

SHORELINE MANAGEMENT GUIDELINES

Karsten Mangor, Nils K. Drønen,
Kasper H. Kærgaard and Sten E. Kristensen



《海岸线管理实用手册》

由DHI于2017年二月出版

作者:

Karsten Mangor, Nils K. Drønen, Kasper H. Kærgaard and Sten E. Kristensen, DHI with contributions from Per Sørensen, Danish Coastal Authority and Aart Kroon, Geographical Institute, University of Copenhagen

本书在丹麦海岸和气候响应计划（COADAPT）研究项目下筹备完成。

Danish Coasts and Climate Adaptation – Flooding Risk and Coastal Protection

丹麦海岸和气候响应计划（COADAPT）项目是由DHI、丹麦海岸管理局和哥本哈根大学执行合作。

丹麦海岸和气候响应计划（COADAPT）项目是由丹麦战略研究理事会和丹麦科学、创新与高等教育部共同出资资助。

Key Words:

Climate Adaptation

Coast Protection

Coastal Classification

Coastal Morphology

Numerical Modelling

Sea Defence

Shore Protection

Shoreline Management

Waterfront Developments

Copyright by authors and DHI
Hørsholm, Denmark 2016

ISBN 978-87-90634-04-9

Photos and illustrations:

- Dan Hasløv
- Christian Appendini, DHI
- Claus Pedersen, DHI
- Danish Coastal Authority
- Graeme Matthews
- Jan Kofod Winther
- Karsten Mangor, DHI
- Marlborough District Council
- Poul Rasmussen, NIRAS
- Schou, A., Nielsen, N., Nielsen, J. and Aagaard, T. from Geographical Institute, University of Copenhagen

The publication is prepared by
Karsten Mangor, Nils K. Drønen, Kasper H. Kærgaard and Sten E. Kristensen, DHI with contributions from Per Sørensen, Danish Coastal Authority and Aart Kroon, Geographical Institute, University of Copenhagen

Check by Ida Brøker

Technical assistance by the following DHI staff:

Rolf Deigaard and Berry Elfrink

Editing and layout: Birgit Edill and Loni Skov Madsen

Published as e-book by DHI, February 2017

The e-book is obtainable from DHI's home page: www.dhigroup.com

Price: free of charge



DHI headquarters

Agern Allé 5
DK-2970 Hørsholm
Denmark

+45 4516 9200 Telephone

dhi@dhigroup.com

www.dhigroup.com

Front cover photo:

Amager Beach Park, August 2009, courtesy of Jan Kofod Winther

前言

《海岸线管理实用手册》是一本关于海岸地貌和海岸线管理的实用手册，让您对当前的海岸地貌及海岸线管理问题有一个基本了解，对于海岸防护并没有太多涉及。我们尽可能地让本书适合于从事海岸地貌和海岸线管理的专业人员或兴趣爱好者阅读，包括私募机构、规划部门、政府部门以及技术工程师等。

本版《海岸线管理实用手册》为第四版，首版出版于2001年。本次修订增加了气候变化对海岸的影响，以及如何适应这些变化的最优解决方案。

国际航运协会曾于2014年出版了《转型期国家：海岸侵蚀减缓准则》一书。该书大部分的灵感来自于2004版的《海岸线管理实用手册》，当然也涵盖了其他新的内容。而在2004版基础上修订的新版《海岸线管理实用手册》，也大量参考了国际航运协会2014年第123的报告，同样的也包括了很多新的资料和信息。

对海岸带管理最具影响性的气候变化参数是海平面上升，而风暴灾害增多也加剧了海岸线的变化。

海平面上升对海岸主要有两个影响：

- 1) 海岸低洼地区洪灾风险加剧。作为自然灾害的一种，洪水可能在极短时间内造成大面积的影响；
- 2) 海岸侵蚀风险加剧。海岸侵蚀将随着海平面上升日趋严重。

《海岸线管理实用手册》在筹备和出版过程中，得到了丹麦科学创新中心与高等教育部下属的丹麦战略研究理事会的大力支持。

丹麦赫斯霍尔姆
2017年2月

目录

1	背景	1
1.1	问题的引出以及解决方法	2
1.2	关于海岸线管理的一些思考	3
1.3	如何阅读本书	3
第一:	部分 海洋气象条件、海岸动力过程和海岸分类	5
2	概述	6
3	海岸名词术语	7
3.1	海岸名词术语的定义	7
4	海滩的物质组成	14
4.1	河流挟带的物质	14
4.1.1	细颗粒粘性泥沙	14
4.1.2	非粘性泥沙	15
4.1.3	粘性和非粘性混合泥沙	16
4.2	由于波浪、风暴潮和风作用力导致的岸滩侵蚀所带来的物质	17
4.3	海滩养护和海滩填积所用泥沙	18
5	海洋气象和动力因素对海岸线管理的影响	19
5.1	风	19
5.2	波浪	25
5.3	短波	26
5.3.1	波浪生成	26
5.3.2	波浪传播变形	28
5.3.3	波浪参数的统计方法	37
5.3.4	由风划分的波况类型	47
5.4	长波	49
5.4.1	拍岸破碎波	49
5.4.2	港内共振	50
5.4.3	假潮	50
5.4.4	海啸	50
5.5	海流	52
5.5.1	近岸流	53
5.6	水位变化	60
5.6.1	天文潮	61
5.6.2	季节变化	66
5.6.3	非常规变化	66
6	气候变化	70
6.1	历史上的气候变化	70
6.2	气候变化带来的预期影响	74
6.2.1	气候变化对沿海地区的影响	75
6.3	气候变化引起的海平面上升	77
6.3.1	区域应用的实例	80
6.3.2	结束语	82
6.4	气候变化对沿海地区的影响	82
6.4.1	沿海洪灾	82

6.4.2	海岸线后退	85
6.4.3	风暴增加	85
6.4.4	海洋水温升高和酸化	85
7	泥沙输运和岸线演变过程	86
7.1	泥沙输运和其他类型输运的概述	86
7.2	沿岸输沙	88
7.2.1	外力作用下沿岸输沙的变化	88
7.2.2	沿岸输沙的估算	90
7.3	断面输沙和海岸剖面的平衡	93
7.4	潮汐汉道的输运条件	96
7.5	引起海岸线位置变化的机制	97
7.6	悬浮细沙的输运	100
7.7	海藻的输运和沉积	102
8	海岸剖面分类	105
8.1	海岸分类概述	105
8.2	海岸剖面分类	105
8.2.1	完全暴露的沿岸沙丘或峭壁海岸	105
8.2.2	部分暴露的沿岸沙丘或峭壁海岸	106
8.2.3	受防护性的海岸或湿地海岸	107
8.2.4	潮滩海岸	108
8.2.5	季风海岸或涌浪海岸	110
8.2.6	红树林植被覆盖的淤泥质海岸	111
8.2.7	珊瑚海岸	111
9	海岸线分类	117
9.1	平直海岸线	117
9.2	其他海岸形态	119
9.2.1	三角洲	120
9.2.2	沙嘴	121
9.2.3	障壁岛和潮汐汉道	121
9.2.4	冲积羽扇	122
9.2.5	潮汐汉道	123
9.2.6	泻湖/海岸泻湖	123
9.2.7	靠近河口和潮汐汉道的海岸线	124
9.2.8	海岬和海湾沙滩	124
第二:	部分 指导原则	126
10	概述	127
11	海岸侵蚀和海岸洪灾的成因以及气候变化的影响	128
11.1	海岸侵蚀的自然因素	130
11.1.1	自然条件下的长期侵蚀	130
11.1.2	自然条件下的短期侵蚀	133
11.2	海岸侵蚀的人为因素	134
11.2.1	海岸结构物对沿岸输沙的影响	134
11.2.2	被动式海岸防护结构	140
11.2.3	大型填海工程	141
11.2.4	月牙形海湾的侵蚀	141
11.2.5	河道整治和河道采砂	142
11.2.6	采砂、珊瑚开采和疏浚工程	145

11.2.7	快艇尾流引起瞬时侵蚀	145
11.2.8	结束语	146
11.3	洪灾的成因	147
11.3.1	洪灾的自然因素	147
11.3.2	洪灾的人为因素	148
12	侵蚀的危害性和风险分类	150
12.1	背景	150
12.2	危害性和风险分类以及干预措施	151
13	洪灾的危害性和风险分类	153
13.1	风暴潮引起的洪灾危害性和风险分类	153
13.2	海啸预警	154
14	海岸带的规划理念	158
14.1	概述	158
14.2	空间规划	160
14.3	区域规划—国家政策和战略	161
14.3.1	法律、法案和规划条例	161
14.3.2	区域立法的管理	162
14.4	可持续发展的贯彻执行	164
14.5	海岸带管理	166
14.6	海岸线管理	168
14.6.1	海岸线管理规划	169
14.6.2	海岸线总体规划	173
14.7	气候响应计划	175
14.7.1	背景	175
14.7.2	气候响应计划	176
15	海岸工程项目	177
15.1	海岸线管理/海岸发展方案	179
15.1.1	海岸线管理方案	179
15.1.2	海岸发展方案/海滨发展方案	179
15.1.3	海岸线发展和海岸发展方案的设计目的	180
15.2	海岸防护方案	182
15.3	海洋防御方案	182
15.4	公共基础设施、公用工程和工业工程	183
15.4.1	港口工程	183
15.4.2	输油管道、电缆和公用/工业工程（取水口/排水口）	185
15.4.3	潮汐汊道或河口的管理	186
15.4.4	固定设施：桥或隧道	187
16	适应气候变化的设计理念	188
16.1	设计依据的概述	188
16.2	气候变化的因素	189
16.3	适应海平面上升的设计理念和风险评估	190
16.4	适应气候变化的措施	195
17	气候变化下的沿岸防护、海岸防护和海洋防御措施	197
17.1	总体考虑因素	197
17.2	可持续解决方案的要求	198
17.3	海岸防护、沿岸防护和海洋防御的类型概述	199
17.4	海岸防护	200

17.4.1	海堤	200
17.4.2	护岸	203
17.4.3	应急防护	209
17.4.4	驳岸结构	211
17.5	采用结构物和海滩填积的综合海岸防护措施	212
17.5.1	丁坝	213
17.5.2	离岸防波堤	223
17.5.3	突堤/改良式防波堤	239
17.5.4	栖息海滩	243
17.5.5	海湾海滩和人工袖珍海滩	244
17.6	沿岸防护	246
17.6.1	滨海区管理	246
17.6.2	人工养滩	251
17.6.3	海滩萎缩/海滩流失	263
17.7	人工海滩和海滩公园	265
17.7.1	人工海滩	265
17.7.2	海滩公园和海滩改造	265
17.8	土地使用限制	269
17.9	海洋防御工程	273
17.9.1	堤坝	274
17.9.2	人工沙丘	275
17.9.3	湿地/红树林修复	277
17.10	海岸防护、沿岸防护和海洋防御措施的功能和适用性总结	280
18	海滨发展方案	283
18.1	介绍	283
18.2	自然景观元素的特征	284
18.2.1	天然海滩的特征	284
18.2.2	天然泻湖的特征	286
18.3	人工海滩的设计原则	287
18.3.1	波浪的影响	287
18.3.2	波浪作用最小化	290
18.3.3	潮差的影响	290
18.3.4	海滩平面形态	290
18.3.5	海滩剖面形态	291
18.3.6	海岸区域的设计标准	291
18.3.7	海滩填积材料	293
18.4	人工泻湖的设计原则	295
18.4.1	泻湖口和泻湖水道断面	295
18.4.2	开敞水域	295
18.4.3	拓展性结论	296
18.5	滨海发展的景观元素	297
18.6	海滩公园发展的成功案例	303
18.7	近海发展的新理念	305
18.8	调查方法	306
18.8.1	总体要求	306
18.8.2	水力学研究	306
18.9	结论和建议	309
19	环境影响评价 (EIA) 和地貌影响评价 (MIA)	310
19.1	EIA和MIA背景与介绍	310
19.2	EIA流程概述	311
19.2.1	需要进行环境影响评价的海洋工程类型	311

19.2.2	环境影响评价的概念	314
19.3	地貌影响评价	322
19.3.1	降低地貌影响的干预手段	322
19.3.2	港口建设对地貌的影响以及缓解措施	323
19.3.3	针对潮汐汉道的缓解措施	330
19.3.4	针对沿岸带内其他结构物的缓解措施	342
19.3.5	针对沿岸带以外结构物的缓解措施	342
19.3.6	针对沿岸带内软性工程的缓解措施	345
19.3.7	针对沿岸带外软性工程的缓解措施	345
19.3.8	针对河流和内陆地区的缓解措施	347
19.3.9	针对开采地下资源的缓解措施	347
19.3.10	针对海平面上升的缓解措施	348
第三:	部分 辅助海岸带管理的水力学研究方法	349
20	数据收集和现场调查	
20.1	现有数据的收集	350
20.1.1	数据类型及相关性列表	350
20.2	现场调查勘测	356
20.2.1	勘测记录的类型和范围及相关性列表	356
21	辅助海岸带管理的数值模型	362
21.1	数值模拟的原理	362
21.1.1	介绍	362
21.1.2	数值模型的基本思路	363
21.2	模型在工程上的应用	373
21.2.1	数值模拟的目的	373
21.2.2	用户背景 and 培训	376
21.3	海岸动力过程—复杂环境建模	376
21.4	海岸动力模型	383
21.4.1	水动力模型	383
21.4.2	相位平均的二维模型	383
21.4.3	波浪	384
21.4.4	潮流和长波	388
21.4.5	波流相互耦合	393
21.4.6	泥沙输运模型	398
21.4.7	泥沙输运过程模拟	398
21.4.8	海岸线模型	413
21.4.9	剖面模型	428
21.4.10	海岸洪灾模拟	430
21.4.11	海陆边界模拟	431
21.4.12	海水入侵	432
21.4.13	气候变化对海岸的影响模拟	438
22	物理模型试验	440
23	参考文献	442
24	索引	449

1 Background

Coastal engineers, planners, administrators, private landowners and politicians should have a common basis as background for planning sustainable human activities along the coasts. In particular the following issues are important:

- coastal processes
- goals for management strategies
- management possibilities and solutions
- adaptation to climate changes

These subjects have been dealt with in numerous textbooks and scientific papers; however these media are not easily accessible to planners, decision-makers and other interested parties, as most of these publications are written and read mainly by researchers. Many of the textbooks are too scientific and too voluminous (and thus time-consuming) for non-specialists to access, and many of the papers are very specialised, either as regards scientific topic or geographical setting. Furthermore, they are published in conference proceedings and journals, which are not - and should not be - standard references for planners and decision-makers.

Most of the required knowledge is therefore only available to specialists. However, the authorities make decisions concerning shoreline management based on their understanding of the subject. Consequently it is the responsibility of scientists and engineers to communicate their knowledge to the public so that it is easily understood.

The recipients of this knowledge are:

- The landowners facing the problems, who often are the main contributor for financing coast protection schemes
- The authorities responsible for planning and approval of shoreline management schemes
- Consulting engineers, who are responsible for designing shoreline management schemes
- The decision-makers, public officers and politicians

Shoreline Management Guidelines aims to fill the gap between the professional coastal scientific community on one side and the above mentioned parties on the other. It offers a relatively short but scientifically correct guide to:

- coastal processes
- holistic management concepts
- environmentally sound shoreline management interventions
- coastal adaptation to climate changes
- up to date investigation methodology

1.1 What are the problems - and how to address them

The problem we face is the accelerating number of conflicts between development on the coast and coastal erosion/coastal flooding; these conflicts are further aggravated by the climate changes. The development pressure on land in combination with the progressing coastal erosion leads to requirements for coast protection, and in many cases subsequent deterioration of our shores. There are many reasons why most coastal regions throughout the world suffer from these problems despite the high level of coastal engineering and the science of coastal processes available today.

Many human activities deprive our shores of a natural supply of sand, such as river regulation works - often far away from the coast – and sand mining in rivers. In addition, the construction of harbours, inlet regulation jetties, maintenance dredging, hard coast protection works and the ongoing Sea Level Rise, all add to the problem. With less sand available our formerly natural and stable sandy beaches will suffer from erosion.

Lack of sustainable planning has, in many cases, permitted urbanisation and infrastructures too close to eroding coastlines, which has aggravated the consequences of chronic erosion. Nowadays, most countries have a legislation, which enforces restrictions on construction activities near the coastline and forces project developers to perform impact assessment studies for coastal projects and to implement remedial measures as part of the project if negative impacts are identified. In most cases there is also nature protection legislation, which promotes sustainable development through requirements to re-establishment of recreational beaches and requirements to preservation of natural beaches. The main problem is that there is normally no budget for fulfilling the requirements to re-establishment and preservation of the coastal resources (sandy beaches).

The climate changes are global problems, which will cause a general Sea Level Rise in the future and which will add to coastal erosion and flooding problems.

Many causes of past and present coastal erosion have a long history and a geographically complex background. It is evident that most of these causes *cannot* be removed within the scope of a typical coastal protection project.

The important elements when dealing with coastal erosion and beach restoration problems are:

1. To investigate the causes of the problem
2. To define the goals for the shoreline management project and to resolve conflicting interests. This phase can also be described as *definition and acceptance of the shoreline management strategy for the project area*
3. To define the financing of the project
4. To engage a qualified group of consultants to assist in achieving the goals of the agreed shoreline management strategy

Coastal engineers' expertise lies especially within items one and four, but items two and three are just as relevant.

This means that:

- coastal engineers must improve their communication and management skills, and
- all other involved parties must improve their basic understanding of the coastal area and of the engineering possibilities

These Guidelines are intended to facilitate this process for the benefit of our valuable shores.

1.2 Some thoughts on Shoreline Management

There is always a delicate balance between the requirements of primary protection against coastal erosion on one hand and protection of the dynamic coastal landscape and sandy shores on the other hand.

Historically, protective measures have been reactive in nature and have concentrated on preventing loss due to coastal erosion. This type of protection has, throughout the world, resulted in loss of the beach and it has had a serious impact on the dynamic coastal landscape. Such protection measures are “coast protection”, not “shore protection”.

1.3 How to read these guidelines

These Guidelines are separated into three parts but the chapters are numbered continuously through the various parts:

- PART 1: Metocean Conditions, Coastal Processes and Coastal Classification, Chapters 2 through 9
- PART 2: Guidelines, Chapters 10 through 19
- PART 3: Hydraulic Study Methodology as Support for Shoreline Management, Chapters 20 through 22
- References and Index are presented in Chapters 23 and 24.

The purpose of Part 1 is to give the reader a basic understanding of the metocean forces acting on the coast and the coastal processes resulting from these forces and how these processes results in coastal changes. Part 1 is opened with a definition of coastal terms to ensure common understanding and meaningful communication and Part 1 is terminated by coastal classification, which is a very useful concept to summarise the status of a coastal section. Part 1 is mainly intended for the interested, non-specialist reader who wants a better understanding of what is happening and why and for the engineer who is venturing into an unfamiliar area and wants an introduction to the subject. The focus is therefore not on the theoretical and numerical side of issues, but on provision of a general understanding of the coastal processes. Practically only very few equations are included in order not to exclude non-scientists from understanding the text. Part 1 should be read from start to finish at least once and can then later be used to look up specific topics or words.

The experienced coastal engineer can skip Part 1 and go directly to Part 2, which contains sections on the following subjects:

- Causes of coastal erosion and coastal flooding including impact of climate changes
- Vulnerability and risk classification for erosion
- Vulnerability and risk classification for coastal flooding
- Planning concepts in the coastal zone
- Coastal projects
- Design philosophy including adaptation to climate changes
- Shore protection, coast protection and sea defence methods with special emphasis on coastal adaptation to climate changes

- Water front development schemes
- Environmental Impact assessment and Morphological Impact Assessment

Part 2 will assist the reader, whether an engineer or a planner, in formulating a suitable strategy for the problem at hand and in selecting realistic solutions. This part can be read from start to finish or used as a reference book.

Part 3 provides guidance in study methodology as support for shoreline management projects divided in data collection and field investigations, numerical modelling and physical modelling

Chapter 23 presents a list of references common for all chapters. In order to make the Guidelines easier to read there are only few references in the text. Chapter 24 presents a subject index.

Results from numerical modelling have been used throughout this book to illustrate coastal processes. The DHI software “MIKE Powered by DHI” has been applied to make these illustrations.