned research project (ProEcoServ), as well as being part of multi-disicplinary student cohorts (both formally through the Tsama Hub, and informally through PhD journal and study groups) greatly assisted with providing access to multiple lenses and tools with which to better understand the emerging phenomena and subject matter.

d. Power

Access to knowledge was also influenced by power dynamics. I found that there were both pros and cons to introducing myself as an individual researcher , and/or being part of a larger team/institution. Some stakeholders felt more comfortable enagaging with me as a PhD student, while other stakeholders did not respond to my research requests until I outlined how my research was aligned with a larger internationally funded project and local institutions. This provided some challenges with how these tensions could be alleviated in order to ensure that the research was as unbiased as possible, and with regards to how stakeholder expectations could be managed.

There are many challenges of doing a PhD using a transdisciplinary approach, but as Max-Neef (2005) said " transdisciplinarity in itself is still an unfinished project, around which there is still much to be discovered and investigated". While an individual piece of doctoral research might not be labelled as authentically 'transdisicplinary', providing the research process aligns with the key tenets of transdisicplinarity and is rigorous and transparent in its process , limitations and findings, I believe it can still make a meaningful contribution for eliciting change and can identify future opportunities for transformative research.

7.5 Future directions

In conclusion given the research findings, and the limitations of this study, the following areas offer unique opportunities for future research and action.

1. Exploring environmental mainstreaming through a mix of quantitative and qualitative research methods adds an important facet to understanding opportunities for mainstreaming ecosystem services. As the conservation of ecosystem services is ultimately a social process, using qualitative research methods for research on issues related to natural resource governance allowed for a richer understanding of the complexities involved in mainstreaming efforts that quantitative methods alone would not have offered.
2. This research offers insight for operationalising Cowling et al.'s (2008) model for mainstreaming ecosystem services, including the social-assessment, opportunities-and-constraints and strategy phases. The mix of methods presented in Chapter 3 and 4 suggests potential approaches for future research to enhance understanding of the social processes necessary for mainstreaming. The benefits of using a multidimensional

concept such as risk, as highlighted in Chapter 5, suggest its usefulness, or indeed that of other appropriate boundary concepts, in the strategy-development phase. Furthermore, the factors that facilitated the integration of environmental information into decision making, as elucidated in Chapter 6, highlight potential learning opportunities for enabling inclusive and effective stakeholder collaboration. Lastly, the findings show that careful consideration of boundary concepts should be given at the beginning of projects as certain concepts (e.g. ecosystem services) can potentially alienate stakeholders and restrict engagement.

3. The methodology presented in Chapter 3 allows monitoring and evaluation of changes in perceptions and policy related to ecosystem services to continue in the future, as stakeholder engagement in the region continues.
4. Investigating both the implicit and explicit manifestation of ecosystem services in decision making allowed for a more nuanced understanding of how the concept of ecosystem services has been used in planning processes linked to development. This is important for future policy analysis related to ecosystem services, which may conclude that ecosystem services have not been accounted for in policy, merely because the term does not feature explicitly. Recognising both explicit and implicit terminology associated with the concept of ecosystem services also provides examples of alternative terms, metaphors or frames that are useful for communication purposes.
5. Integrated development planning requires extensive public participatory processes to ensure that community concerns are addressed in IDPs. Thus, further research on how best to communicate the benefits of ecosystems, especially in relation to the role they play in mitigating the impacts of hazards, will enable community members to raise ecosystem protection and restoration activities as community needs that municipalities must address.
6. While I originally intended to co-develop an ecosystem services-based decision-support tool with decision makers in the region, and to test its utility and uptake, these objectives proved beyond the scope of this PhD, especially considering the length of time needed to measure uptake and use. This, however, still remains an important future research pursuit.
7. Whereas the importance of issues related to credibility, saliency and legitimacy are argued for in theory, it would be useful to determine whether decision makers – especially those within a developing world context who have limited resources and

decision support – perceive these issues to be important, and how credibility, legitimacy and saliency might trade off against each other within real-world settings.

8. Research is also still required to develop a better understanding of the potential for integrating the concept of ecosystem services into the terms of reference for developing Integrated Development Plans and Spatial Development Frameworks at various scales.
9. Although this research showed the encouraging potential of the concept of risk as a framing strategy for integrating ecosystem-based concerns into decision making, there may be other frames or metaphors that hold equal promise, and which should therefore be explored in future such as ecological infrastructure.
10. Although challenging, this research advocates taking a transdisciplinary approach when engaging in environmental mainstreaming activities. Given that numerous transdisciplinary projects aimed at improving the environment–development nexus in South Africa have been implemented (see discussion in Chapter 3), it would be valuable to explore the potentially unique insights that might emerge from collating and analysing the learning that has occurred across the different projects, but also to compare this to insights developed from similar project implementations in other regions.

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