

MAN MADE BEACHES BALANCING NATURE AND RECREATION

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ABSTRACT

Intensive mixed development of township, industry and tourism takes place in the coastal zone worldwide. This is often giving reason for conflicts between the commercial and industrial development, the need for recreational facilities and the interest for protection of the natural quality of the coastal zone and the environment.

Artificial beaches has been developed in Denmark at a high quality level with a successful balancing of the priorities of interest for the urban area population and for the natural and environmental content.

The paper describes with examples how the development of artificial beaches in great scale close to the City can be an efficient tool for the balanced development which combines solutions to known areas of conflict.

1. INTRODUCTION

Public beaches are often scarce in the close vicinity of densely built areas.

Artificial beaches will therefore strengthen the recreational value of the area when the beach is developed in balance with the interests of the commercial and industrial development.

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The environmental concerns for an artificial beach park are on the one hand the water quality at the new advanced sea beach and on the other hand the water quality in a created lagoon system. The water quality is usually related to hygienic water quality (bacterial and viral pollution) and eutrophication. The latter may be excessive growth of algae leading to accumulation of dead seaweed at the beaches or very turbid waters in the lagoon and potential problems with depression of the oxygen concentration in the water.

Many of these problems can be avoided when the proper methods for design are used including determination of the requirements for reduction of pollution load to the area, which may be conditional for turning the project into a success story.

The examples used in this presentation are from the two projects Køge Bugt Beach Park and Amager Beach Park, both located close to the center of Copenhagen and next to industrial areas and the densely populated township.

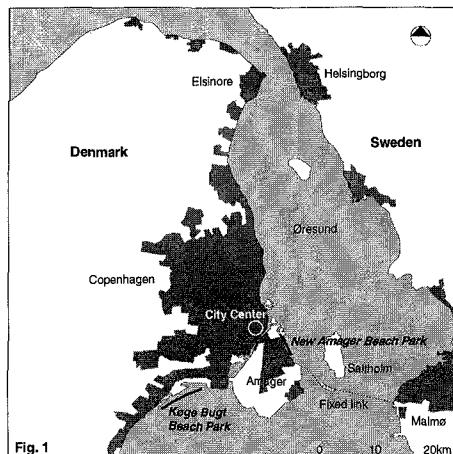


Figure 1, Location of Beach Parks near Copenhagen

2. BACKGROUND

The authors of this paper have through almost 25 years individually and in cooperation worked on a great number of projects in the coastal zone, in Denmark as well as internationally. They combine the wide experience from specialized scientists and practical planning, architecture and engineering and they have jointly been responsible for the technical preparation of conceptual design and model analysis of two alternatives for the new Amager Beach Park project. The design has been prepared for the Planning Section of the Danish Ministry of Traffic during 1995-1996.

Further the authors have, since their participation in the planning and construction in the seventies of the Køge Bugt Beach Park, followed and been involved in the monitoring and maintenance works for the beaches, dunes and dikes forming the waterfront of this beach park as well as in the functioning of the recreational facilities and the natural appearance developed by the artificially reclaimed areas.

3. AREAS OF CONFLICT

The Problem areas or Areas of Conflict which will be addressed through the examples in the paper are:

- **Recreational Values versus Densely built-up City Areas**
Development of a sustainable connection between the high recreational value of the coastal zone and the densely built-up areas of the City with access for the public.
- **Recreational Coast versus Commercial Port**
Combination of the recreational coastal zone and the continued development of the commercial port of Copenhagen as an important economic factor for the City.
- **Recreational Coast versus Industrial Development**
Maintenance and renewal of the City's industrial areas and employment in balance with the recreational value of the coastal zone.
- **Public versus Private Financing and Maintenance**
Balancing public and private interests in financing and maintenance of the project.
- **Stability against Wave Exposure**
Coastal morphology and exposure to wave action balanced to a stable beach configuration.
- **Bathing Water Quality versus Waste Water Discharge**
Attractive bathing water quality in the City's waste water environment.
- **Recreational activities creates increased pollution problems**

4. PREVIOUS PROJECTS

It has often been a tradition to develop densely built waterfronts with promenades and beaches based on the existing beaches with a well functioning coastal morphology.

The Køge Bugt Beach Park located south of Copenhagen, constructed in the late seventies, has previously been described at conferences as a new concept based on a qualitative development of the existing coastal zone with new beaches as a recre-

ational support to the developed township in the hinterland. The new beaches was developed on a system of shallow sand barrier islands located 500 to 1500 metres from the coastline. The shallow lagoon behind the barrier was developed as a combination of reclaimed land, dredged lagoons and for the marinas.

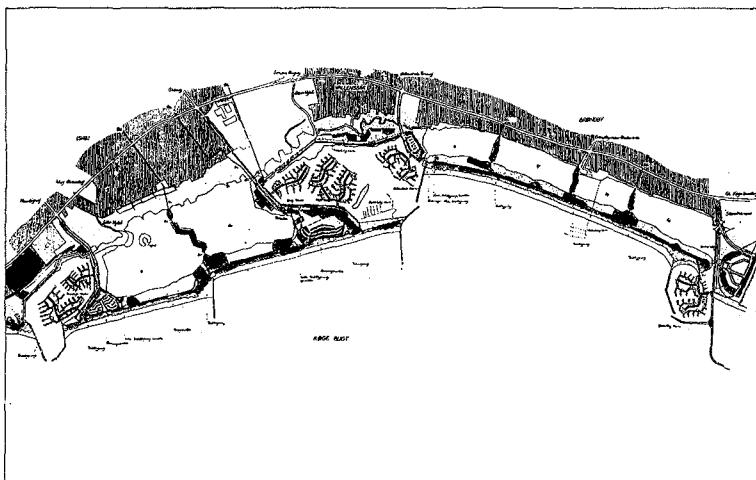


Figure 2, Køge Bugt Beach Park - Beaches and reclamation with lakes and marinas

The tools available at the time when the beach park in Køge Bugt was designed was very simple compared with today's numerical models. The alignment of the beaches and their stability was designed on basis of numerical refraction calculations and morphological indications provided by the existing barrier island formations.

The result was successful as the artificial beach line has practically stable during the following 20 years and there has not been any need for replacement of sand lost from the beaches.

The existence of algae and drifting seaweed has always been a problem in the bay and the project has not eliminated this problem. Algae and seaweed is still appearing along the shoreline during the bathing season as it is the case along most natural beaches in Denmark.

However, the quality of the bathing water at Køge Bugt Beach Park is so good - despite the existence of a next door large sewage treatment plant - that the beach park has been able continuously to flag the attractive blue flag permitted only for recreational areas with a proven high quality of the bathing water. The project has thus proved that it is possible to retain a high recreational quality with a limited amount of maintenance resources in a highly developed area, however the precondition is that the society maintains a high standard with respect to the treatment of sewage.

5. NEW STEPS IN THE DEVELOPMENT

The New Amager Beach Park is an example of a new generation of artificial beaches. The location of the beach park, which is very close to the centre of Copenhagen and densely populated areas, has for generations been used for industrial development. The industry in the area is however undergoing a winding up process and a rehabilitation of the area to an attractive residential township is now being planned. The Port of Copenhagen is at the same time planning to merge all their bulk activities in the area in immediate vicinity of the beach park.

The area was previously burdened with some of the larger discharges of sewage from the city.

The coastal zone today is a narrow park with a beach of poor quality. The water quality is good following the implementation of one of Copenhagen's largest treatment plants some years ago, but still a number of storm water run-offs are existing.

The planned project will result in the development of a new advanced beach coast and lagoons.



Figure 3, Location of New Amager Beach Park

The new urban beach park will be a more intensive developed activity region for the city population, not only with beaches, but also with sports facilities and specialized centres of activity. The project is at the planning phase in which the government and the City of Copenhagen has cooperated in the preparation of a conceptual plan, for the development of the area. The possibilities for project financing is being analysed and negotiated at present.

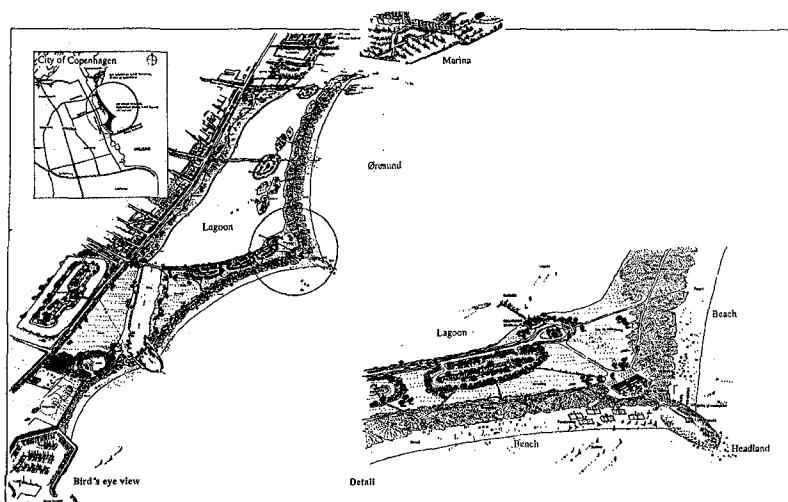


Figure 4, Amager Beach Park

The presentation will also describe how this type of project can be politically and economically integrated in the township development of the hinterland. The project is thus not based on a substantial reclamation to be sold in order to provide the economic background for the construction and maintenance of the public area as often practised in similar situations worldwide. It will be described how the concept used for the Amager Beach Park can be developed so that it is meeting the demand for actual town development as well.

6. COASTAL MORPHOLOGY AND HYDRODYNAMICS

The present Amager beach is located along the Sound approximately 5 km S of Copenhagen, as shown on Figure 1 and 3. Due to its location, the present Amager Beach Resort is not fully exposed to wave action. The island of Saltholm provides partly shelter for waves coming from Eastern directions. Consequently, waves from the direction intervals N-ENE and ESE-SSE are dominating along the frontage of the Amager Beach, refer Figure 5.

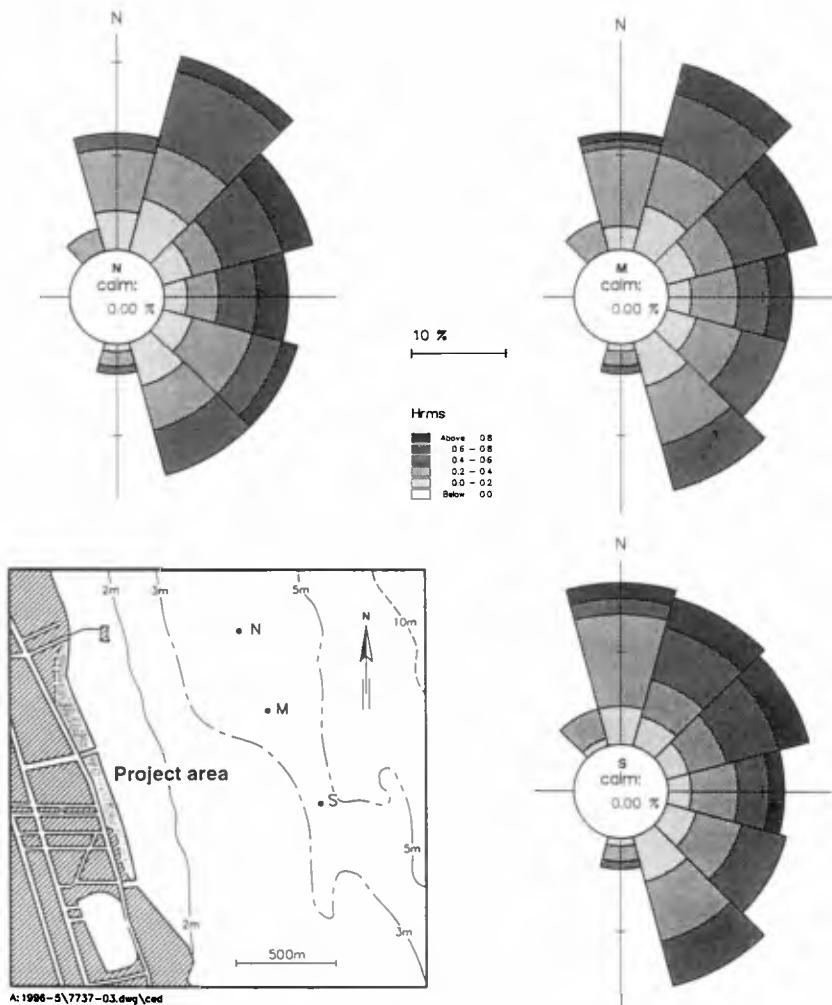


Figure 5. Wave roses for three locations along the Amager Beach according to numerical modelling by MIKE 21'NSW

Furthermore, the slope of the shoreface in front of Amager Beach is very mild. A large part of the wave energy is lost due to bottom friction.

In the layout of the new Amager Beach Resort, the quality of the beaches is improved considerably by increasing the exposure of the beaches to wave action by seaward shifting of the beach, thus eliminating the shallow shoreface.

The littoral transport distribution rose, Figure 6, right, for the area shows clearly the shadow effect from Saltholm Island and from the Port of Copenhagen.

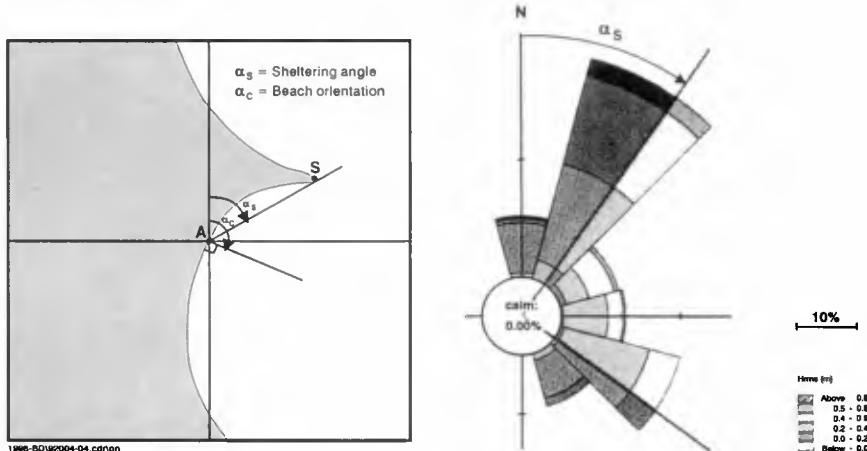
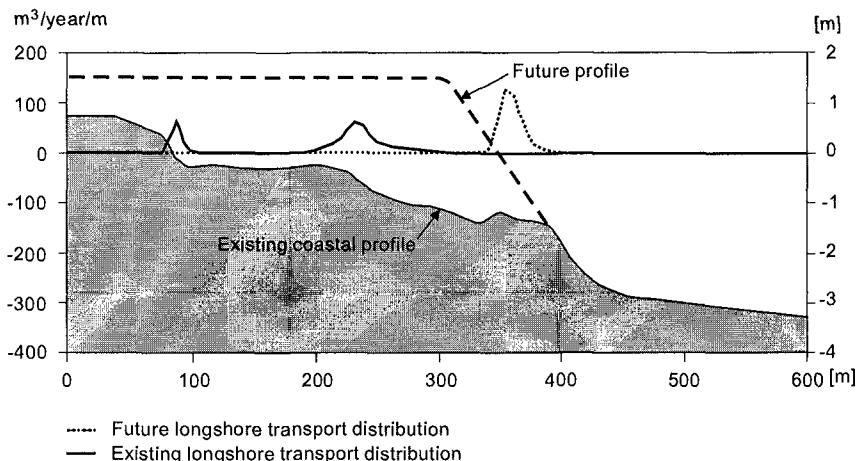


Figure 6, Definition of sheltering angle in relation the the artificial headlands (left) and the corresponding adjustment of the littoral transport distribution

Stable beach configurations were obtained by intersecting the beaches by artificial headlands. These stable beach planshapes have been computed by taking into account the sheltering effect of the headlands, as shown in Figure 6 (left and right), so that the orientation of all sections of the beaches corresponds to the equilibrium orientation. The design of the stable beach configurations were supported by detailed 2D modelling of waves, hydrodynamics and sediment transport.

The diagrammes in Figure 7 shows the longshore sediment transport profiles for the existing and the future beach configurations, respectively. It is noted that the present very wide distribution of the littoral transport is transferred to a narrow distribution concentrated on the foreshore of the future beach. This will provide a better beach quality.



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Figure 7, Distribution of the littoral transport in the coastal profile for the present and future coastal profiles as computed by LITPACK

7. WATER QUALITY

The firming water quality problem foreseen at Amager Beach park is the hygienic pollution due to the discharge of treated waste water from the two treatment plants for Copenhagen located not far away and storm water run-offs located along the existing beach as shown on Figure 8. The secondary problem is the potential excessive growth of algae in the lagoon and the accumulation of seaweed at the beaches in the lagoon area and at the seaside. Models describing the spreading and decay of bacteria and the eutrophication were established using MIKE21. Because of the large number of studies of water quality in the adjacent areas model calibration could be extracted very easily from previous works. Situations describing the year 2000 assuming the planned discharge and treatment of waste water and also some extra actions concerning diversion of storm water were investigated for two different beach layouts.

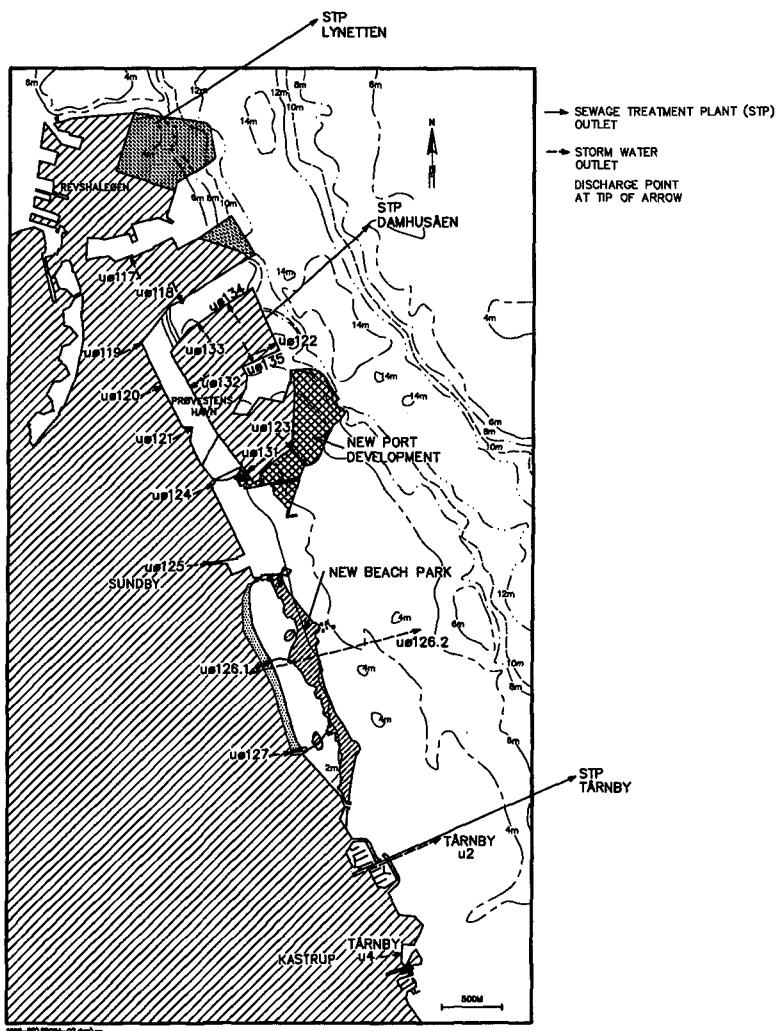


Figure 8. Overview of outlets from Sewage Treatment Plants and Storm Water outlets in the area near the New Amager Beach Park

The design and the natural conditions revealed a relatively high water exchange in the lagoon, which means that the fear of excessive algae blooming could be excluded. The primary production in the lagoon was predicted to be of the same order as in the adjacent areas, which means that some accumulation of seaweeds must be foreseen, similar to what can be observed at the beaches today. Due to the water depths in the lagoon, growth of eelgrass can not be expected. The bathing water criteria were achieved in the lagoon. The criteria were observed even under

At the seaside beach the water quality is expected to be better than at the present beach. The amount of accumulated seaweed is not expected to be larger than at similar beaches in the region. The bathing water quality (i.e. the hygienic water quality) is predicted to be even better than at the present beach due to avoidance of storm water run-offs at the new seaward shifted beach.

8. CONCLUSION

The development of artificial beaches which can support the demand for recreational outdoor life for the population in the urban areas and create the background for tourism development has proved to be an attractive concept for development. It is possible to create projects with a high quality level in which the prioritization of the urban against the natural content can be made according to the local interests and demand for development. The studies will underline that a preassumption for these projects is that they are viewed in their entirety and with a substantial and careful planning in order to ensure their environmental functionalism and viability.

9. REFERENCES

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