

# **Complex coastal systems**

transdisciplinary learning on international case studies

*Cover photo:* The featured astronaut photograph ISS015-E-5977 of 1 May 2007 is provided by the ISS Crew Earth Observations experiment and the Image Science & Analysis Laboratory, Johnson Space Center

# **Complex coastal systems**

transdisciplinary learning on international case studies

## **Editors**

**Jill Slinger**

**Susan Taljaard**

**Floortje d'Hont**

# Colophon

COMPLEX COASTAL SYSTEMS  
TRANSDISCIPLINARY LEARNING ON INTERNATIONAL CASE STUDIES

*Keywords* transdisciplinary research; coastal management; systems analysis; social-ecological systems; integrated environmental management; estuaries, inlets and bays; California; Republic of Ireland; The Netherlands; South Africa; Sri Lanka; Suriname

*Editors* Jill Slinger, Susan Taljaard, Floortje d'Hont

*Editorial support* Aashna Mittal

*Layout support and cover design* Floortje d'Hont

The publication of this book has been funded by the Dutch Research Council (NWO)



First edition, January 2020

ISBN 978-90-6562-44-37

© Delft Academic Press / VSSD / Jill Slinger, Susan Taljaard, Floortje d'Hont

Published by Delft Academic Press / VSSD  
Leeghwaterstraat 42, 2628 CA Delft, The Netherlands  
[www.delftacademicpress.nl/f049.php](http://www.delftacademicpress.nl/f049.php)  
[dap@vssd.nl](mailto:dap@vssd.nl)

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the editors or the publisher.

The sources used preparing this book have been identified to the best of our ability and permission has been granted to use the materials. If a source has been incorrectly identified or appears without the appropriate permission, please contact the publisher and/or editors.

# Preface

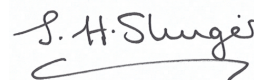
The project Co-designing Coasts using natural Channel-shoal dynamics (CoCoChannel), funded by the Dutch Research Council (NWO), commenced in 2015 with the broad aim of increasing knowledge on the nested scale behaviour of inlet and estuary coasts. The Texel inlet on the Dutch Wadden Sea coast was selected as the central case study of the project with two of the three sub-projects focussing here. The other sub-project, Multi-actor Systems - Co-Designing Nature-based interventions in Coastal Systems, under the leadership of Delft University of Technology, undertook the development of a co-design approach on Texel, but also initiated an international cross-comparative study to anchor the knowledge development within international experience.

Seven case studies located in South Africa, Sri Lanka, California, Suriname, Ireland and the Netherlands (2x) form the objects of inquiry. The case studies, focussing on tidal inlet or estuary mouth management issues, were selected to provide learning on the biophysical and the social systems. For this reason each of the authors invited to contribute a chapter and engage in a week-long workshop was deeply familiar with their specific case study. The workshop, convened in September 2017, was designed to facilitate transdisciplinary learning through consecutive divergent and convergent knowledge exchange phases. This book documents the learning from this international cross-comparative component of the CoCoChannel project.

This book is intended for:

- Transdisciplinary scholars who are interested in interdisciplinary learning and knowledge exchange,
- Policy analysts, environmental historians and coastal policy specialists who are interested in the role of science in the evolution of coastal policy and management,
- Coastal scientists and engineers interested in the dynamics of tidal inlets and estuary mouths,
- Coastal managers looking to learn about tidal inlet and mouth management practices,
- Educators focussed on interdisciplinary skills or interested in using the case studies in coastal, management and engineering classes or as the basis for problem structuring exercises by policy students, and
- Students interested in coastal systems management and wanting to broaden their interdisciplinary competence.

Enjoy learning from the reflective experience of the scientists involved in this transdisciplinary learning endeavour!

A handwritten signature in black ink, reading "S. H. Sluiter". The signature is written in a cursive style with a long, sweeping underline that extends to the right.

# Authors

The authors contributing to this transdisciplinary endeavour draw upon a broad spectrum of scientific backgrounds ranging from engineering, through the biophysical sciences to the policy sciences. They include (in alphabetical order): Janine Adams (Nelson Mandela University), Dane Behrens (Environmental Science Associates), David Dann (University of California, Davis), Trang Minh Duong (IHE Delft, Netherlands), Filipe Galiforni Silva (University of Twente, Netherlands), Kate Hewett (University of California, Davis), Floortje d'Hont (Delft University of Technology, Netherlands), Piet Huizinga (formerly CSIR, South Africa), Michael Koohafkan (California Department of Water Resources), Stephen Lamberth (Department of Environment, Forestry and Fisheries, South Africa), John Largier (University of California Davis, USA), Suzanne Linnane (Dundalk Institute of Technology, Ireland), Declan MacGabhann (), Priscilla Miranda (Staatsbosbeheer, Suriname), Jan Mulder (University of Twente, Netherlands), Rosh Ranasinghe (IHE Delft, Netherlands), Matt Robart (University of California, Davis), Robin Roettger (University of California, Davis), Alec Rolston (Dundalk Institute of Technology, Ireland), Jill Slinger (Delft University of Technology, Netherlands), Susan Taljaard (CSIR, South Africa), Ad van der Spek (Deltares, Netherlands), Mick van der Wegen (IHE Delft, Netherlands), Lara van Niekerk (CSIR, South Africa), and Kathelijne Wijnberg (University of Twente, Netherlands).

# Editors

## **Prof. dr. Jill Slinger**

Prof. dr. Jill Slinger is an interdisciplinary specialist focussing on the contribution of inclusive, participatory processes in the environmental management of water and coastal systems. She holds a faculty appointment at Delft University of Technology and an honorary visiting professorship at Rhodes University, South Africa. She currently serves on the Netherlands Centre for River Studies Programme Committee and the Coastal Working Group of the Dutch Expertise Network for Flooding Safety. Dr. Slinger has published in water, coastal, environmental science, policy, planning and engineering journals. She has undertaken research on the southern African coast, the Incomati and Volta Deltas, the Scheldt Estuary, the Rhine River and the North Sea coasts of the Netherlands, England, Scotland, Belgium, Germany and Denmark. She has an ongoing involvement in pan-European and African research projects related to environmental systems management, participatory planning and design. Her current research activities focus on using ecosystem-based design knowledge to support the interactions between people, science and policy in river and coastal systems – an inclusive co-design approach to planning and management.



## **Dr. Susan Taljaard**

Susan Taljaard is a marine, coastal and estuarine researcher in the Coastal Systems Research Group of the CSIR, South Africa. Her research has been shaped by the CSIR's mandate to foster science that contributes to the quality of life of South Africa's people, in collaboration with the private and public sectors. She has developed water quality guidelines and operational policies for marine disposal of land-derived wastewater, both nationally and internationally through the Benguela Current Large Marine Ecosystem Programme, as well as the Western Indian Ocean Land-based Activities Programme. In 2014, she was project leader of the CSIR's team that assisted the national environmental authority with the development of South Africa's first National Coastal Management Programme under the Integrated Coastal Management Act. Her research outputs focus on the implementation of environmental policies, protocols and guidelines for sustainable growth and development. Her recent appointment as Adjunct Professor at the Institute for Coastal and Marine Research, Nelson Mandela University, offers her the opportunity to share her transdisciplinary insights and learn from the next generation of marine and coastal scientists.





**ir. Floortje d'Hont**

Floortje d'Hont is in the final year of her PhD in the Policy Analysis section of the Faculty of Technology, Policy and Management of Delft University of Technology. She holds a MSc degree in Systems Engineering, Policy Analysis and Management from the same faculty. Her research is funded by the CoCoChannel (Co-designing Coasts using natural Channel-shoal dynamics) project and focuses on design-oriented collaborative activities that promote innovative solutions for coastal systems. She has drawn on her teaching and student supervision experience to design, analyze and report on stakeholder engagement and expert workshops. She is particularly interested in methods to support creative collaboration between citizens, experts, scientists, and governmental actors.



**ir. Aashna Mittal**

Aashna Mittal is a graduate from TU Delft with a Master's in Engineering and Policy Analysis cum laude. She has an academic background covering diverse domains such as engineering, liberal arts, and policy analysis. Her Master's research focussed on the potential of a community-based approach to groundwater management in peri-urban areas of India. Throughout her Master's, she was actively involved in teaching activities at the faculty of Technology, Policy, and Management at TU Delft. Continuing this interest forward, she is currently supporting the development of a new MOOC called Beyond Engineering: Building with Nature, and the editorial work of this book.



# Reviewers

The reviewers attended the final public presentations (on 28<sup>th</sup> September 2017) that concluded the week-long workshop. They did not participate in the preceding discussions and transdisciplinary learning on which the final presentations were based. As such, they were familiar with the workshop outcomes, and through this and their individual experience in the fields of policy analysis and environmental management, were well positioned to review the methods, system understanding and learning that occurred through the transdisciplinary engagement of scientists with a range of international case studies.

## **Prof. (em.) dr. ir. Wil Thissen**

Wil Thissen is emeritus Professor of Policy Analysis at the Faculty of Technology, Policy and Management of Delft University of Technology, where he pioneered the development and realisation of the teaching and research program in Systems Engineering, Policy Analysis and Management. He has served as an editorial board member of Technological Forecasting and Social Change, Impact Assessment and Project Appraisal, and The Environmental Impact Assessment Review, and has authored many scientific papers and books. His research interests are in developing and testing concepts and methods for supporting strategic policymaking in multi-actor environments, with particular emphasis on applications in the fields of infrastructure, energy policy and environmental and water management. Recently, he has developed a strong focus on working in the water and environmental management field in partnership with actors in developing countries, including Bangladesh, India, Indonesia, Rwanda, Suriname and Senegal.



## **Dr. ir. Heleen Vreugdenhil**

Heleen Vreugdenhil is an innovation specialist in the Marine and Coastal Systems Department of Deltares in the Netherlands. Her PhD from the Delft University of Technology focussed on pilot projects in water management, analyzing their effects on changing management practices along the Rhine River in Switzerland, Germany and the Netherlands. After a post-doctoral period at the University of Maastricht in which she analyzed stakeholder engagement processes from national to local level, she joined Deltares where she currently employs her systems analysis skills to engage in the public domain and advance nature-based, participatory planning approaches. She complements these environmental management and innovation activities by a strong reflective focus through her part-time employment in the Policy Analysis Section of Delft University of Technology.



# Acknowledgements



The CoCoChannel project (Co-designing Coasts using natural Channel-shoal dynamics) was funded by the Dutch Research Council (NWO), Earth and Life Sciences, and co-funded by Deltares and Hoogheemraadschap Hollands Noorderkwartier. Drs Theo Saat of NWO is acknowledged for advice and support to Sub Project C: Multi-actor Systems - Co-Designing Nature-based interventions in Coastal Systems (grant number 850.13.043). Further, support for the editors is acknowledged: for Jill Slinger, from the Multi-Actor Systems Research Programme of Delft University of Technology; and for Susan Taljaard, from the CSIR and the National Research Foundation of South Africa.

# Contents

<b>1.</b>	<b>Introduction</b>	<b>13</b>
	<i>By Jill Slinger, Susan Taljaard and Floortje d'Hont</i>	
1.1.	Background	13
1.2.	Theoretical framing	15
1.3.	The seven case studies	20
1.4.	Transdisciplinary approach	23
1.5.	Reading and use guide	24
1.6.	References	25
<b>2.</b>	<b>Texel Inlet Dynamics and Shoreline Management</b>	<b>31</b>
	<i>By Jan Mulder, Filipe Galiforni-Silva, Floortje d'Hont, Kathelijne Wijnberg, Ad van der Spek, Mick van der Wegen and Jill Slinger</i>	
2.1.	Introduction	31
2.2.	Study area	32
2.3.	Natural dynamics of the inlet	33
2.4.	Evolution of coastal policy in response to new scientific insights	36
2.5.	System understanding and insights gained	42
2.6.	Concluding remarks	43
2.7.	References	43
<b>3.</b>	<b>Integrated Coastal and Catchment Management of Dundalk Bay</b>	<b>47</b>
	<i>By Suzanne Linnane, Alec Rolston and Declan MacGabhann</i>	
3.1.	Motivation for interest and approach	47
3.2.	Study area	48
3.3.	Natural dynamics of bay	49
3.4.	Human interventions	54
3.5.	Social context	55
3.6.	System understanding and insights gained	56
3.7.	Concluding remarks	59
3.8.	References	59
<b>4.</b>	<b>Climate Proof Management of Maha Oya Inlet, Sri Lanka</b>	<b>63</b>
	<i>By Trang Minh Duong and Roshanka Ranasinghe</i>	
4.1.	Motivation for interest and approach	63
4.2.	Study area	65
4.3.	Natural dynamics of inlet system	66
4.4.	History of (mouth) management policies and practices	66
4.5.	Social context	66
4.6.	Modelling climate change scenarios	67
4.7.	System understanding and insights gained	68
4.8.	Concluding remarks	69
4.9.	Acknowledgements	70
4.10.	References	70
<b>5.</b>	<b>Managing the Mouth of Russian River Estuary, California</b>	<b>73</b>
	<i>By John Largier, Dane Behrens, Kate Hewett, Michael Koohafkan, Matt Robart, David Dann and Robin Roettger</i>	
5.1.	Introduction	73
5.2.	Study area	74

5.3.	Biophysical dynamics	76
5.4.	Estuary water quality and habitat volume	80
5.5.	Stakeholders and mouth management	83
5.6.	Towards systems understanding in management	86
5.7.	References	87
<b>6.</b>	<b>Advancing Mouth Management Practices in the Groot Brak Estuary, South Africa</b>	<b>89</b>
	<i>By Lara van Niekerk, Janine Adams, Susan Taljaard, Piet Huizinga and Stephen Lamberth</i>	
6.1.	Motivation for management	89
6.2.	Study area	91
6.3.	Inlet dynamics	91
6.4.	Building systems understanding for management	92
6.5.	Concluding remarks	101
6.6.	References	101
<b>7.</b>	<b>The Practice of Managing the Bigi Pan Multiple-Use Management Area in Suriname</b>	<b>105</b>
	<i>By Priscilla Miranda and Jill Slinger</i>	
7.1.	Motivation for interest and approach	105
7.2.	Study area	107
7.3.	Natural dynamics of system	109
7.4.	History of (mouth) management policies and practices	110
7.5.	Social context	112
7.6.	System understanding and insights gained	113
7.7.	Concluding remarks	114
7.8.	Acknowledgements	116
7.9.	References	116
<b>8.</b>	<b>On the Role of System Understanding in the Slufter, Texel, the Netherlands</b>	<b>119</b>
	<i>By Floortje d'Hont and Jill Slinger</i>	
8.1.	Motivation for research approach	119
8.2.	Research motivation and approach	121
8.3.	Theoretical background	122
8.4.	Natural dynamics of inlet	123
8.5.	The role of human interventions on the Slufter	125
8.6.	The knowledge intervention – intervening in the social system	128
8.7.	Conclusions: system understanding and insights gained	131
8.8.	References	132
<b>9.</b>	<b>Transdisciplinary Learning Across Case Studies</b>	<b>137</b>
	<i>By Jill Slinger and Susan Taljaard</i>	
9.1.	Insights from the case studies	138
9.2.	Framing the case studies in terms of the system diagram of policy analysis	139
9.3.	Framing the key knowledge sources of the case studies	141
9.4.	Stepping towards the future	143
9.5.	References	145



# Introduction

**By Jill Slinger, Susan Taljaard and Floortje d'Hont**

## 1.1. Background

This book captures the learning from a cross-comparison of seven international inlet or estuary mouth management situations. The conceptual framing is provided by a focus on systems knowledge and its development and use within coastal management. Systems and systems knowledge have been described as holistic, embodied ways of conceptualising reality, forming “both a way of inquiry and an object of inquiry” (Nelson, 2008). To date there has been little research focussing on the role of systems approaches in informing coastal management despite the early development of systems thinking (late 1950’s onwards) (Ison et al., 1997), the general acceptance of the adaptive learning cycle of integrated coastal management (Group of Experts on the Scientific Aspects of Marine Environmental Protection [GESAMP], 1996; Olsen et al., 1999), and ongoing engineering infrastructural and urban development along our coasts. Recently, Reis et al. (2014) undertook a study on systems approaches for implementing integrated