MIKE BY DHI CASE STORY

OPTIMISING COASTAL AQUACULTURE OPERATIONS

Using integrated coastal modelling to assess water renewal strategies

The Oualidia Lagoon, located on the Atlantic shores of Morocco, is a shallow 10 km long tidal estuary and the home of oyster aquaculture. However, increasingly poor water quality is threatening the oyster production. The area experienced insufficient water renewal in the upstream section of the lagoon causing the oyster aquaculture production to suffer. Hydrosoft S.A. was contracted to examine possible water renewal strategies for the lagoon. They chose to apply MIKE by DHI hydrodynamic modelling software, which enabled them to reach the conclusion of removing the upstream dike and thus improving the aquaculture environment.

ASSESSING WATER RENEWAL METHODS

In order to support prosperous oyster aquaculture production, a number of conditions are essential such as water quality, temperature, salinity levels and currents. Thus, when the water quality deteriorate due to insufficient water renewal, the oyster aquaculture production suffers.

In order to remedy the insufficient water renewal, the Moroccan Ministry of Transport funded a study. It was carried out by Hydrosoft S.A. (Quebec, Canada), Roundel Hydrographic Ltd. (Greece) and University of El-Jedida (Morocco). The aim of this study was to examine two possible scenarios:

- removing an upstream dike separating salt ponds from the rest of the lagoon
- regular dredging to increase the depth of water circulation channels within the sandy flood delta at the downstream end of the lagoon

The Qualidia Lagoon. © Hydrosoft S.A.

SUMMARY

CLIENT

- Hydrosoft S.A.
- Moroccan Ministry of Transport

CHALLENGE

- Insufficient water renewal in the upstream section of the lagoon
- Consequent reduction in oyster aquaculture production

SOLUTION

A coupled hydrodynamic, advection-dispersion and mud transport model to evaluate strategies for improving upstream water renewal.

VALUE

- Availability of water renewal options to protect and facilitate oyster aquaculture
- Insight into the factors and conditions that impede aquaculture in order to choose the proper remediation strategy

LOCATION/COUNTRY

Morocco

SOFTWARE USED

- MIKE 21

MARKET AREA

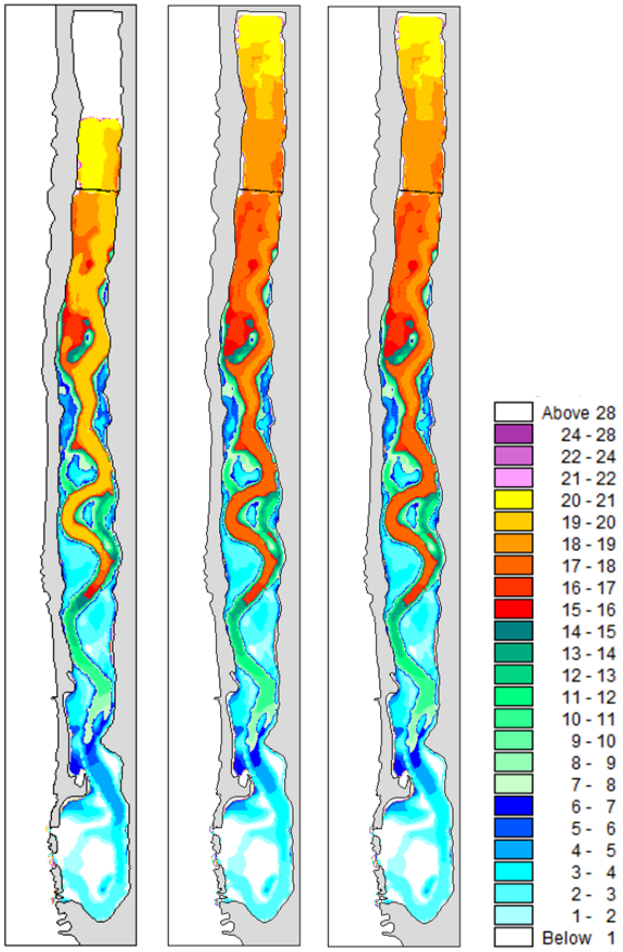
Coast and sea

INTEGRATED HYDRODYNAMIC MODELLING

Hydrosoft chose MIKE 21 software to develop a coupled hydrodynamic, advection-dispersion and mud transport model to study the following within the lagoon:

- salt transport
- heat transport
- mud transport
- water renewal

In addition, they applied a coupled hydrodynamic, wave, advection-dispersion and sediment transport models to study the effects of increased channel depth in the flood delta channels.



Local water renewal times in days for actual conditions (left), proposed removal of upstream dike (center) and proposed dredging of flood delta circulation channels (right) © DHI / Hydrosoft S.A.

The models were calibrated against two-month long series of currents, water levels, salinity and temperature. These were measured at four different locations inside the lagoon. Also, waves at the entrance were calibrated against wave measurements of the same duration.

For each of the two mitigation scenarios above, two-dimensional water renewal maps were produced and compared. Hydrosoft S.A. did this by using their own numerical Eulerian dissolved-tracer dispersion method.

FLOOD DOMINANCE IN QUALIDIA LAGOON

Harmonic analysis of sea level 2D time series results indicated that the ratio of M4/M2 tidal harmonic amplitudes increases above 0.25 in the upstream region and the phase lag differences 2 x phase M2 - phase M4 remain between 0o and 180o. This indicates that the lagoon is flood dominated, especially in the upstream region.

In this case, flood currents are stronger and shorter than ebb currents and as a consequence, net mud transport is directed upstream. In a previous study, Hydrosoft SA suggested the dredging of a mud pit upstream. The pit was built and the upstream mud is being trapped.

INCREASING WATER RENEWAL BY REMOVING EXISTING UPSTREAM DIKE

The main findings of this study indicate that removing the upstream dike would increase the tidal prism and slightly reduce upstream tidal asymmetry, mud transport and water renewal (see figure on the left). The alternative of dredging the circulation channels in the flood delta would greatly reduce the upstream renewal time, mud transport and tidal asymmetry. However, this would only be possible during very specific wave and sand transport conditions. In conclusion, it was recommended that the upstream dike was completely removed to increase water renewal.

FURTHER STUDY: FLOOD DELTA MORPHOLOGY

In case the renewal rate remains insufficient after a few years, the circulation channels in the flood delta could be dredged to increased depths. However, this is only possible if a longer-term study of the flood delta morphology reveals that it is safe to do so.

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