History and development of the Eastern Sheldt's project

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1. History and development of the Eastern Scheldt's project

The historical background

The storm surge barrier in the Eastern Scheldt is the last stage of a scheme to safeguard the delta region in the south-west of the Netherlands (Fig. 1). The immediate reason for undertaking this massive project was the disaster of 1 February 1953, when an area of 1,500 km² was flooded (Fig. 2) and 1,800 people were drowned. A further 70,000 people had to be evacuated and damage to property amounted to 1,500 million Dutch guilders.

The Delta Project

Three weeks after the disaster the Delta Commission was set up. Its terms of reference were to advise the Minister of Transport and Public Works on the problems of the Delta region. The work of the Commission resulted in the Delta Project, a highly ingenious and carefully conceived plan, which was formally approved by Parliament on 5 November 1957. The main objects of the Delta Project were:

1) to protect the countryside by strengthening the dykes along the entire Dutch coast and to shorten the coastline by damming the mouths of major inlets;
2) to combat the salinisation of the inlets and adjacent canals and thereby stimulate agricultural production (land reclamation was emphatically not an object of the scheme);
3) to develop new opportunities for recreation and tourism;
4) the construction of a new shipping route linking Antwerp and the Rhine.

In order to achieve these objects, it was intended to close all the tidal inlets except the New Waterway and the Western Scheldt. Furthermore, all the dykes along the Dutch coast, as well as those along waterways which were not to be dammed, were to be raised and strengthened. On completion of the project (scheduled for 1978), the coastline would be 700 km shorter.

A review of the work that has already been carried out gives some idea of the vast scope of the whole scheme. It consists of the damming of estuaries and inlets, the construction of auxiliary dams, improvements to the fresh-water regime, and the Antwerp-Rhine canal, or more specifically:

- the storm surge barrier in the Hollandsche Yssel 1958;
- the secondary dam in the Zandkreek 1960;
- the damming of the Veerse Gat 1961;
- the Grevelingen dam 1965;
- the damming of the Lauwerszee 1970;
- the Haringvliet dam with outlet sluices 1971;
- canalisation of the Neder-Rijn (Lower Rhine) 1970;
- the Brouwers dam 1972;
- and the outlet sluice in the Volkerat dam 1977.

The final project, the dam closing the mouth of the largest inlet, the Eastern Scheldt, was started in 1969.

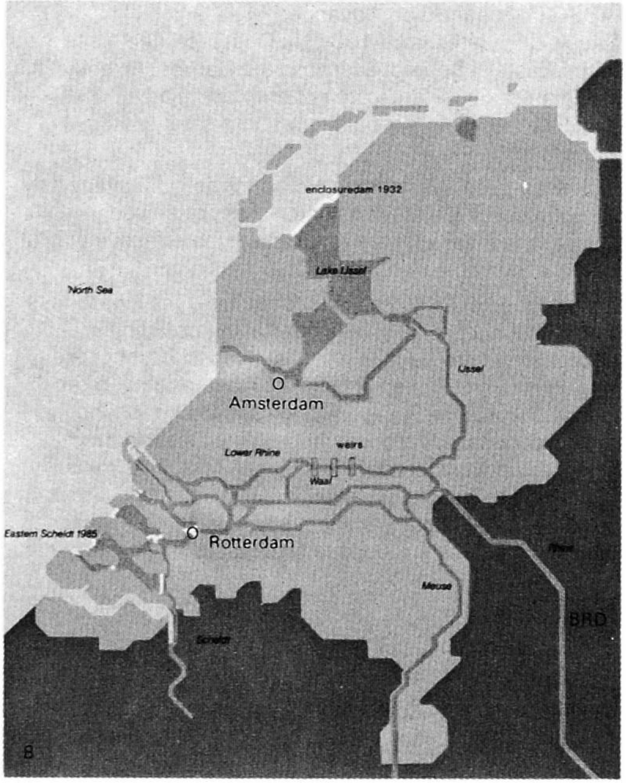

Fig. 1

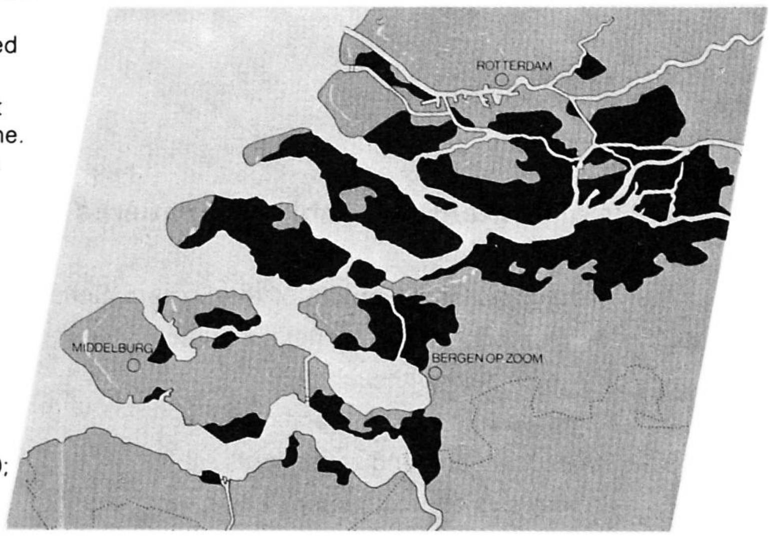

Fig. 2 Areas flooded in the 1953 disaster

The environment

From about 1967 onwards, a process of reassessment of the objectives of the Delta Project from various points of view was embarked upon. The environment in the widest sense of the term, became much more important than it had hitherto been: should one leave the Eastern Scheldt open for the sake of the environment or close it in the interests of safety?

After heated political, technical and emotional discussions and consultations with experts and government departments, the authorities took the decision – approved by the Lower House of Parliament on 20 November 1974 – to build a storm surge caisson dam, contingent upon three conditions:

1) the technical feasibility of the semi-open dam had to be established within 1.5 years;
2) the project was not to cost significantly more than 2000 million guilders over and above the cost of permanent barrier across the estuary;
3) the storm surge caisson dam had to be operational by 1985.

In order to answer the questions posed by these conditions, the Rijkswaterstaat was instructed to undertake a study and to present a report within 1.5 years. The "Blue Paper", as it is known, was published in May 1976, and on 23 June 1976 the final decision was made, still subject to fulfilment of the above conditions. The over-all cost of the project was now fixed at 4,265 million guilders, including secondary dams and partial raising of dykes, at 1976 prices.

The storm surge barrier

The basic principle of the storm surge barrier is that it will be left open under normal conditions. If very high water levels are predicted (the limit level exceeded on average once every two years) the barrier will be closed in about 1 hour, either as the tide turns or while it is running.

The principle is technically attractive, but there are a number of objections to it; human shortcomings, meteorological surprises and the desirability of maintaining water levels in the tidal basin for environmental reasons necessitate allowing for the possibility of opening and closing the barrier while the tide is running. This also creates a certain amount of room for manoeuvre since the barrier can also be closed in response to other contingencies such as offshore oil pollution, overtopping of the structure by waves, leakage, and in anticipation of predicted and actual water levels. With this design the risk that the barrier will be closed in circumstances that are not necessary, it is therefore very slight.

Compartmenting and flow cross-sections

One of the aims of the present scheme is to preserve the existing ecosystem of the Eastern Scheldt and to interfere as little as possible with tidal movements, currents, salt content and the temperature of the water.

The storm surge barrier and the compartment dams should be viewed as the parts of a whole. Apart from the fact that the two aspects interact and influence one another, there is the further consideration that tidal movement in part of the area will entirely cease a result of the compartment dams, while in the rest of the area the horizontal component of tidal movement and flow will be influenced.

The compartment dams are necessary to protect the Scheldt-Rhine route from tidal movement and to form a basin of relatively fresh water (Lake Zoom) between the salt Eastern Scheldt and the fresh water Haringvliet estuary. From among a number of alternative schemes, the "C3 model" was selected (Fig. 3) involving the construction of: the Oester dam extending from Tholen to Zuid-Beveland and containing a lift lock; an outfall in the Western Scheldt; the Philips dam between St. Philipsland and the Grevelingen dam comprising two sets of twin locks, for push-propelled barges and for yachts respectively; a siphon in the Grevelingen, dam; development of the canal through Zuid-Beveland.

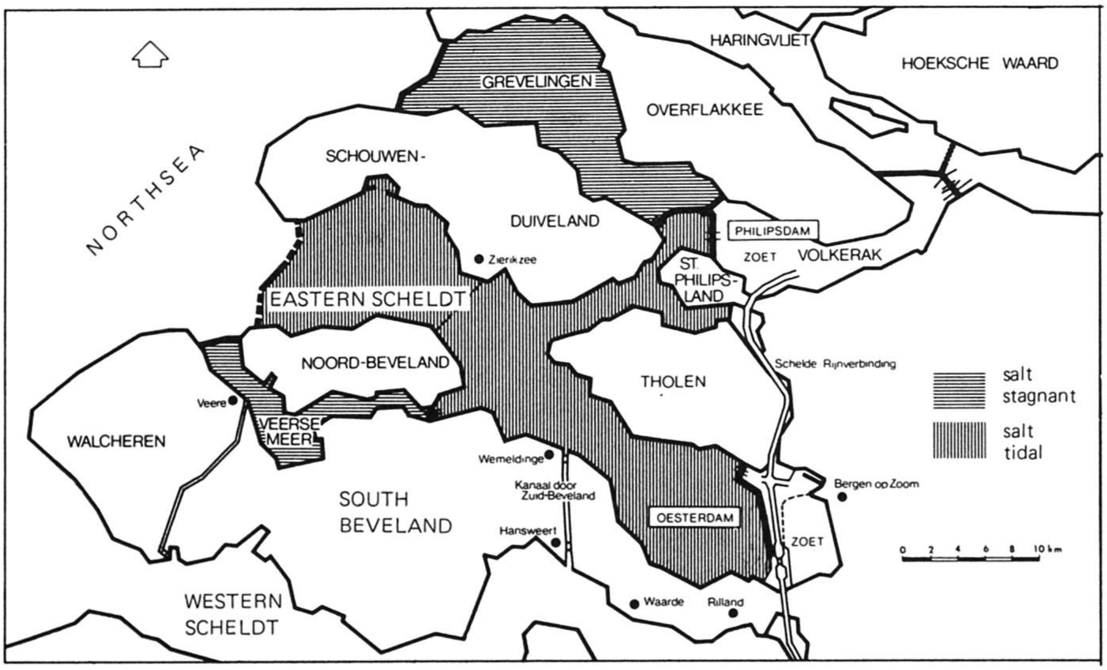

Fig. 3 Modified Delta Project

The latter means that the canal will communicate directly with the Eastern Scheldt. All the navigation locks in the compartment dams are to be provided with a salt water/ fresh water separation system. The dams should be completed at the same time as the storm surge barrier, since they directly affect its flow cross-section. Three flow cross-section variants were investigated. The differences between them are relatively minor, though it should be noted that the variant with the largest flow cross-section will cause the least change in existing conditions, but is the most expensive.

In September 1977 the flow cross-section, i.e. the cross-sectional area available for discharge of water through the openings of the barrier, was officially fixed at 14,000 m^2, with scope for some future increase should it prove necessary. An effective cross-section of 14,000 m^2 means a cross-section of 18,000 m^2, because some reduction due to the coefficient of discharge of the openings (1,500 m^2), maintenance work on gates (1,000 m^2), and inaccuracies in the hydraulic model test results, etc. (1,500 m^2). The discharge passage of the barrier is adapted as closely as possible to the cross-sectional features of the existing tidal flow channels, Hammen, Schaar van Roggenplaat and Roompot.

The ecosystem

Because the existing ecosystem has not yet been properly recorded, the effects of the storm surge barrier and the compartment dams upon the environment can be measured only in a limited number of ways, namely the fate of the mud flats, the environmental effects of the restriction of the intertidal zone, changes in the salt content and sedimentation in the basin.

As a result of the reduction of vertical tide movement, the frequency with which the mud flats will be flooded at various levels will decrease. This will mean changes from vegetation with a lower tolerance. The existing mud flats, which used to be "saltings", will undergo desalinisation. The probability that new mud flats will develop in front of them is slight, because with reduced tidal movement, and as a consequence of locally generated wave action in a smaller intertidal area, the rate of wave attack and sediment transport is likely to increase rather than decrease.

Furthermore, the annually available quantity of biomass in the form of bottom-dwelling creatures and underwater plants (which together determine food supplies for birds and fish) will diminish as a result of the reduction of the intertidal area. To begin with, the biomass is expected to decrease as a result of the smaller tidal range, but it should subsequently increase when lower flow velocities create greater silt sedimentation and thus a higher level of organic nutrients in the silt.

It is not yet clear whether this will affect the number of species comprising the ecosystem.

A reduction of the horizontal tidal movements (currents) affects the organisms suspended in the water (plankton) of bottom-dwelling creatures which need a regular flow of water to keep them supplied with food and to carry away their waste products. It has been worked out that a tidal range corresponding to not less than 2.3 m at Yerseke is necessary for shellfish farming to fulfil this requirement.

Sedimentation in the top 10 m of water is permissible, provided that it remains below a rate of about 10 cm per year. Another factor that will affect the existing range of species is that fresh water introduced into the salt basin will not now mingle so readily with the salt water as it used to before. Thus, if the salt content can be maintained at not less than 15.5 g Cl/litre (which is expected to be the case), there will be no appreciable desalinisation and the number of species – plants, squids, fish, reptiles, amphibians and mammals – is likely to remain approximately the same or even increase somewhat.

Under present circumstances, erosion is the dominant factor which determines the morphological character of the Eastern Scheldt basin as a whole. Seawards from the mouth, a further extension of the underwater delta is in progress (sedimentation). It is expected that, in consequence of the reduction in tidal volume, some levelling of channels and sandbanks will occur, though this will not have any effect on water levels in the long run.

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