Processing 50 years of oxygen and hydrogen-sulphide observations in the Baltic Sea

Susanne Feistel, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), susanne.feistel@io-warnemuende.de
Michael Naumann, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), michael.naumann@io-warnemuende.de
Günther Nausch, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), guenther.nausch@io-warnemuende.de
Anne Hiller, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), anne.hiller@io-warnemuende.de
Philipp Paysen, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), philipp.paysen@io-warnemuende.de
Martin Hansson, Swedish Meteorological and Hydrological Institute (Sweden), martin.hansson@smhi.se
Lars Andersson, Swedish Meteorological and Hydrological Institute (Sweden), lars.andersson@smhi.se
Lena Viktorsson, Swedish Meteorological and Hydrological Institute (Sweden), lena.viktorsson@smhi.se
Elzbieta Lysiak-Pastuszak, Institute of Meteorology and Water Management (Poland), elzbieta.lysiak-pastuszak@imgw.pl
Rainer Feistel, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), rainer.feistel@io-warnemuende.de
H.E. Markus Meier, Leibniz Institute for Baltic Sea Research Warnemünde (Germany), markus.meier@io-warnemuende.de

The Baltic Sea is a complex estuary characterized by a strongly fluctuating, fragile balance between high freshwater runoff and saline water inflows, a persisting vertical stratification, and a bottom topography of several connected basins. By the sensitivity of this system, climatological fluctuations appear amplified on the decadal time scale. Changes that may be insignificant in the open ocean typically constitute significant indicators in the Baltic Sea. Salt and nutrients remain present in the estuary for 20 and more years before being flushed to the Atlantic along with the brackish water export. This long residence time attenuates short-time fluctuations in environmental conditions, but highlights systematic, even small long-term anomalies.

Lateral property distribution maps published in 2016 by Feistel et al. (https://www.io-warnemuende.de/msr-2016-0100.html) allow an evaluation of occasional inflow events, of the progress of oxygen-consuming processes and of the development of hydrogen sulphide distributions over longer periods of time. The oceanographic database IOWDB (https://odin2.io-warnemuende.de) serves as a central primary data source and contains harmonized, quality-controlled oxygen and hydrogen-sulphide data from regular seasonal monitoring cruises that have visited the western and central Baltic Sea since 1969. Furthermore, our research task combines IOW long-term data with those from cooperating partner institutions in Sweden and Poland. The result presents the most comprehensive dataset currently available and can be used to illustrate and analyze the shifting levels of oxygen deficiency.

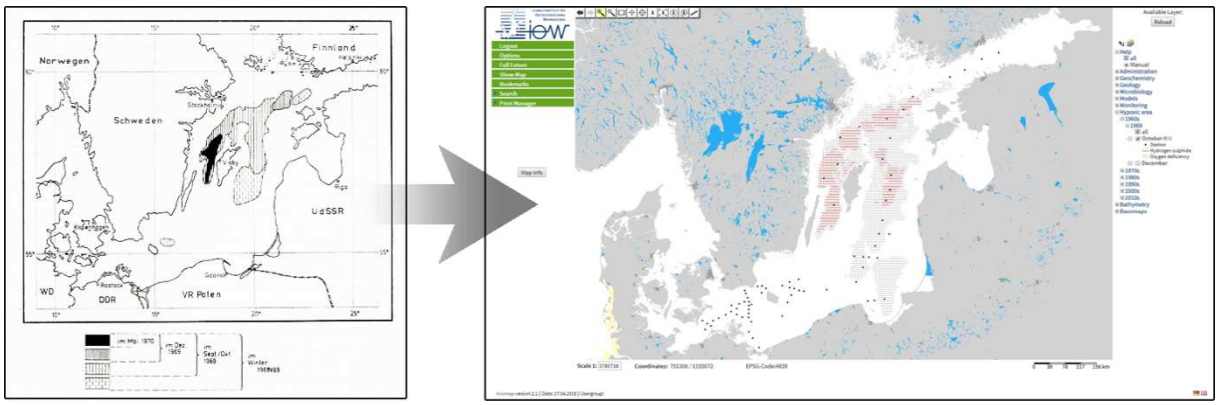

Figure 1: Change over time: The visualisation of the Baltic Sea with hypoxic and euxinic areas in 1969. On the left a hand-drawn map from 1971, on the right as a shape file and web map service from 2018.

The applied database- and software-based methods represent transparently and reproducibly the distribution of hypoxic and euxinic waters in the near-bottom layer of the Baltic Sea (Fig. 1). The datasets of IOWTOPO (https://www.io-warnemuende.de/topography-of-the-baltic-sea.html) and RANGS (https://www.io-warnemuende.de/rangs-en.html) form the topological framework for all created maps. As a new feature, we now present all extrapolated map data as so-called shape files for GeoInformationSystems and offer them as open-access web service for public use (http://www.io-warnemuende.de/baltic-sea-atlas). The maps permit detailed statistical analyses covering the central basins in all seasons, spanning several decades as outlined in Naumann et al. 2017.

For example, fig. 2a shows long-term change of hypoxic and euxinic areas in the Baltic basins, where maximum extents were reached in the early 1970's as well as from 2000 on. Fig. 2b shows the change over time of the mean redoxcline depth which is more or less constant at about -110 m and is temporarily lowered during inflow situations. Under recent meteorological and hydrographic conditions, a further expansion seems to be restricted by the pycnocline depth.

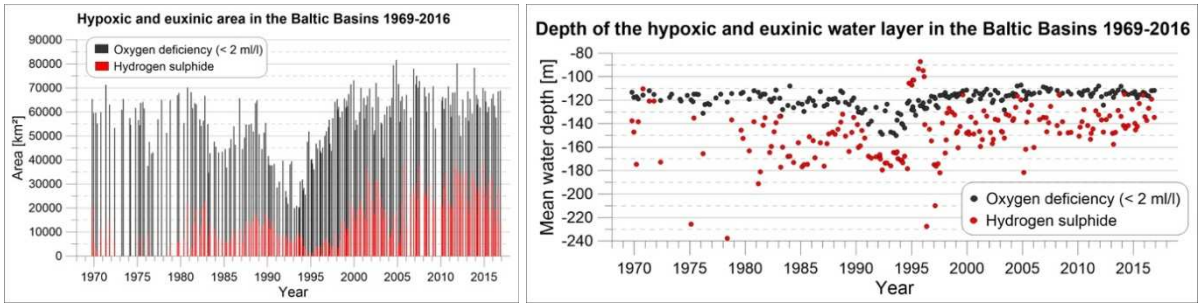

Figure 2: Analytical results of available datasets: a) Spatial analysis of hypoxic to euxinic conditions in the Baltic Sea since 1969; b) Mean water depth showing hypoxia and euxinia, considering all deep basins (after Naumann et al., in prep).