Popular science summary-Modelling water exchange in the Flommen Lagoon

Water quality is very important for the ecosystem in a lagoon. Water quality in the Flommen Lagoon is typically depends on the water exchange between the lagoon and the sea because there is no river or drainage flow is discharged into this lagoon and the volume of rainwater is small enough to be neglected. There is one inlet between the sea and the Flommen Lagoon through which water can be exchanged. Therefore, the inlet properties determine the water exchange rate.

The inlet properties are influenced by different physical processes. One is the longshore sediment transport and regular dredging of the inlet channel. When sand accumulate around the inlet, the inlet cross-section area is reduced, and less water can be exchanged. Another physical process is the operation of the sluice gate. The sluice gate on the inlet was constructed to protect the area from flooding. It allows water flow in and out if water level is above -0.35 m. When sea level is above 0.5 m, it is closed to avoid large inflow from the sea to the lagoon. While the sluice gate decreases the threaten from flooding, it may also decrease the water exchange rate. In order to increase the water exchange rate, the possibility of constructing a second inlet is also of interest.

In order to study the influence of these processes, a model was build using MATLAB code to simulate the water level and water exchange in the Flommen Lagoon. In this model, inlet properties, the operation of the sluice gate and the construction of a second inlet can be controlled by simply changing the value of some parameters.

According to the result from this study, 61000 m^3 sand is transported to the inlet per year from the south, while 13000 m^3 transported away to the north by waves. The surplus of sand tends to accumulate around the inlet and increase the tendency towards inlet closure. Unlike expected, inlet geometry has no significant influence on the water level in the lagoon, but it will significantly influence the water exchange rate. For the simulated time period, halve the cross-section area decreases the gross water exchange rate by 40% and double cross-section area increases it by 15%. The sluice gate reduces water exchange. Without the sluice gate, gross water exchange rate is 30% larger than with the gate under operation. The sluice gate also deceases the threaten of flooding in adjacent areas when extreme event happens. Without the gate, the golf courses around the lagoon will be totally flooded if an event with a return period of 100-year happens. The sluice decreases gross water exchange rate by 31.6%, but it plays an important role in protecting the golf courses around the lagoon from flooding. With two inlets, gross water exchange rate is 15.3% higher than with one inlet, and water level is also slighter higher.

This study provides the municipality with a reference for the operation of the sluice gate and the regular dredging of the inlet channel. It can also be used as a guideline if a second inlet is to be constructed in the future.