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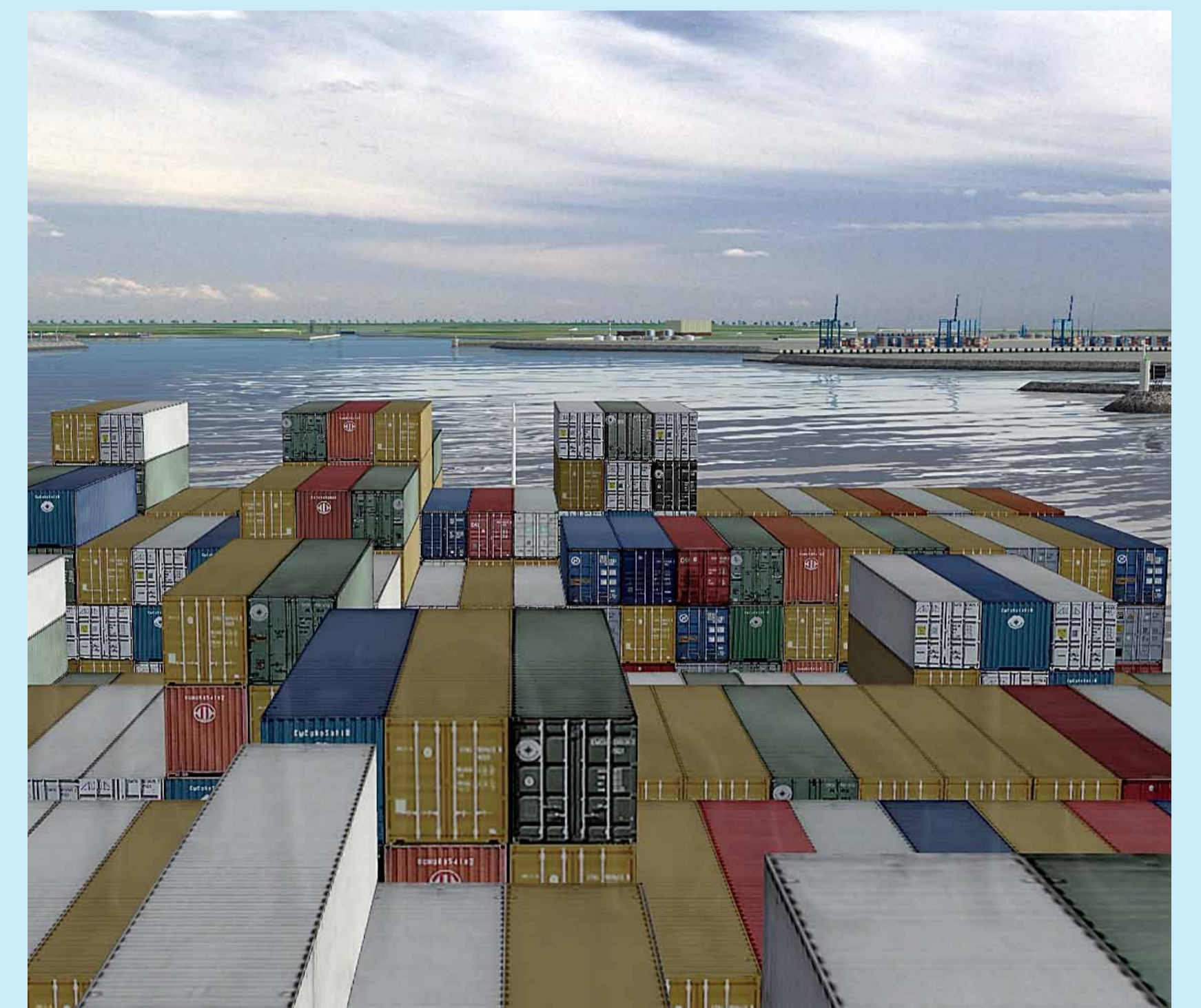
## Introduction

During the previous years a lot of efforts were undertaken by the Flemish government to improve the accessibility of the port of Zeebrugge. This has resulted in the current situation in which the port is accessible for ships with a draught up to 16,0 m. However the inbound sailing window for these large container ships is restricted to a couple of hours a day.

# Optimising the maritime access to the port of Zeebrugge: example of a large multi-tool study



Aerial photo of the port of Zeebrugge, located at the Belgian coast



View on the port of Zeebrugge from a containership entering the port (picture from the ship manoeuvring simulator)

## Problems to cope with

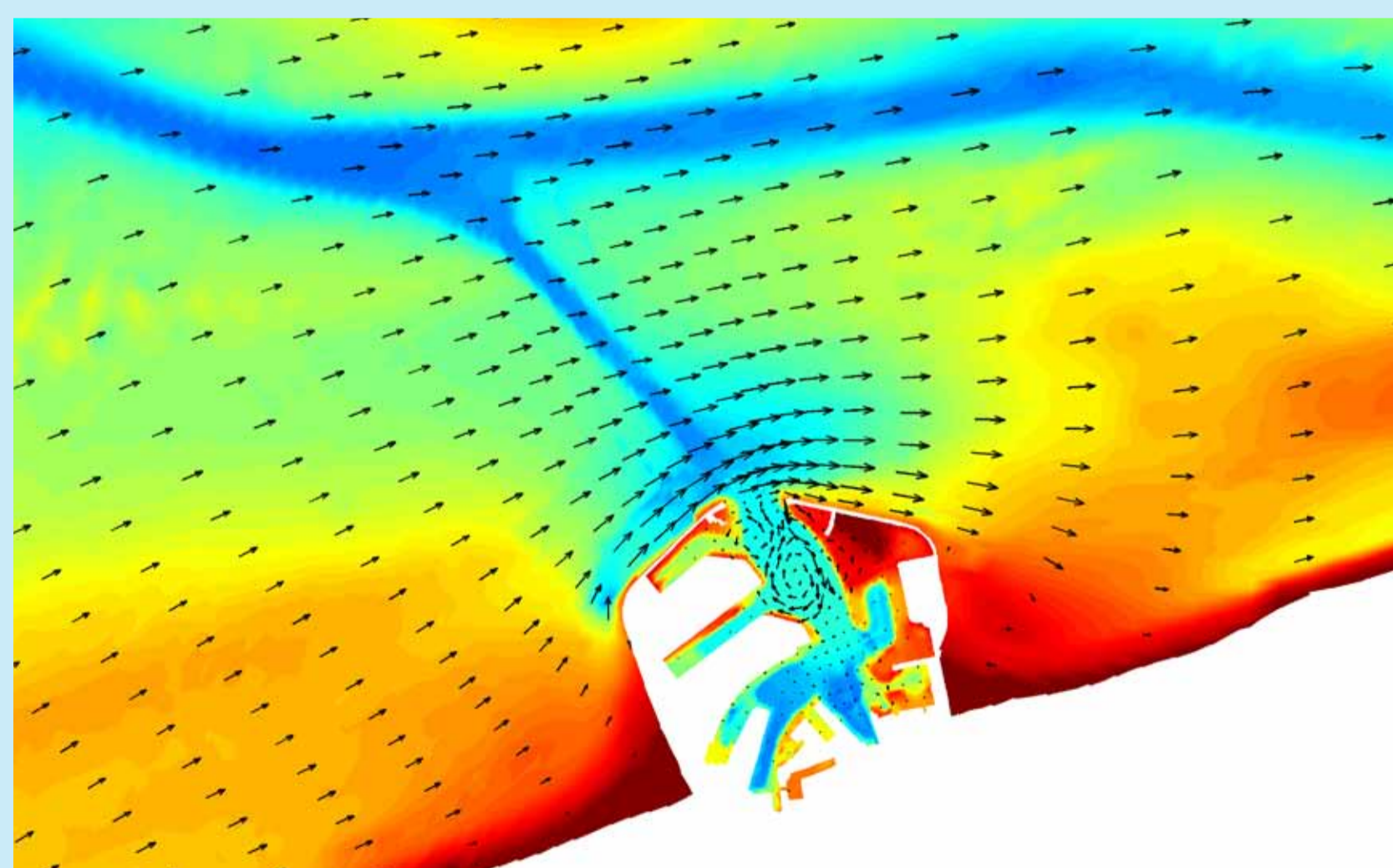
There are 2 problems which cause the rather limited inbound sailing window for large container ships. The first problem is the strong flood flow in front of the harbour mouth of Zeebrugge. As a result of this strong flood flow, the ships sailing in the navigation channel Pas van het Zand to the port of Zeebrugge experience a rather strong side current. Around high water the side current is so strong that these ships are not able to enter the port safely.

## Large multi-tool study

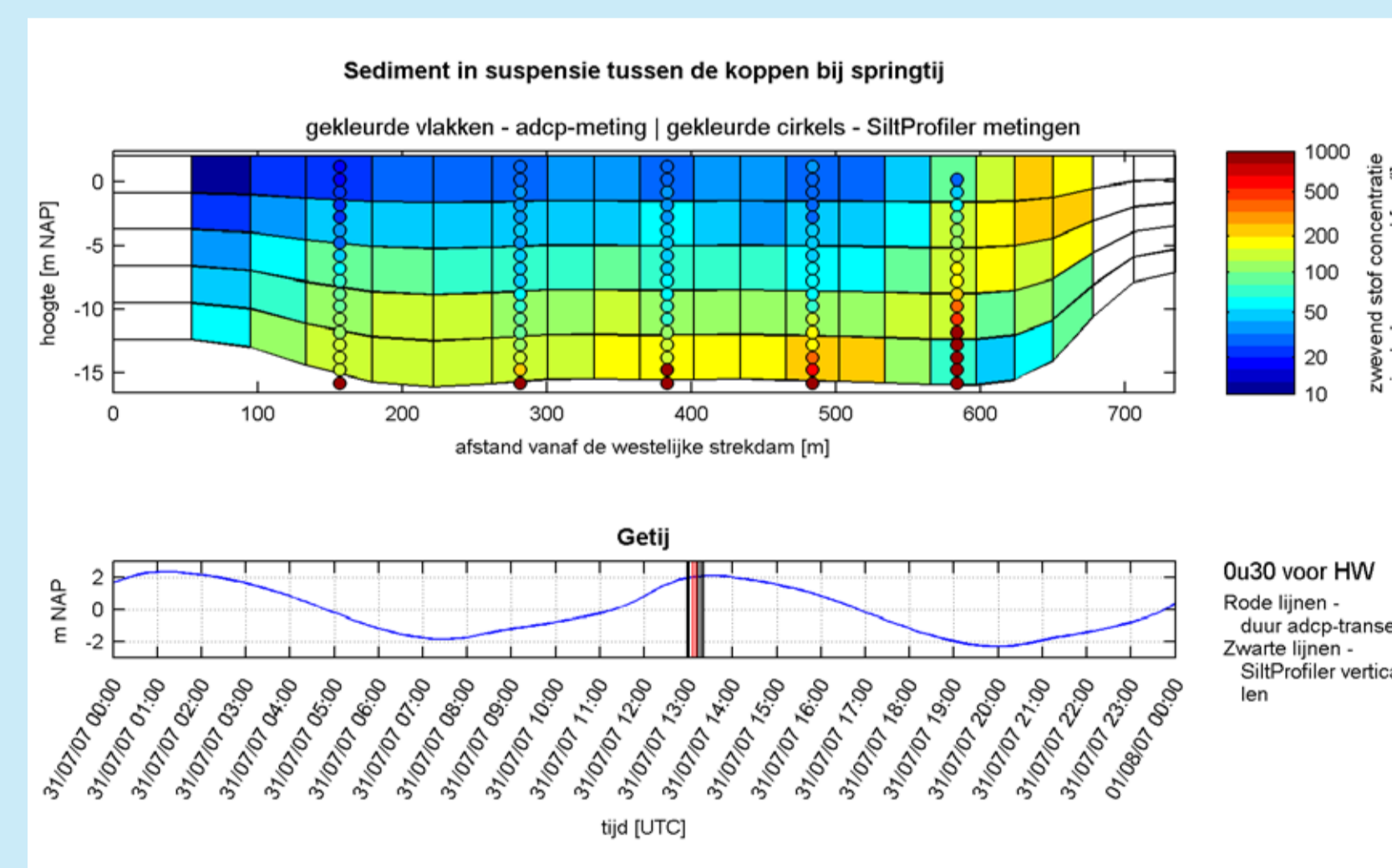
The Maritime Access division – division of the Flemish government responsible for the dredging works – asked the researchers of Flanders Hydraulics Research to set up a study on the optimization of the maritime access to the port of Zeebrugge. In order to investigate this difficult issue, a multi-tool approach was suggested including field measurements, a physical scale model, a numerical model as well as the ship manoeuvring simulator of Flanders Hydraulics Research.

## Conclusion

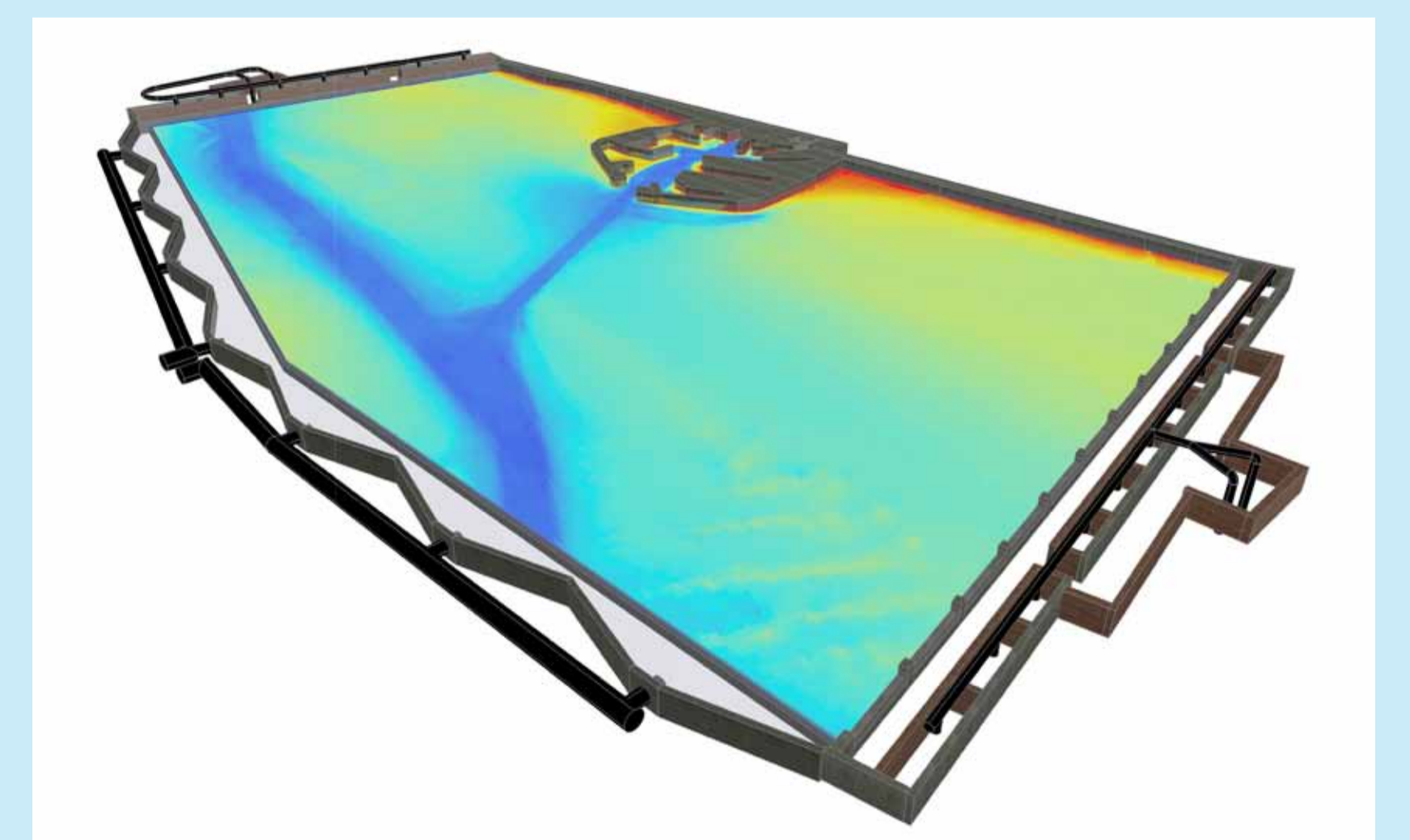
At Flanders Hydraulics Research a multi-tool study is set up to try to improve the accessibility of the Port of Zeebrugge for large container ships. By combining different tools the researchers hope to be able to find a measure to decrease the side currents at the mouth of the harbour. In meantime a reduction of the sediment inflow - and thus a reduction of the maintenance dredging works - in the harbour is targeted.



Flow velocities during maximum flood (result of numerical model)



Analysis of sediment transport measurements at the harbour mouth



3D picture of the Zeebrugge scale model, under construction at Flanders Hydraulics Research

A second problem is the fluid mud layer in the harbour itself. Every tide a huge amount of mud in suspension enters the harbour and will settle there. This process has resulted in a fluid mud layer in the harbour with a thickness of a couple of meters. As a consequence of this layer it is not possible to guarantee the necessary draught at any time and at any location.

While the large scale model (approximately 75 m x 30 m) is being built at Flanders Hydraulics Research, the numerical model has been calibrated. Combining the in situ measurements and the numerical model, the water and sediment exchange at the mouth of the harbour of Zeebrugge has been analysed. And last but not least the experience of the pilots will also be included in this study using the ship manoeuvring simulator.