Abstract

Inshore areas with restricted water exchange may be sensitive to local or large scale eutrophication. The effect of a certain supply of nutrients is to a large part determined by the local residence times for water and organic matter. In this thesis I investigate the response of inshore areas of various topography to different kinds of forcing. This was done both through data analyses and by development of conceptual/analytical models.

The influence of long-term climate variation, e.g. due to the North Atlantic Oscillation, NAO, was investigated. It was found that the decrease in the minimum oxygen concentration in the bottom water of Gullmar Fjord since about 1970 can partly be explained by delayed ending date of the stagnation period due to climate variation (NAO and longer periods). Through modelling it was found that the length of the stagnation period may be influenced by the variability of the coastal water density of longer periods, e.g. climate variation, if the vertical mixing in the basin water is weak, resulting in stagnation periods T_{stag} of several years. Vertical mixing was found to determine the length of T_{stag} and the residence time T_e of the basin water in fjords with short T_{fill}, i.e. where the basin water is exchanged during one occasion of inflow; *mixing systems*. In case of long T_{fill}, i.e. when several inflows are needed to fill up the basin, it was shown that the transport capacity of the mouth was increasingly important for increasing T_{fill}. The spatial mean density in such system decreases with increasing T_{fill}, and for sufficiently large energy input for mixing, these systems were shown to be "over mixed" in which case the residence time is controlled solely by the transport capacity of the mouth; *transport systems*.

A conceptual/analytical model of the vertical transport of particulate organic matter POM to the deepwater was developed for the three sources of POM/nutrients, i.e. coastal water exchange, freshwater input and uplift of nutrient rich water by deepwater exchange. The analytic model thus gives the opportunity to estimate the sensitivity of an area to local and large scale eutrophication. The results of the analytical model agreed well with the results from a process oriented numerical model. It was found that Skagerrak water is the dominating source of POC to Gullmar Fjord, which also can be understood using the analytic model developed in this thesis. The amount of POC in the surface layer can be estimated by observations of transparency of the water, through Secchi depth observations. But this is complicated by the existence of light attenuating matter LAM entering with freshwater input. A method including the effects of LAM, POC, and wind speed was developed, in order to separate the effect of POC. One can then use Secchi depth observations together with simultaneously obtained salinity profiles and wind observations, to detect trends in the amount of POC and thereby identify effects of eutrophication also in freshwater influenced systems.

Keywords: water quality indicators, water quality modelling, fjords, oxygen concentration, oxygen consumption, water exchange, residence time, mixing, vertical flux of POM, deepwater renewal, Secchi depth, visibility, over mixing