

Integrated water resources and coastal zone management in European lagoons in the context of climate change



Project partners

- University of Aveiro (PT)
- Bioforsk- Norwegian Institute for Agricultural and Environmental Research (NO)
- Institute of Hydro-Engineering of the Polish Academy of Sciences (PL)
- Atlantic Branch of P. P. Shirshov Institute of Oceanology of Russian Academy of Sciences (RU)
- National Marine Fisheries Research Institute in Gdynia (PL)
- University of Dundee (UK)
- Odessa State Environmental University (UA)
- Potsdam Institute for Climate Impact Research (DE)
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Case study – Vistula Lagoon (Poland-Russia)

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Description of physical conditions (lagoon and drainage basin)

Vistula Lagoon (Fig. 1) is one of the largest inner marine water basin in Europe (second after Curonian Lagoon in the Baltic Sea) of an area 838 km² and a drainage basin of 23,870 km².



Fig. 1 Location of the Vistula Lagoon and main discharging rivers.

It is shared by one EU-state (Poland) and one non-EU state (Russia). 473 km² belongs to Russia, and the remaining part to Poland. It has the single inlet – the Baltiysk Strait, located on the Russian part of

the lagoon. The lagoon has an elongated shape, going from south-west to north-east, with a length of 91 km. The average width of the lagoon is about 9 km, at the widest point - 13 km. The length of the coastline is of about 270 km, and the volume of water in the Lagoon is about 2.3 km³. It is a shallow coastal ecosystem. The average depth of the lagoon is 2.7 m, and the maximum natural depth is 5.2 m close to the Baltiysk Strait.

The Vistula Lagoon is separated from the Baltic Sea by the Vistula Spit - a sandy peninsula 55 km long. The lagoon exchanges water with the Gulf of Gdansk of the Baltic Sea through the Baltiysk Strait, which has a width of approximately 400 m, length of two kilometres and the average depth of 8.8 m.

Navigation channel continues from the Baltiysk Strait up to the harbour of Kaliningrad and it is twice deeper than the largest natural depth in the lagoon. Despite its relative narrowness, it plays an important role as a way of salt transport from the Baltic Sea to the lagoon.

With respect to salinity the Vistula Lagoon is found to be a transitional area. The average salinity (1950 - 1965) for the eastern part of the lagoon (spring-autumn) is 2.5-4.3 PSU, for the central part 3.9-5.0 PSU, and for the southern part 1.0-3.4 PSU. This is a result of salt water inflows from the Baltic Sea that influence all aquatic areas of the lagoon, including the mouth of the Pregola River, the largest river in the catchment. At the Baltiysk Strait salinity may reach 7 PSU.

The catchment area of the Vistula Lagoon is 23,871 km² and the average retention time due to the river drain is about 6-7 months. There are more than 20 rivers discharging directly to the Vistula Lagoon. Among them the most important are: Pregola, Elbląg, Pasłęka, Nogat, Prokhladnaya, Mamonovka, Bauda, Primorskaya and Szarpawa (Fig. 1). The main part of the annual fresh water inflow (41%) is coming from the Pregola River.

Usually, the Vistula Lagoon is covered by ice during several months. In coldest years permanent ice stays in the lagoon from December to March. In warmest ones this period is very short, or even no permanent ice cover is observed. Due to recent climate changes regular ice coverage of the lagoon is not stable in time, and become fractioned in space. This means great changes in ecosystem functioning, as ice period, when wind influence is blocked and ice accumulates air pollution, promotes active self-cleaning of the lagoon waters at least during part of the year (Chubarenko, 2008).

Main water management problems (ecological/environmental, social, economical etc)

The horizontal distribution of water quality parameters in the Vistula Lagoon is strongly influenced by hydrological and meteorological factors, one of the most important of which is the exchange of water masses between the Gulf of Gdańsk and the lagoon. As a consequence, the area close to the Baltiysk Strait is "washed-out" and the concentrations of nutrients in this area are lower in comparison with those in remote parts of the lagoon. The high internal potential for eutrophication is caused by significant sources of nitrogen and phosphorus that have accumulated in the sediments and are released from them. Light and nutrient availability are the most important parameters controlling primary production. The average annual production in the Polish and the Russian parts of the lagoon was estimated at 300 and 180 gC m⁻² year⁻¹, respectively. Phytoplankton growth is limited mainly by nitrogen. Phosphorus limitation is only observed during early spring (Chubarenko, Margonski, 2008).

- Eutrophication is among the most important environmental problems.
- Recycling of nutrients from sediments is most probably responsible for a limited response of the water quality to nutrient load reduction.
- Increase of salinity occurs due to the continuous dredging of the Baltiysk Strait and salt intrusions upstream the Pregola River occur during wind surges, which cause temporary problems with supply of drinking water to Kaliningrad.

- Overuse of the Polish part of the Vistula Spit for recreational purposes during the summer season beyond the carrying capacity of resources is observed.
- Fishing pressure.
- Alien species appearance.
- There is danger of flooding of low-lying areas due to poor technical condition of anti-flood and drainage infrastructure.

Economical problems (based on the Polish part) are the results of:

- high level of unemployment,
- small size of farms with relatively low profit potential;
- unused tourism potential of the lagoon due to poor water quality;
- shrinkage of commercial fishing activity due to water quality and overexploitation;
- and the loss of historical role of Elblag city as a marine harbour.

Loss of working places in the fishery sector, low activity in development of tourism, recreation and aquaculture are the main problems for the Russian part of the lagoon.

Most of the problems are of the internal origin (unemployment, eutrophication, overexploitation of resources). Only some of them are caused by a limited transboundary cooperation. Definitely, both parts of the lagoon could benefit from strengthening of the transboundary cooperation.

End users

Polish end users:

- Regional Water Management Board in Gdansk and Warsaw
- Environmental Inspection in Olsztyn
- Environmental Inspection in Gdansk
- Office of the Warmian-Mazurian Region President
- Institute of Meteorology and Water Management
- Municipal Union of Communes Located at the Vistula Lagoon
- Association of Baltic Coastal Towns and Communes
- Maritime Office in Gdynia
- District of Elblag
- Euroregion Baltic
- Ministry of the Environment
- Sea Fisheries Inspectorate in Gdynia

Russian end users:

- Maritime Inspectorate and Baltic Directorate on Marine Inspection,
- Russian Nature Protection Inspectorate (ROSPRIRODNADZOR)
- Agency for Nature Protection of Kaliningrad Oblast.
- Kaliningrad Centre for Hydrometeorology and Environmental Monitoring
- Administration of Harbour Kaliningrad and ROSMORPORT Shipping Co
- Municipal authorities (Kaliningrad, Baltiysk, Svetly, Mamonovo, Ladushkin)
- Euroregion Baltic

Case study objectives

- Modelling of changes in water quality and eutrophication level due to different climate change and socio-economic scenarios.

- Evaluation of salinization level in the Vistula Lagoon as an effect of expected water level rise and intensification of water exchange with the Gulf of Gdansk based on proposed scenarios.
- Evaluation of possible increase of low-lying areas flooding risk due to climate change based on proposed scenarios.
- Evaluation of possible increase of salt intrusions upstream the Pregola River due to climate change based on proposed scenarios.
- Consequences of selected scenarios on fish assemblages as well as on fisheries activities will be evaluated.

References

- Chubarenko, B., Margonski, P. The Vistula Lagoon. [In] U. Schiewer (ed.) Ecology of Baltic Coastal Waters. Ecological Studies. 197. Springer-Verlag, 2008. Pp. 167-195.
- Chubarenko B. (Ed.) Transboundary waters and basins in the South-East Baltic. Kaliningrad: Terra Baltica, 2008- ISBN 978-5-98777-031-3.- 306 p.