



# Environmental control for the Sound fixed link – DK/SE

## 1. Policy Objective & Theme

- ADAPTATION TO RISK: Preventing and managing natural hazards and technological (human-made) hazards; Integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment

## 2. Key approaches

- Knowledge based
- Technical

## 3. Experiences that can be exchanged

One of the major challenges in constructing the fixed link was to ensure that the establishment of the link was performed in way that did not impair the environment in the Sound or the Baltic Sea. An efficient and comprehensive cooperation was established between the responsible Danish and Swedish Environmental Authorities at all levels, with one Authority in Denmark (The environmental Agency) and in Sweden (KSÖ) responsible for the daily management. Øresundsbro Konsortiet communicated and cooperated intensely with these entities. In order to fulfill the ecological criteria the consortium established a special environmental management system enabling an efficient control of the environmental performance during construction. T.

## 4. Overview of the case

The construction of the fixed link between Sweden and Denmark started in 1995 and was inaugurated and opened for traffic in 2000. The environmental considerations and management taken during the construction on the fixed link was a successful cooperation between Sweden and Denmark, managed by the Authorities and the owner company, Øresundsbro Konsortiet ("the Öresund Bridge consortium "). The owner consortium is a Swedish – Danish company owned to 50% by the Swedish state and 50% by the Danish state.

One of the major concerns expressed before the construction started was that the fixed link would affect the exchange of water and oxygen between the Kattegat and the Baltic Sea, which would affect the marine life in the Baltic. It was stated in the environmental criteria, that no impact on the water flow must occur, which meant that any impact due to the link proper had to be compensated by compensatory dredgings (the so-called zero solution). Assessments based on comprehensive hydrodynamic modeling was carried out and the final constructed link fulfilled the zero-solution, i.e. no hydrographic impacts on the Baltic. Monitoring of birds, water quality fish and benthic flora and fauna showed negative impacts during the construction phase but also a full recovery at the latest six months after the completion of the construction.

## 5. Context and Objectives

### a) Context

The Sound is part of the hydrographic link between Kattegat and the Baltic Sea, as approximately 30% of the water exchange between these two water bodies occur through the Sound. Due to the sensitive environment of the Baltic Sea any kind of limitation of the water flow may have huge impact on the marine life in the Baltic Sea. The Drogden - Limhamn sill stretches as an underwater ridge across the Öresund with an average water depth of only 8-10 meters. Early modeling showed that a fixed construction in this location would block the water flow by %. It was however stated by the Swedish and Danish authorities that the final link must only block the water flow with at most 0.5%, and that this blocking should be eliminated by compensatory dredgings, resulting in a 0% blockage (the zero-solution). The compensatory dredging was carried out at the slopes of the navigation channels.

## **b) Objectives**

The objectives of the environmental management system were primarily to register the environmental condition and to be able to take action if any parts of the on-going construction exceeded the pre-defined limits on environmental impact. After the completion of the construction the system should also register if the temporary effects on the marine environment abate as they were predicted to do.

## **6. Implementation of the ICZM Approach (i.e. management, tools, resources)**

### **a) Management**

The management of the environmental control for the Sound fixed link was implemented by the Øresundsbro Konsortiet and supervised by national, regional and local authorities from Sweden and Denmark.

### **b) ICZM tools**

The main part of the consortium's environment system was the implementation of the so called control and monitoring programs.

**Contractors spillage monitoring** – These obliged the contractors to measure the spillage from their construction work and the data was continuously reported to the consortium. Whenever the threshold limits were reached the consortium immediately stopped the work.

**Consortium's feedback monitoring** – Outside the construction areas the consortium carried out continuous monitoring of selected parameters that quickly reacts to dredging operations, such as eelgrass, mussels and spreading of sediment. Feedback in this case means that if the limits for environmental impact were exceeded construction would immediately be stopped or adjustments in the construction will be made. Computerized simulation models were also used as a part of the monitoring program in order to predict unwanted effects.

**Authorities' control and monitoring program** – Run by Swedish and Danish authorities before, during as well as after the completion of the construction. Began in 1995 and documented the extent of changes on the Sound environment. Furthermore, the program acted as an independent control of the monitoring performed by the Øresundsbro Konsortiet. The program consists of an annual survey assessing the following parameters: water quality, flora and fauna, fish, common mussels, birds and coastal morphology.

## **7. Cost and resources**

Complete costing is not available

## **8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)**

Already 6 months after completion of the construction works all environmental issues were unaffected or recovered to baseline conditions. The reason why the environmental management system functioned so well during the construction of the fixed link is to be found in the environmental awareness and the early start of the environmental investigations (5-6 years prior to the start of the construction). Proper baseline studies were made between 1992-1995 collecting data to understand the biological system in the Sound, and set up operational criteria for maximum acceptable impacts. Based on this the owner consortium drew up a detailed a work plan which complied with these criteria. They defined operational threshold values for acceptable sediment concentrations which then were used in the day to day work. For example, in order to not exceed these values, dredging in both channels (Drogden and Flinterånnen) was not allowed at the same time during winter and spring, since this could cause a risk of blocking of herring migration from the Sound to Rügen. Moreover, dredging in or close to eelgrass beds mainly took place during the winter instead of during the growth period in the summer.

## 9. Success and Fail factors

Sediments from the spillage during the dredging could potentially cause the main impact on the environment during the construction. The sediment shades the eelgrass from sunlight and also constrained the food uptake of the mussels. However most of it fell in the immediate surroundings of the dredging and some 10-15 km away from the construction site it was hardly detectable.

Monitoring of mussel populations and eelgrass populations revealed only small and insignificant impacts due to the construction works, and all populations had recovered only six months after the completion of the construction of the fixed link. The beds in the channel then looked as healthy as they did before the construction began. The bird populations at Saltholm showed temporary displacements away from the intense construction works, but no impacts on the population size, whereas a nearby population of harbour seals showed no sign of disturbance at all.

The hydrodynamic modelling using two independent 3 dimensional model systems confirmed that the final link did not impact the exchange of water, salt and oxygen between Kattegat and the Baltic Sea.

## 10. Unforeseen outcomes

None as yet

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## 13. Sources

Final environmental report on the fixed link across Öresund"; 2000, Ministry of Environment and Energy, Ministry of Traffic, Controllgroup on the Öresund fixed link

Mid-term report on the fixed link across Öresund"; 1996, Ministry of Environment and Energy, Ministry of Traffic, Controllgroup on the Öresund fixed link

## 14. Relevance for cross-border management of transitional waters

The Sound is the threshold between the Baltic Sea and the North Sea. It is only given certain meteorological situations that water of a high level of salinity from the Kattegatt is capable of passing over the shelf and into the Baltic. The Sound is a rather specific, yet critically important transitional water body linking the Baltic Sea with the North Sea. The construction of a mega-project of such a scale as the Sound fixed link over such a sensitive transitional water body triggered a lot of international attention. Therefore, the environmental control programme implemented during the construction period was well-designed and well-implemented. Hence, the relevance of the case study is high.