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The role of Coastal Engineering in Integrated Coastal Zone Management

Peter Fröhle and Sören Kohlhase

Institute for Hydraulic and Coastal Engineering, University of Rostock, Germany

Abstract

Wide parts of coastal areas were used by humans from time immemorial, in Germany since more than 1000 years. Nowadays, coastal zones are utilized for various purposes e.g. human settlements especially in towns and villages, agriculture, aquaculture, human recreation, handling of goods, industrial and commercial development, energy generation, nature preservation and preservation of cultural heritage, which can be – more or less – summarized as "human activities in the coastal zone".

The development of the human activities in the coastal zone is strongly related to the development of coastal protection and the construction of flood protection structures e.g. dwelling mounds, dykes and dyke openings. All those constructions were designed and built up with the support of -now called- coastal engineers. Coastal engineers (and their predecessors) were coastal zone managers long before the term "coastal zone management" was coined. With the by and by change in the use of the coasts, the demand for an overall management of the coastal zone arose, including administrative-, socio-economic-, biological-, regional development-, regional planning-, civil engineering- and coastal engineering aspects. Since the functional and constructional design of all coastal structures are performed by coastal engineers, and the assessment of the possible development (appearance) of the coast is impossible without the knowledge and work of coastal engineers, coastal engineering plays an important role for the management of coastal stretches.

1 Introduction

The role of Coastal Engineering in Integrated Coastal Zone Management ICZM can only be characterized on the basis of a definition of the term Integrated Coastal Zone Management. Many definitions or descriptions on what ICZM is can be found in publications and also in the Internet. A good definition maybe the following of Cicin-Sain & Knecht (1998).

„Integrated coastal (area) management can be defined as a continuous and dynamic process by which decisions are taken for the sustainable use, development, and protection of coastal and marine areas and resources. ICM acknowledges the interrelationships that exist among coastal and ocean uses and the environments they potentially affect, and is designed to overcome the fragmentation inherent in the sectoral management approach. ICM is multi-purpose oriented, it analyzes and addresses implications of development, conflicting uses, and interrelationships between physical processes and human activities, and it promotes linkages and harmonization among sectoral coastal and ocean activities".

Hence, theoretically in Integrated Coastal Zone Management a wide number of sciences are involved, including Law, Oceanography, Sociology, Economy, Regional Planning, Traffic Planning, Geology, Geography, Physics, Biology, Ecology, Chemistry and Coastal Engineering.

In practice of ICZM all those sciences have to be managed by a coastal manager, which should - at least in Germany - come from a governmental authority. Also a Communicator is needed for the public participation and to ensure the public awareness.

Coastal Engineering may be defined as a field of Hydraulic Engineering, which itself is part of Civil Engineering, In Coastal Engineering a wide field of disciplines are integrated. In fig. 1 an overview on Coastal Engineering and the related fields is schematically presented.

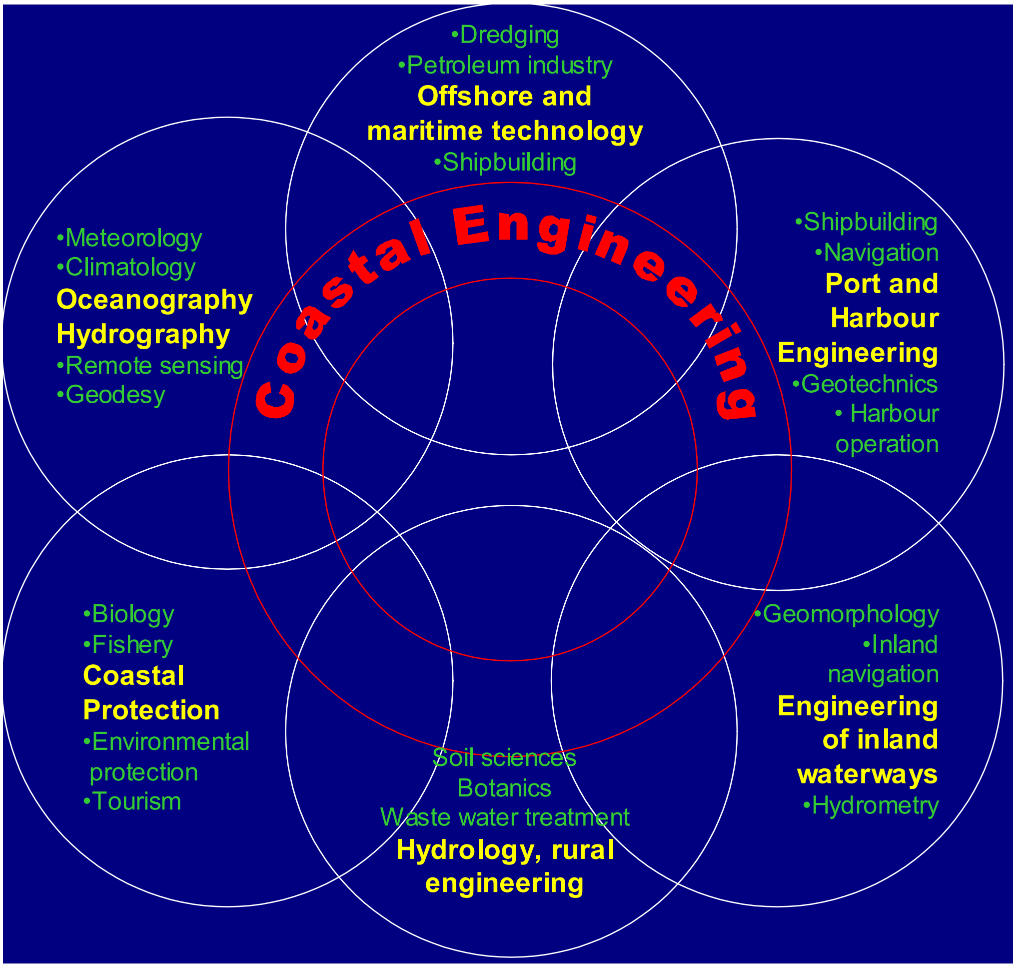

Figure 1: Coastal Engineering and the fields involved

Many publications and research results on ICZM indicate that from the wide field of Coastal Engineering works, Coastal Protection, Port and Harbour Engineering and Offshore and Maritime Technology are important for ICZM. For example, Pickaver (2004) stated that Coastal Erosion and Tourism are most important sectors in ICZM in the international focus. Gee et al. (2004) identified „the sea as a public good, ports, shipping, fishery, wind farms and marine protective areas“ as the key themes on the coast in Germany.

2 Coastal Engineering works for ICZM

In this part of the paper some examples for Coastal Engineering works are presented. They show the necessity of the work and especially the result of these works for the intention of ICZM. The examples are taken from the fields of Coastal Protection and Marina Planning to cover the key themes Coastal Erosion and Tourism / Ports, Shipping, Fishery and the Sea as a public good.

Coastal protection consists of two general parts, flood protection and management of erosion. In fig. 2 and fig. 3 two examples are shown to indicate that flood protection has the same importance for the use of a coastal stretch as erosion protection. It can be seen that in both example areas the erosion is in the order of magnitude of 30m to 100m per century. 70% of the coast of Mecklenburg-Vorpommern is eroding permanently, 23% of the coast are stable and in only 7% of the coast accretion and accumulation of sand can be observed.

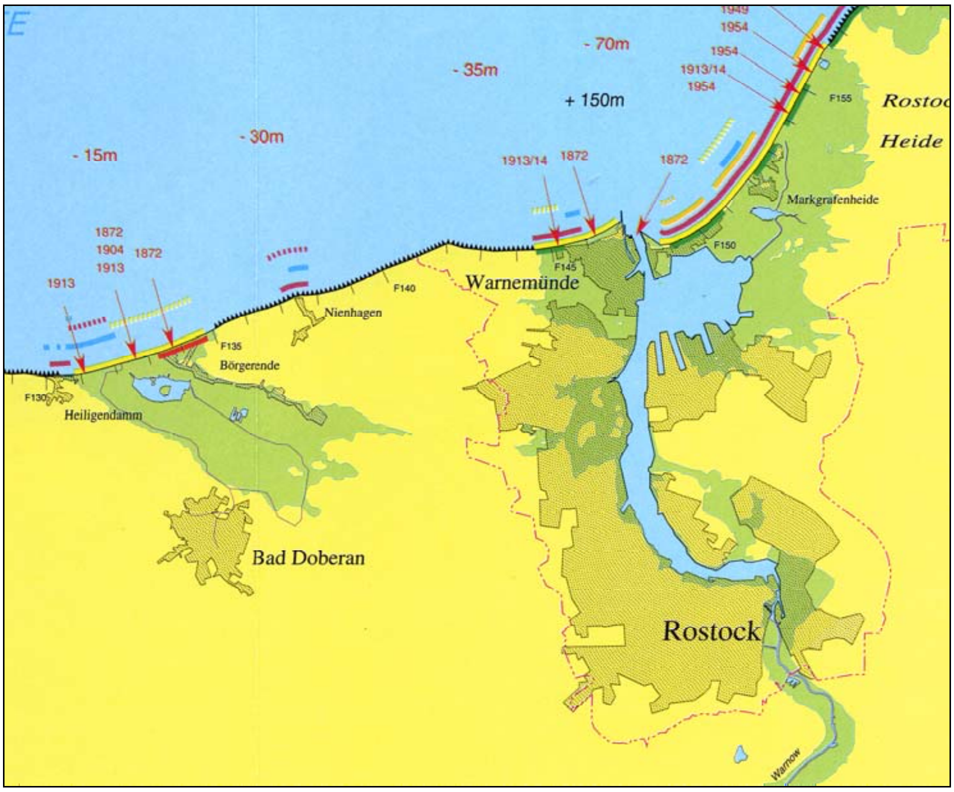

Figure 2: Coastal Erosion, Coastal Protection Works and Low Lying Coastal Areas for the area of Rostock, Mecklenburg-Vorpommern (from Master Plan Coast Conservation Mecklenburg-Vorpommern, 1995).

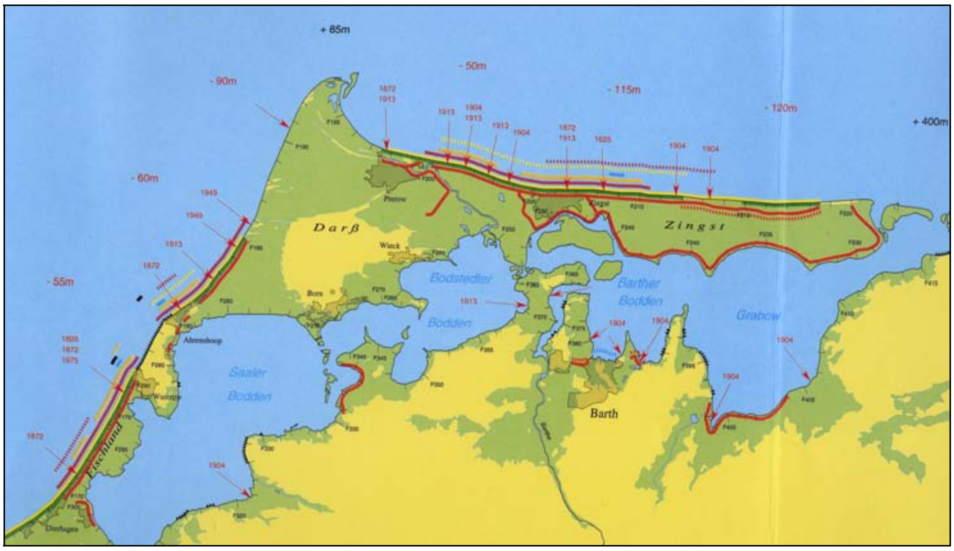

Figure 3: Coastal Erosion, Coastal Protection Works and Low Lying Coastal Areas for the Fischland, Darss, Zingst Area of the Coast of Mecklenburg-Vorpommern (from Master Plan Coast Conservation Mecklenburg-Vorpommern (1995).

Besides the information on the erosion (and accumulation) rate of the coast the low lying areas are marked with green colour. These areas would be flooded during extreme storm events without flood protection measures on the coast. It can be seen in fig. 2 and fig. 3 that also parts of the cities at the coast are affected without flood protection. Approx. ¾ of the Fischland – Darss – Zingst Area would be flooded during severe flood events without flood protection and so would be lost for human use.

An example for coastal protection works at the Streckelsberg / Usedom Island is given in fig. 4. A combination of beach nourishment, groins and offshore breakwaters are installed to fix the Streckelsberg and to stabilise the adjacent coastal stretches. The overall aim of the complete system is to ensure the flood protection of the low lying areas north-west of the Streckelsberg.

Figure 4: Coastal protection/flood protection works with a system of offshore breakwaters, groins and beach nourishment at the Streckelsberg / Usedom Island (Photo: Dr. B. Gurwell).

For coastal protection and flood protection there exists a wide number of technical solutions. The general possibilities for technical solutions for the protection of sandy beaches are given in fig. 5. They can be divided into active and passive measures, where active measures include sand bypassing structures, beach fill and beach nourishment works. Passive measures consists of constructions normal to or in direction of the shoreline as, e.g., groins, breakwaters, revetments. For practical projects often combinations of active and passive measures are used, as the Streckelsberg example in fig. 4 shows.

As an example for the second key issue "tourism / ports / fisheries" marinas are used. Marinas are planned all over the Baltic Sea and are – sometimes – heavily discussed in public. Conflict potentials and conflict parties are manifold. For example: investors, environmentalists, private, public and administrative interests have to be considered in various fields including: economics, environment, tourism, sports, coastal and flood protection, local and general eco systems and aestethic aspects.

Investigations on the influence on coastal and flood protection but also on the influences on the morphological development of adjacent areas are typical coastal engineering tasks related with the planning of marinas within a comprehensive ICZM. An overview of the major topics within the planning of marinas and related coastal engineering tasks is given in fig. 6.

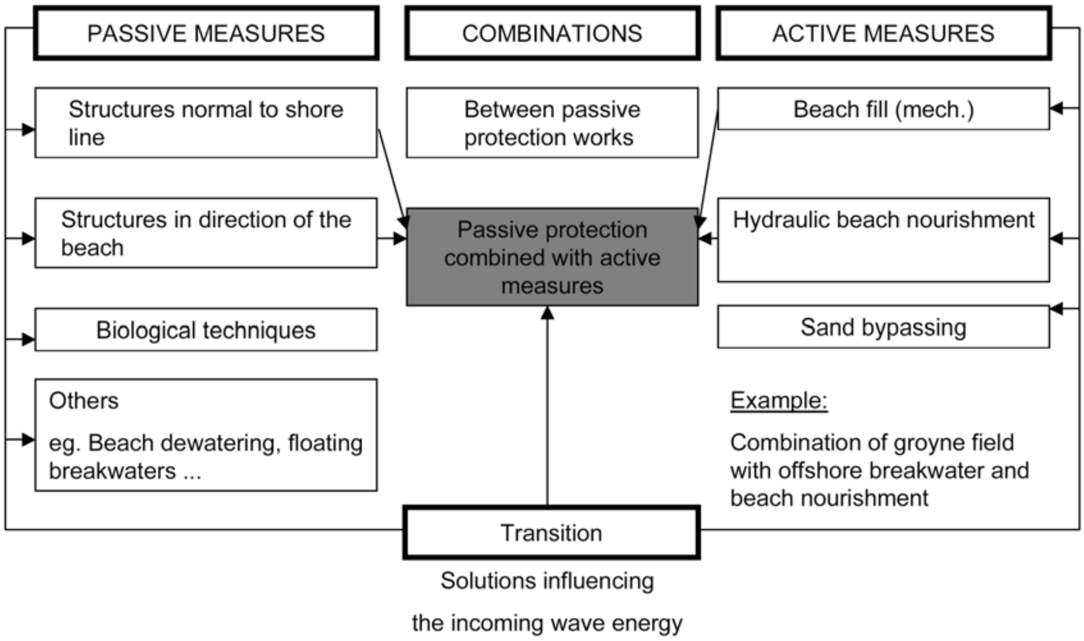

Figure 5: Technical solutions for the protection of sandy beaches (after Kohlhase 1991).

Figure 6: Planning steps and Coastal Engineering tasks for design and construction of marinas.

The general influence of a marina on a sandy coast on is illustrated in fig. 7. Since the marina breakwaters are crossing the zone of the main sediment transport, the transported sediment is deposited on the luff side of the marina and, hence, the coastline is eroded on the downdrift (lee) - side. The main objective for the assessment of the morphological development of the coast is to calculate the local sediment transport and to determine the influences of the structures on the sediment transport.

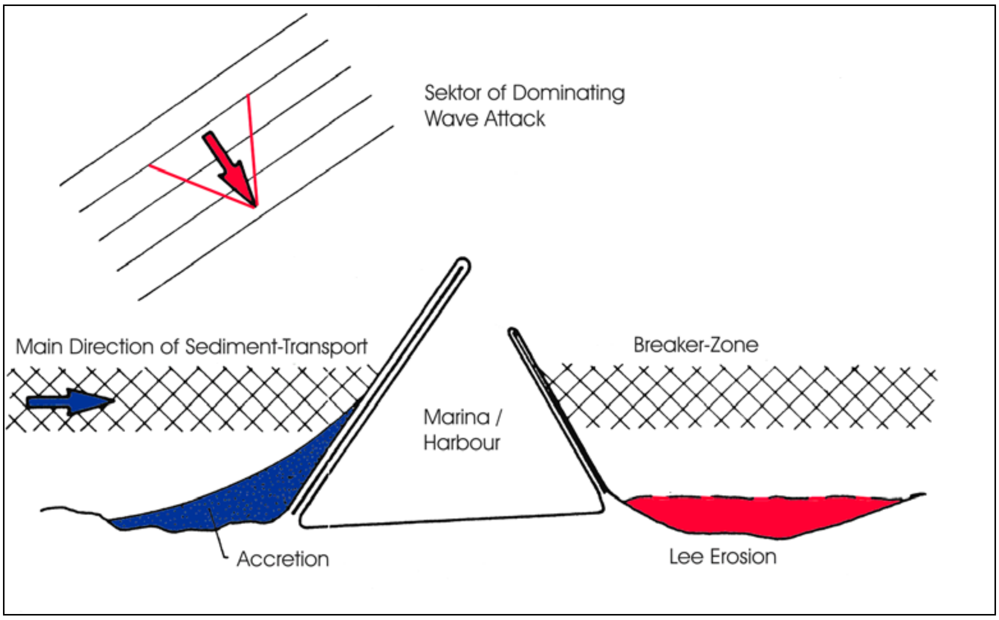

Figure 7: General influence of a marina on sediment transport (Kohlhase 1983).

For the calculation of the local sediment transport and the assessment of the influence of a marina on the morphological development of a coastal stretch several engineering methods are available. Numerical models are nowadays widely used. Fig. 8 shows an example result of a numerical model with a marina installed on an open coast beach.

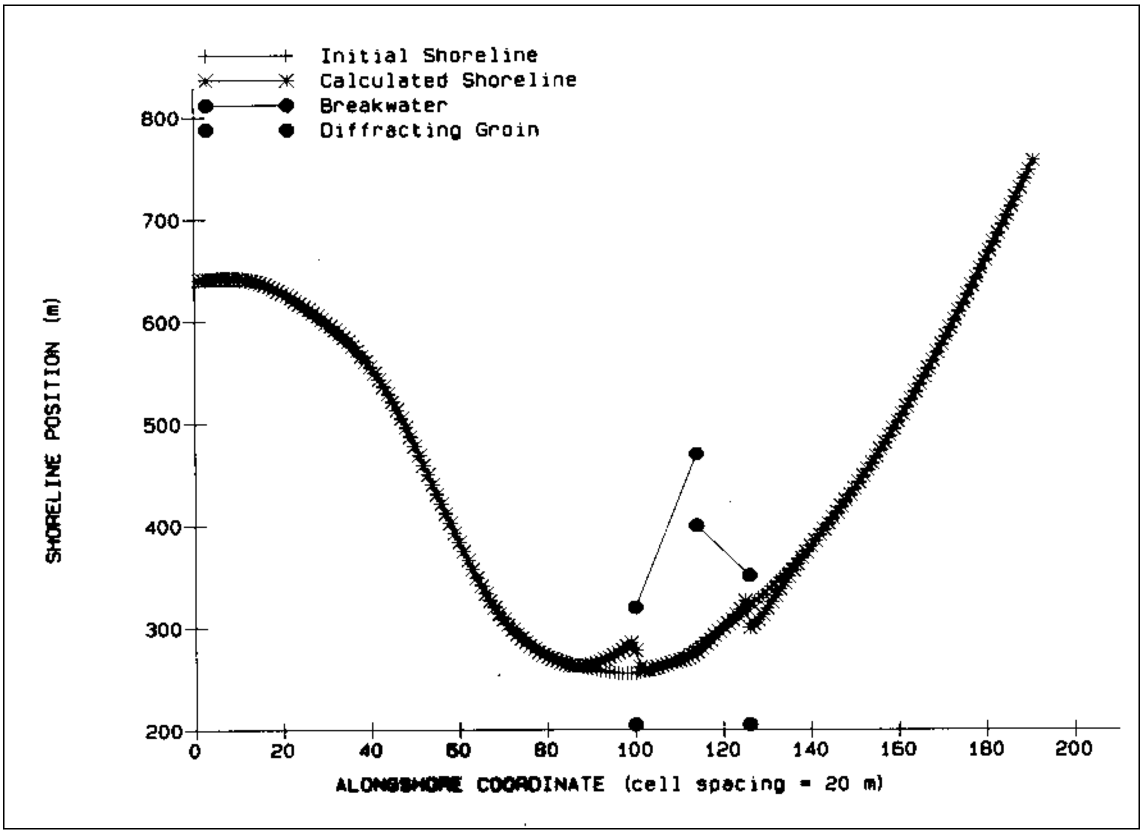

Figure 8: Influence of a marina on the morphological development of a coastal stretch. Example results calculated with the numerical model GENESIS.

If necessary, the negative influence of a marina has to be controlled by technical measures. As outlined before, technical measures include:

- beach nourishment,
- groin fields,
- offshore breakwaters,
- artificial reefs / submerged offshore breakwaters and others.

Since all coastal engineering constructions have positive (desired) influences but also negative (undesired) effects, the influences of all technical measures have to be carefully assessed. Usually, detailed investigations have to be carried out for any coastal engineering project.

3 Conclusions

Very often coastal engineering projects and coastal engineering constructions have a significant influence on the development of the coastal area. In the paper two illustrating examples showing the role of engineering within Integrated Coastal Zone Management are presented.

In summary and with respect to Integrated Coastal Zone Management it can concluded, that:

- Coastal Engineering problems play an important role in Integrated Coastal Zone Management.
- Coastal Engineering works and constructions are the basis for human use of the coastal zone and in general for all human activities in the coastal zone.
- Coastal Engineering includes the assessment of all possible positive <u>and</u> negative effects of the constructions.

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Address

Dr.-Ing. Peter Fröhle
Institute for Hydraulic and Coastal Engineering
University of Rostock
Justus-von-Liebig-Weg 6, LAG II
18059 Rostock
Germany

E-mail: peter.froehle@bauing.uni-rostock.de