The Baltic Sea marine system – human impact and natural variations

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Abstract

The environmental state of the Baltic Sea system is influenced by both natural and anthropogenic factors. Water exchange with the adjacent ocean and within the system depend on large-scale atmospheric circulation and properties of the straits separating the different sub-basins. Physical processes control the stratification and determine residence times of water and dissolved substances, which has a major impact on the oxygen situation. Deep water oxygen demand is coupled to the production of organic material, which in turn depends on the availability of plant nutrients in the sunlit surface layer. Plant nutrients are supplied from external waterborne and airborne sources, but there is also an internal supply of remineralized nutrients from the deep water resulting from decomposition of organic material previously produced in the surface layer. In large areas of the system the contemporary rate of deep water oxygen consumption exceeds the rate of oxygen supply, resulting in oxygen poor water hostile to higher forms of life.

Mathematical models of the marine system are the only tools able to determine the relative importance of the many different factors that influence the Baltic Sea environmental state. Without a proper system understanding and attribution of detected threats to their dominant sources, it is not possible to determine the future effects of ecosystem management strategies. The work in this thesis is a part of the development of Baltic Sea modelling tools that can address several different ecosystem threats, and thus serve as support concerning management decisions. In this case the foci are on eutrophication, acidification and climate change. Reconstructions of the factors forcing the system are used to do hindcast simulations up to half a millennium back in time. The ecosystem changes on longer time scales are mainly attributed to anthropogenic fuelling of phytoplankton production as the result of a massive increase in nutrient supply during the twentieth century. Model results indicate that eutrophication may have damped the effect of increasing atmospheric levels of carbon dioxide on surface water pH. The reconstruction of the Baltic Sea past suggests that the physical forcing, which is related to climate variability, so far mainly affects the oxygen situation on an inter-annual to decadal basis whereas significant long-term trends coupled to climate change have not been detected.

Key words: Baltic Sea, modelling, salinity, oxygen, nutrients, eutrophication, acidification, climate.

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Examination:
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Time and Place:
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