Coastal modelling of Liepaja port-lake system

Vilnis Frishfelds, Uldis Bethers, Juris Sennikovs, Andrejs Timuhins

Faculty of Physics and Mathematics, University of Latvia
Sea bathimetry at port

Bathimetry of Baltic proper from EMODnet, but Latvian data are bad there. Depth increased by few meters for better agreement with port bathimetry and coastline at Liepaja.
Port and lake bathimetry

Lake bathimetry rather approximate from available countourlines
Non-nested HBM setup

Resolution 22 m

Water level, temperature, salinity at gates from LU_HBM Baltic sea operational model
Ice jam in the channel
Nested HBM setup

1 nm resolution Baltic proper

30 m resolution port and channels

Boundary data from LU_HBM, DMI.
Weather forcing: DMI HIRLAM

60 m resolution lake
Observations

Automatic, hourly: water level, run-off, temperature

Manual, daily: sea surface temperature, salinity

Liepaja meteorological station

Automatic, hourly: water level, temperature

Automatic, hourly: water level, temperature. Occasionally: run-off
Barta hourly river discharge and temperature

Yearly average ~12 m³/s  ~ 20 km from Liepaja lake

From rating curve and water level in river, we get hourly river run-off. Hourly data also for inlet temperature.
Salinity, temperature

October 18, 2017
Inflow events

October 6, 2017

Currents exceeding 1 m/s in the channel
Water level at channel and lake

RMSE ~ 3 cm
Run off though the channel
Run-offs through gates

N

S

N

M

S

More inflow

More outflow

Discharge, m³/s

Calc.North_gate(+)
Calc.North_gate(-)
Calc.North_gate(tot)

Calc.South_gate(+)
Calc.South_gate(-)
Calc.South_gate(tot)

2017-09-14 2017-09-21 2017-09-28 2017-10-05 2017-10-12 2017-10-19

2017-09-14 2017-09-21 2017-09-28 2017-10-05 2017-10-12 2017-10-19
Conclusions

- Nearly a week of simulation period is required to reach a stationary salinity distribution in the port.
- Inlet currents in the port are improved by using nested setup.
- Hydrodynamic resistance of the channels can be fitted by adjusting its bottom friction factor.
- Predominant inflows occur through the southern gate and outflow through the northern gate according to predominant directions of wind and currents.
- There is less agreement in stormy events, when waves and long-shore currents have to be accounted.
- Wetlands have to be accounted in case of high water level in the lake.
- Both model and observations show that there are Helmholtz oscillations (seiches) of water level in the lake with roughly 10-12 hours:

\[ \text{Period} = 2\pi \sqrt{\frac{L_{ch} A_{lake}}{g A_{ch}}} \]