



Contribution ID : 22

Type : **Oral**

The Baltic Sea: From Understanding to Management

Thursday, 6 September 2018 12:25 (35)

Excessive nutrient inputs over the last century have altered the subtle balance between oxygen supply and oxygen consumption and changed the Baltic Sea from a state with hypoxia confined to the deepest bottom waters to widespread hypoxia in most bottom waters. The Baltic Sea is naturally susceptible to hypoxia because the pronounced vertical stratification in the water column prevents the resupply of oxygen below the permanent halocline, and the salt water inputs from the adjacent North Sea through shallow sills influences both horizontal and vertical water exchange. Analysis of the extensive data available from different countries, their monitoring program and research cruises, has allowed for the computation of basin-wide trends of oxygen conditions over more than a century. The low oxygen zone has increased by a factor of 10 over the last 115 years and has grown from about 5,000 km² around 1900 to more than 60,000 km² in recent years. Anthropogenic nutrient inputs are the primary cause of the hypoxia, however, global warming has exacerbated low oxygen conditions. In the estuarine and coastal systems of the Baltic hypoxia is much more variable and strongly dependent on processes controlling vertical mixing. The low oxygen conditions have altered many biogeochemical cycles (P, N, Fe, Mn, S, etc.) and influenced many processes including the nutrients limiting phytoplankton production, altering microbial communities and changing the burial of elements in sediments. In addition, the enhanced accumulation of organic-rich sediments with hypoxia, e.g. the legacy of eutrophication, has increased benthic oxygen demand. Although reductions in nutrient loads have reduced overall eutrophication, especially local conditions, a response is not yet evident in the dynamics of hypoxia. The time lag in responses to current efforts to reduce nutrients is slow, which also challenges management efforts to reduce eutrophication. Additional efforts to achieve nutrient reductions from catchments will be necessary to improve oxygen conditions in the Baltic Sea.

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Session Classification : 08 Coastal Systems: From Understanding to Management