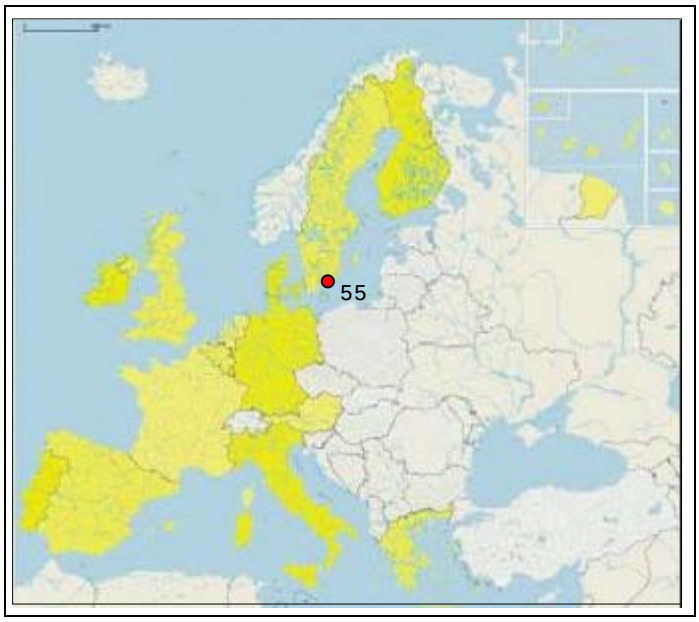
YSTAD
(SWEDEN)



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1. GENERAL DESCRIPTION OF THE AREA

1.1 Physical process level

1.1.1 Classification

Fig. 1: Location of case area.

Ystad is located in the southern point of Sweden (see Figure 1) in the province of Scania, east of Malmö. Sweden is subject to land uplift by isostatic rebound. Notable erosion only occurs in Scania where the land uplift is around zero. The remainder of Sweden does not suffer from coastal erosion because of the land uplift. The Scania coast is micro-tidal.

The coastal type according to the scoping study is:

3b. Wave dominated sediment. Plains.
Dune coasts in micro tidal zones

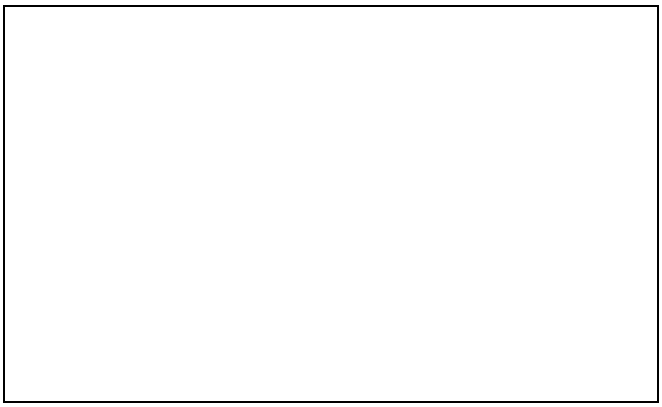


Fig. 2: Overview of the case area.

1.1.2 Geology

Sweden forms the Archean marginal basement with the Baltic-Russian sedimentary basin to the east, the Danish-German basins in the south and the Caledonian mountain range in the west. During several stages of the Quaternary, Sweden and the surrounding seas were completely glaciated, as well as during the final, Weichselian substage, which culminated only some 30,000 years ago.

When the front of the receding ice, in about 12,000 BC, reached Scania, the southernmost province of Sweden (where Ystad is located), a complicated history of shore development started that was dependent on rate of deglaciation, land uplift by isostatic rebound, sea-level variation and shifting outlets from the Baltic basin. The present rate of land uplift by isostatic

rebound varies from 0 in southern Scania, where the case area Falsterbo Peninsula is located, to a maximum of 0,9 m / century on the coast of the Bothnian Bay.

The inland ice produced a till cover of variable texture and thickness and glaciofluvial sediments of two distinctive types: sandy, coarser sediments and suspended silt and clay.

Stenig/grusig strand= stone and gravel beach
Sandstrand= sandy beach
Strandskoning/ utfylland= sea wall/ sand nourishment

Fig. 3: Sediment types at coast of Ystad.

The province of Scania, from a geological point of view, belongs to the European continent rather than to Fennoscandia because it was covered by the Late Cretaceous. The Archean basement was broken up, mainly in the Permian, along NW-SE fracture zones, resulting in horsts and grabens. Except for the Horst areas, glacial drift deposits are usually thick in Scania, 40-50 m is not exceptional, and although low coasts dominate, active cliffs cut in till and glaciofluvial sediments are found along elevated tracts. The isoline of zero-land uplift runs NW-SE through central Scania, which at least partly explains why Scania is the only mainland province with notable coastal erosion.

West of Ystad, most of the beach consists of stone and gravel beach. At the coast of Ystad some sea walls are present to protect the beach. East from Ystad, the beaches are mainly sandy with another sea wall at Löderups strandbad.

1.1.3 Morphology

The coast at Ystad is a reasonably straight lined coast, with no spit or land tongue development. A small bay has formed between Ystad and Löderups strandbad, called Ystad Bay.

1.1.4 Physical processes

Tide

Normal tidal ranges in the adjacent Baltic Sea are less than 0,25 m. Tidal action plays practically no role in this area.

Waves

In Figure 4, the wave directions at Ystad are shown. The predominant wave direction is alternately west or east-southeast. The long shore current is mainly wave-induced.

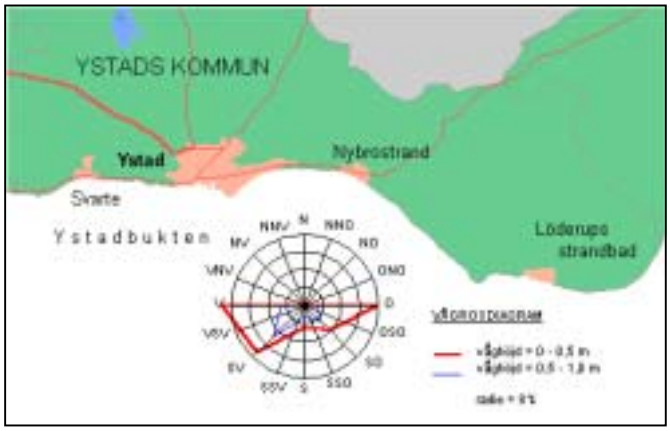


Fig. 4: Wave directions at Ystad.

The average wave heights vary from 0-1 m, maximum wave height is not known.

Land subsidence

At the southern coasts of Scania, instead of land uplift, there is a small land subsidence present of 0,5 mm/year.

1.1.5 Erosion

Structural erosion

The land subsidence, though it is really small and seems insignificant, on the long run will result in ongoing erosion at the biggest part of the southern coast of Scania. On a shorter timeframe, the net long shore transport caused mainly by wave action is of considerably greater importance for the erosion of the coasts.

The net sediment transport is shown in Figure 5. Due to the alternating dominating wind directions (west or east), the net sediment transport in the Ystad Bay is also alternating. In the western part of the bay the net transport direction is eastward, in the eastern part the net transport direction is western. At Löderups strandbad however, due to the orientation of the coast, the net transport direction is eastern again. In the bay the sediment is transported in a circulation pattern, as can be seen in the figure. The quantity of sediment transport varies from –200.000 to 200.000 m3/yr, depending on the coast angle.

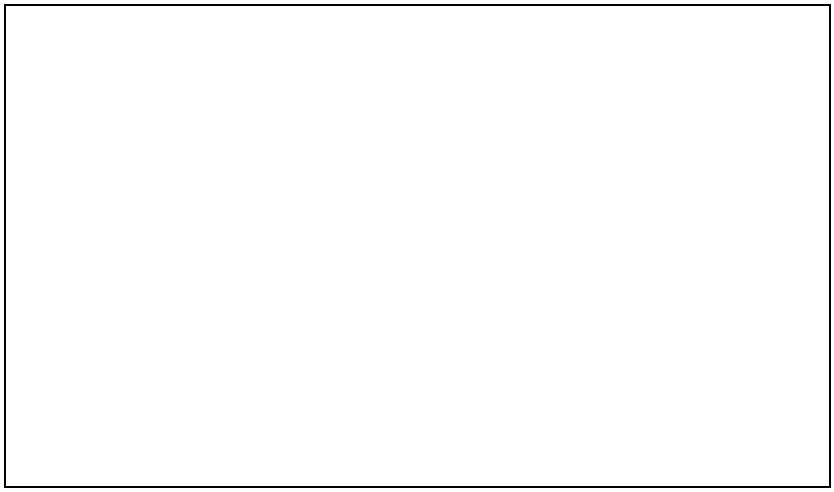


Fig. 5: Net sediment transport directions at Ystad.

Acute erosion

The combination of high water levels with strong wind has on many occasions resulted in severe damage of the coast of Ystad municipality.

1.2 Socio-economic aspects

1.2.1 Population rate

The population counts 16,000 persons in Ystad itself. The entire municipality of Ystad counts 25,949 persons / 352 km^2 = 73 persons/km^2. The municipality is not very densely populated. However, almost 2/3 of the municipality population is concentrated in Ystad itself. This implies a high population density in Ystad.

1.2.2 Major functions of the coastal zone

Ystad is a small town at the Southern tip of Sweden, which with the new bridge between Sweden and Denmark is included in the Öresund Region, with Copenhagen and Malmö as the dominating population centers. In Figure 6, the functions of the coastal zone are shown for Ystad.

- **Agriculture and forestry:** As can be seen in Figure 6, agriculture is the main activity along the coast between Ystad and Löderups strandbad.
- **Tourism and recreation:** At the beaches of the built up areas, open-air life is predominant. This implies tourism and recreation, but not at a big scale, at the sandy beaches of Ystad.
- **Urbanisation:**
- **Industry:** Ystad is one of the seaports of Sweden on the southern Baltic coast. It's artificial harbour, which admits vessels drawing 19 ft., is freer from ice in winter than any other Swedish Baltic port. About 2,1 M ton of cargo 2,1 M ton is handled every year.
- **Nature conservation:** At Löderups Strandbad a nature reserve is located.

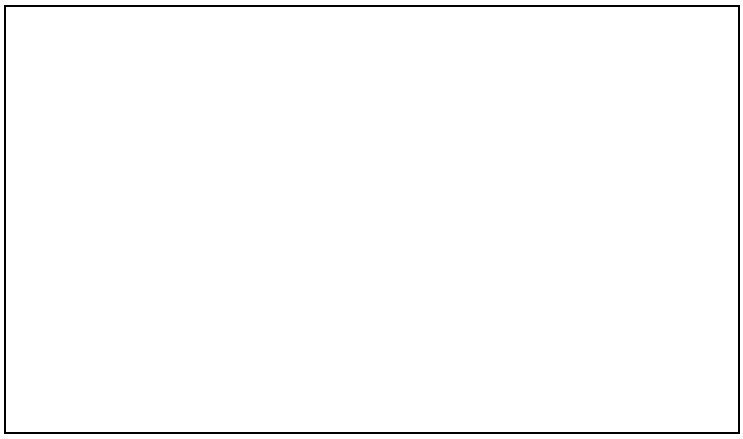


Fig. 6: Functions of the coastal zone at Ystad.

1.2.3 Land use

Along the coastal strip in Ystad Bay, the primary land use is agriculture, as can be seen in Figure 7. Along the eroding sites however, mainly built-up and recreational land use occurs.

Jordbruk, impediment m.m.= agriculture
Friuftsliv el. dyl.= open-air life
Bebyggelse m.m.= built-up area

Fig. 7: Land use in the case area Ystad.

1.2.4 Assessment of capital at risk

According to Bryant et al (1995), the coast at Ystad is at high risk.

- High: city or major port or > 150 persons/km2 or >150 m road/km2 or > 10 m pipeline/km2
- Moderate: 150 < persons/km2 > 75 and 150 < m road/km2 > 100 and 10 < m pipeline/km2 > 0
- Low: persons/km2 < 75 and m road/km2 < 100 and no pipelines

The population rate of 73 persons/km2 implies a low risk according to this classification; this is the risk for the entire municipality of Ystad. However, the risk for Ystad the town is high because the town is densely populated.

Fig. 8: Severe erosion at Ystad.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

In Figure 8, the eroding sites of Ystad municipality are shown. Three eroding areas are distinguished, from west to east:

1. East of water treatment plant
2. Hotel Saltsjöbaden – Sandskogen
3. Löderups Strandbad

Through the years these areas has been severely affected by erosion. The coastal line has eroded 1-1.5 m/year at average for the last 150 years.

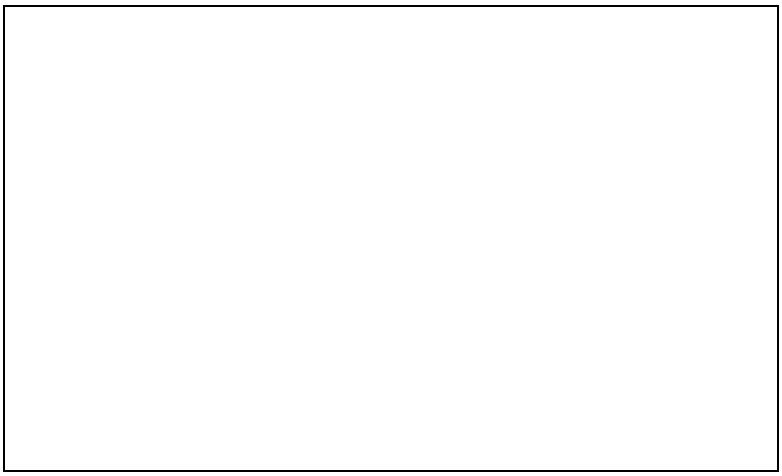


Fig. 9: Eroding sites in Ystad municipality.

2.2 Impacts

The erosion mainly affects urban areas and industry, and threatens human lives, property and investments. At Löderups strandbad recreational beaches are threatened.

3. SOLUTIONS / MEASURES

3.1 Policy options

Because of the threat to properties, human lives and investment the policy option at Ystad is "hold the line".

3.2 Strategy

After several decades of serious erosion along the southern coast of Sweden, the Swedish Environmental Protection Agency finally decided to support an effort by the local municipality Ystad in 1995 to halt the erosion. As a part of this project, a series of groins were constructed along the coast. Following this, the community asked the Department of Water Resources Engineering (TVRL) at Lund University to establish a camera monitoring system for the beach. As a part of this, the beach evolution outside the Löderups Camping is monitored by a video camera.

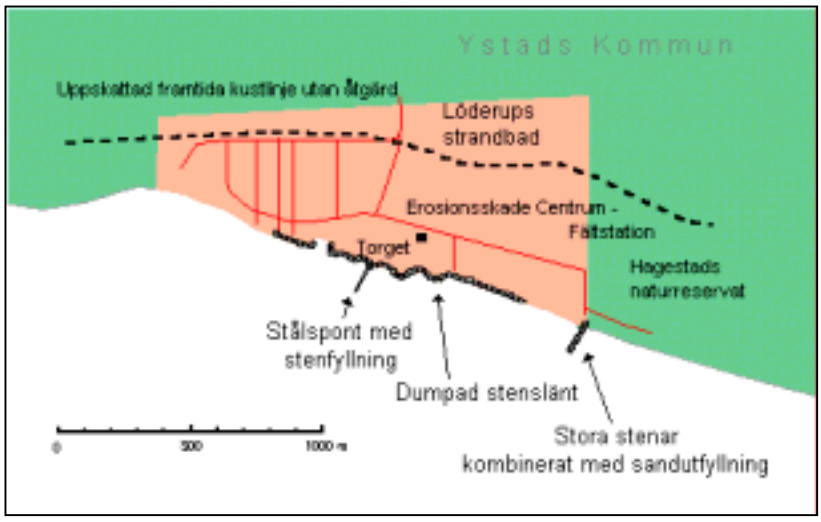
In general, in Sweden beach nourishments are very unusual for coastal protection. In these cases the volume of supplied material is of the order of a few thousands up to 15,000 m^3. In almost all coastal erosion cases, revetments or groynes have been used.

3.3 Technical measures

3.3.1 Type

- **Löderups Strandbad**

The taken measures at Löderups strandbad are shown in Figure 10. The net sediment transport is eastward at Löderups strandbad. In order to safeguard their plots, the owners in the area have dumped rocks/bricks along the coast since the 1950's. This has increased the depth in front of the rocks. Dumping still occurs but in much smaller scale. Furthermore, two groins were built in 1994 with a 800 m distance in between the groins. Another four groins



Uppskattad framtida kustlinje utan åtgärd *= estimated future coastline without measures*
Torget *= square*
Stålspont med stenfyllning *= groin with stone filling*
Dumpad stensläntt *= dumped stone slope*
Stora stenar kombinerat med sandutfyllning *= large stones combined with sand nourishment*
Hagestads naturreservat *=*

Fig. 10: Taken measures at erosion site Löderups strandbad, Ystad.

have been built in this area later on. The six groynes are part of a full-scale project. The purpose of this project is to protect the buildings and infrastructure in the areas. It is a research project and the project is financed by the Swedish Government, Ystad municipality and the "home owner society of Löderups strandbad". An independent group of experts are doing a '10 year follow up" of the project.

- **Sandskogen**

In Figure 11, the measures at Sandskogen are shown. The net sediment transport direction is eastward at Sandskogen. In front of the hotel at Saltsjobad a seawall with a length of about 300 m was built. The edge in front of the hotel is very steep and stones have been laid there to delay/mitigate further attacks.

Just east of the hotel four groynes with a length of 100 m were built during the 50's and 60's and in 1995 one additional groyne was established immediately east of the hotel. The coastline at the Jaktpaviljon street and Hackspett road is also an affected area because it is very flat and the dunes are sensitive. The dunes were strengthened by placing geo textile (armoring med Tensar Mat) and by planting vegetation in one section, and west of that a seawall was built with a length of about 1000 m.

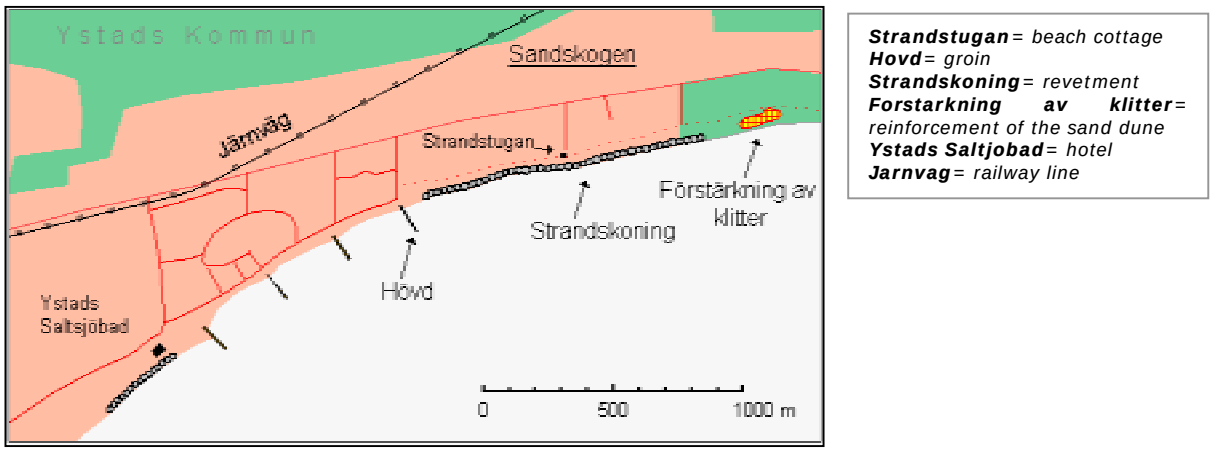


Fig. 11: Taken measures at erosion site Sandskogen, Ystad.

- **Water treatment plant**

In Figure 12, the taken measures east of the water treatment plant are shown. Ystad's main sewage drain has earlier been threatened to be destroyed and to avoid that a 200 m long seawall was erected. The measure was executed as a pilot project, various materials and construction types were used for the seawall. The three applied construction types are 1.- solid concrete (foreshore protection), 2- gabions (= net baskets with stone filling) and 3- concrete slabs attached, forming a net (=Flexiplattor). The purpose of this project is to see which material works best with nature. The project was partly funded by "Byggbranchens Utvecklingsfond" (The Building Society Development Fund). In front of the coastal protection slope, two smaller groynes have been built at an angle with the coast.

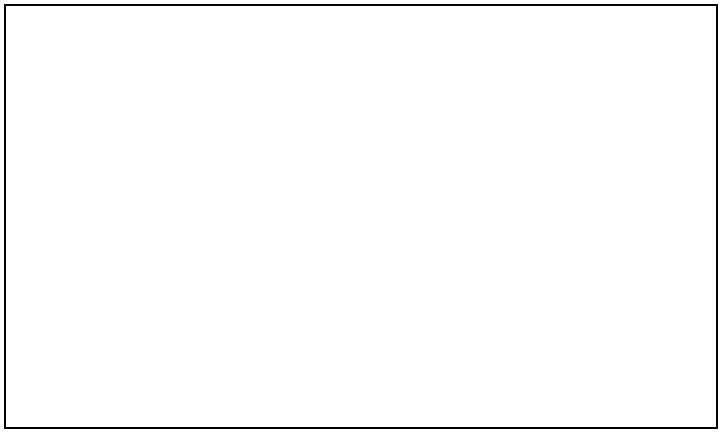


Fig. 12: Taken measures at erosion site Reningverket, Ystad.

3.3.2 Technical details

- **Loderups strandbad**

Seawall	approx. 700 m	rocks/ bricks
Groins	approx. 100 m	stones

- **Sandskogen**

Seawall	approx. 300 m	rock
Groins 100 m		stones
Seawall	1000 m	rock
Dune protection	-	vegetation and geotextile

- **Watertreatment plant**

Seawall	200 m	various (see previous)
Groins at an angle	-	rock

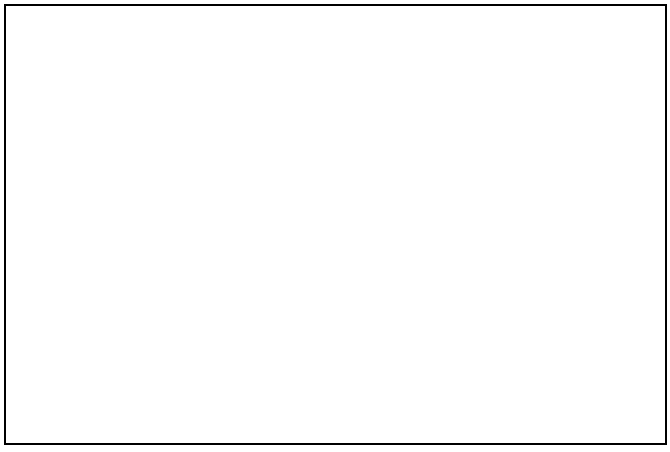


Fig. 13: Protection of dunes with geotextile at Sandskogen.

3.3.3 Costs

No information was found on costs of the applied coastal protection scheme.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

The dumping of rocks by the owners at Löderups Strandbad temporary saved the buildings. However, on the long run the (unprofessional) way in which the dumping had occurred resulted in much graver damages and more problems. However, the overall effect of the protection scheme at Ystad has been positive. In some areas the problem has been moved further downstream because only hard protections were applied.

4.2 Effects related to socio-economic aspects

The coastal protection scheme protects the beaches from being eroded and protects the safety of recreational facilities at the coast such as the hotel Saltsjobad, in this way the recreational value of the area is preserved.
Furthermore, the threatened built-up areas at Löderups Strandbad and Ystad are protected from erosion (land owners at the coastal strip were loosing their land) and from flooding by increasing the strength of the dunes.

4.3 Effects in neighbouring regions

Because only hard protection types were applied, the problem has been moved further downstream in some areas of the coastal protection scheme. However, in these areas the problems are less urgent because of the absence of important infrastructure or recreational facilities.

4.4 Relation with ICZM

In Sweden, coastal planning is mainly the responsibility of the municipalities, for some special sector planning the region or even national level can become responsible. The coordination of the different state sector interests in the physical plans of the municipalities however, is the responsibility of the County Administrative Board. The County Administrative Boards develop regional guidelines, and have to assure that national and regional policies will be considered in local planning. An Environmental Code was drawn up with the purpose to create a stronger environmental legislation. Furthermore, following the HELCOM recommendation 15/1 (protection of the coastal strip), a protected shoreline zone ranging 100 m inland and offshore is reserved for out-door recreation and nature protection and may be extended to 300 m if necessary. The planning control system is mainly restrictive; the state of implementation depends very much on the way these planning instruments are used.

In Sweden, on a national level fifteen national environmental quality objectives were adopted in 1999, these comprise “a balanced marine environment, sustainable coastal areas and archipelagos”. It says that sea and coast must have a high degree of biological diversity, opportunities for aesthetic experiences and natural and cultural values. Industrial activities and recreations shall be carried out in a way that promotes sustainable development.

Integrated coastal zone planning is in a very early stage in Sweden, increased environmental problems and conflicts between different interests in coastal areas led to experimental works

with integrated physical planning of sea and coast by the Swedish Marine Resources Commission and the Swedish Board of Housing, Building and Planning.

At the case area Ystad, especially the pilot project shows the influence of integrated coastal zone management. Several materials were used to find out which works best with nature. In following projects the conclusions of this pilot project could be used in the choice for a certain material.

4.5 Conclusions

Effectiveness

The purposes of the protection works along the Ystad coast have been different in different areas. Therefore the effects were different too. The purposes can be protection of infrastructure, hold the line and rebuilding of the sand dunes. The overall effect of the entire coastal protection scheme is positive in Ystad Bay, and the purposes were reached at the selected areas.

Possible undesirable effects

Outside the study area Ystad Bay, no undesirable effects were observed. Within the study area, locally the erosion has increased due to the hard measures in other places.

Gaps in information

No information was found on costs of the coastal protection scheme. Furthermore, little specific information is available on the effects of coastal protection measures; monitoring programmes on coastal protection schemes so far appear to be practically non-existent in Sweden.

5. REFERENCES

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Figures:

Figure 1: http://www.icm.noaa.gov/country/sweden.html
Figure 2: http://aqua.tvrl.lth.se/hh/atlas/
Figure 3: http://aqua.tvrl.lth.se/hh/atlas/
Figure 4: http://aqua.tvrl.lth.se/hh/atlas/
Figure 5: http://aqua.tvrl.lth.se/hh/atlas/
Figure 6: http://aqua.tvrl.lth.se/hh/atlas/
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Figure 8: http://www.ystad.se/Ystadweb.nsf/AllDocuments/5E9421ED3F7AD437C1256A37002D0327
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