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Morphology and anoxia in enclosed seas: Aitoliko lagoon - Greece

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Several recent studies suggested that oxygen levels are generally decreasing mainly in coastal areas and inland seas. Morphology, nutrients load and meteorological/hydrological regimes control anoxic conditions, while changes in these preconditions affect the characteristics of the anoxic environment in certain ways.
Although, there are studies referred to impacts on water body anoxia caused by nutrients management and hydrological/meteorological changes there is lack of information about the impacts on water column anoxia resulted by morphological modifications.
The main objective of this study is to investigate and correlate geomorphological changes in anoxic basins with physicochemical alterations in their water column. Aitoliko lagoon constitutes the case study, as it is a semi-enclosed anoxic basin, in western Greece, on which recent human induced morphological changes have implicated in increased water exchange with its source basin.
The deep basin of Aitoliko ($\sim$27.5m) is connected with the adjacent Messolonghi lagoon ($\sim$2m deep) through shallow and narrow openings (mean depth $\sim$1.2m). The morphology of Aitoliko lagoon in combination with the large fresh water inflows, the limited connection with the Messolonghi lagoon and the high nutrient/organic load lead to the development of a permanent pycnocline and an anoxic monimolimnion with high H2S concentrations.
During the last decades, a progressive increase of the anoxic layer extent was ascribed to the human interference on the lagoonal system. Nutrient load increased, fresh water discharges increased and water exchange between the two lagoons was limited through several technical works. Finally, the anoxic layer reached up to the depth of 4 meters in 2004.
During last years, an effort to reverse the degradation of the system back to its previous natural state, facilitating water exchange between the two lagoons, was made. The deepening of the connecting sill between the two lagoons was included in the morphological modifications completed on May 2006. An increase of about 30% in the sill's total cross section increased the inflow of denser water from the saltier Messolonghi lagoon, affecting Aitoliko lagoon hydrography.
Samplings were conducted on a monthly basis at fourteen sampling sites from May 2006 to April 2007. Continuous profiles of temperature, salinity and dissolved oxygen were measured in situ, while wind data were used, in order to assess the wind effect on lagoon's hydrography.
After data processing, we concluded in lagoon's monimolimnion oxygenation during January and February 2007. Winter lagoon's oxygenation ascribed to the salty water inflows from the adjacent Messolonghi lagoon. A bottom density current, at the southern part of Aitoliko lagoon was recorded from June until October 2006. When the water in the dense bottom current achieved the same density as the surrounding water, it was interleaved into the interior of Aitoliko lagoon promoting efficient vertical mixing within the basin. Vertical density instabilities in Aitoliko lagoon were recorded, demonstrating the mixing in its water column.
Intensive and prolonged southern winds can enforce denser water from Messolonghi to inflow Aitoliko lagoon and cause mixing of the water column. However, throughout the sampling period strong winds (10 – 12m/s) were always associated with northeast directions, while southern winds were always weak (up to 6m/sec). These winds cannot alter water body anoxia, through vertical mixing, which means that wind could not be the reason for the monimolimnion oxygenation.
The limited deepening of the sill created a mild increase of water flow into the anoxic Aitoliko lagoon. This inflow of oxygenated saltier water from the source basin resulted in a weak mixing of the water column. Such small scale mixing, introduced oxygen into the halocline waters, without destroying the stratification.
Morphology modification of the sill can lower the anoxic-oxic interface and not destroy the anoxic character of the lagoon.