involved placing 21.5 million m³ of sand on the North Sea coast near The Hague. This unprecedented pilot project, the Sand Motor, is a large sandy peninsula, constructed in 2011 on the Dutch coast. The NatureCoast is the largest research program that focused on the Sand Motor. A consortium of knowledge institutes and governmental organizations was formed to conduct interdisciplinary research on the Sand Motor. The research in NatureCoast focused on six themes: coastal safety, dune formation, marine ecology, terrestrial ecology, hydrology and geochemistry, and governance. This book presents countless facets of the Sand Motor, but we also hope it demonstrates the scientific merits of interdisciplinary research and how, ultimately, societies can benefit from it.
THE SAND MOTOR: A NATURE-BASED RESPONSE TO CLIMATE CHANGE

FINDINGS AND REFLECTIONS OF THE INTERDISCIPLINARY RESEARCH PROGRAM NATURECOAST

Edited by

Arjen Luijendijk
Alexander van Oudenhoven

DELFT UNIVERSITY PUBLISHERS 2019
Climate change is the most formidable challenge that our ever-increasing world population faces, and it poses special problems for those living near coasts. People have always been attracted to the coast, as a place to live and work, and to relax. By 2050, around half of the world’s population is expected to live near the coast, the vast majority in developing countries. How will we cope with rapidly rising sea levels and more intense and frequent storm surges?

Although retracing from coastal areas might not be such a bad idea, this is an unlikely option for most coastal settlements. Although retreating from coastal areas might not be such a bad idea, this is an unlikely option for most coastal settlements. Artificial structures and nature concerns are to be integrated into coastal infrastructure projects. By considering how the local ecosystem functions, which means that the state and the functioning of the ecosystem must be studied and understood before a design can be proposed. This knowledge is crucial if we are to create integrated multifunctional coastal protection solutions that have minimal environmental impact and are widely appreciated. The shift away from treating symptoms towards integrated, multifunctional designs requires a new approach. Throughout the Netherlands, the Building with Nature approach has been adopted. The key to this innovative approach is using prototype pilots to develop new knowledge and insights. In this book, we present the findings of a multidisciplinary research program, called “NatureCoast”, which studied a full-scale coastal protection pilot project, the “Sand Motor”.

Building with Nature
Building with Nature (BwN) is a proactive approach to surface water management. The approach advocates an integrated approach that harmonizes coastal management solutions with the requirements of ecosystems. Decisions must be taken about desired societal and ecological functions, which means that the state and the functioning of the ecosystem has to be studied and understood before a design can be proposed. The BwN approach maintains that this knowledge is crucial if environmental and nature concerns are to be integrated into coastal infrastructure projects. By considering how the local ecosystem can become part of the solution, project managers anticipate legal opposition and avoid having to create alternative nature areas. This is almost directly opposite to mainstream infrastructure approaches, which often avoid having to consider biodiversity, ecosystem services and societies’ quality of life.

NatureCoast
TOWARDS MULTIFUNCTIONAL COASTAL MANAGEMENT

ALEXANDER VAN OUDENHOVEN, EWERT AUKES AND ARJEN LJUJENDIJK

Climate change is the most formidable challenge that our ever-increasing world population faces, and it poses special problems for those living near coasts. People have always been attracted to the coast, as a place to live and work, and to relax. By 2050, around half of the world’s population is expected to live near the coast, the vast majority in developing countries. How will we cope with rapidly rising sea levels and more intense and frequent storm surges?

Although retracing from coastal areas might not be such a bad idea, this is an unlikely option for most coastal settlements. Although retreating from coastal areas might not be such a bad idea, this is an unlikely option for most coastal settlements. Artificial structures and nature concerns are to be integrated into coastal infrastructure projects. By considering how the local ecosystem functions, which means that the state and the functioning of the ecosystem must be studied and understood before a design can be proposed. This knowledge is crucial if we are to create integrated multifunctional coastal protection solutions that have minimal environmental impact and are widely appreciated. The shift away from treating symptoms towards integrated, multifunctional designs requires a new approach. Throughout the Netherlands, the Building with Nature approach has been adopted. The key to this innovative approach is using prototype pilots to develop new knowledge and insights. In this book, we present the findings of a multidisciplinary research program, called “NatureCoast”, which studied a full-scale coastal protection pilot project, the “Sand Motor”.

Building with Nature
Building with Nature (BwN) is a proactive approach to surface water management. The approach advocates an integrated approach that harmonizes coastal management solutions with the requirements of ecosystems. Decisions must be taken about desired societal and ecological functions, which means that the state and the functioning of the ecosystem has to be studied and understood before a design can be proposed. The BwN approach maintains that this knowledge is crucial if environmental and nature concerns are to be integrated into coastal infrastructure projects. By considering how the local ecosystem can become part of the solution, project managers anticipate legal opposition and avoid having to create alternative nature areas. This is almost directly opposite to mainstream infrastructure approaches, which often avoid having to consider biodiversity, ecosystem services and societies’ quality of life.

NatureCoast

TOWARDS MULTIFUNCTIONAL COASTAL MANAGEMENT

ALEXANDER VAN OUDENHOVEN, EWERT AUKES AND ARJEN LJUJENDIJK
focused on six themes: coastal safety, dune formation, marine ecology, terrestrial ecology, hydrology and geochemistry, and governance. NatureCoast researchers collaborated actively with researchers from the NEMO project (Page 19), who studied the behavior of the Delfland coast, including the Sand Motor.

The purpose of this book is to tell you more about both the innovative mega-nourishment, the Sand Motor, and about the uniquely interdisciplinary NatureCoast program. We share concrete research findings about the Sand Motor's behavior and about the societal context of the pilot Sand Motor. We also reflect on the merits of collaboration and integration within a multidisciplinary research program.

The Sand Motor
The Sand Motor is a large sandy peninsula, constructed in 2011 on the Dutch North Sea coast near The Hague. This unprecedented pilot project involved placing 21.5 million m$^3$ of sand on and in front of the beach with the aim that it would spread along the coast. Sand nourishment itself is not a new method to prevent coastline erosion. In fact, the Netherlands has had a structural nourishment program since the early 1990s. However, the Sand Motor is a unique beach nourishment due to its size, the design philosophy behind it, and its multifunctionality. The volume of sand used for the Sand Motor is about five times that of an average nourishment. The Sand Motor is intended to feed the adjacent coasts by using the natural forces of tides, waves and wind; in a way, it is built to "disappear". Another unique aspect of the Sand Motor is that it combines the primary function of coastal protection with the creation of a new natural landscape that also provides new leisure opportunities. From the outset, "learning by doing" has been a crucial part of the project. Because of its innovations, the Sand Motor has triggered considerable political and scientific interest from all over the world. Large research consortia such as NatureCoast were formed to conduct interdisciplinary research on the Sand Motor.

Interdisciplinary research: NatureCoast
NatureCoast is the largest research program that focused on the Sand Motor. The program was carried out by a large consortium of knowledge institutes, and the research was conducted in cooperation with end-users from private companies, research institutes and governmental organizations. The Dutch Technology Foundation (NWO- TNO) supplied the largest share of project funds. The research in NatureCoast focused on six themes: coastal safety, dune formation, marine ecology, terrestrial ecology, hydrology and geochemistry, and governance. NatureCoast researchers collaborated with researchers from the NEMO project (Page 19), who studied the behavior of the Delfland coast, including the Sand Motor.