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Description of the mechanism leading to the development of seasonal anoxia in Amvrakikos Gulf, Greece.

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The environmental problem of coastal anoxia has become common nowadays, as its frequency of occurrence increases daily. Anoxic zone is created when there is a large demand for oxygen in deep waters. Although this is sometimes natural, the increased area of water affected, the extended length of each anoxic episode and the higher frequency occurrence, it can happen due to human activities. In general, geomorphology and circulation patterns are the two important factors which make marine systems prone to anoxia. The main features which lead to the development of anoxia in coastal areas are the eutrophication, the low physical energy and the large freshwater input. The combination of them form stratified water masses that become anoxic when they are isolated. The case study region is the seasonally anoxic zone in Western Greece, Amvrakikos Gulf, one of the most important protected wetland in Greece and in Europe.

In order to determine the time and the place in which anoxic zone occurs and finally the mechanism which leads to the occurrence of anoxic conditions in Amvrakikos, physicochemical characteristics of water column were measured at sixteen stations, at four different seasons during 2009-2010. Taking into account the dissolved oxygen distribution and the hydrogen sulfide concentrations during the year, Amvrakikos Gulf can be characterized as seasonally anoxic semi-enclosed embayment, with important differences between the western and the eastern part of it throughout the year. Amvrakikos is a eutrophic system which is being affected more from river discharges, topography and wind than from tide.

The mechanism which leads to the formation of seasonal anoxia is the following: In spring, the combination of high river runoffs and solar radiation creates a strong density stratification, which causes the isolation of the bottom layer, and through the decomposition of organic matter decrease the oxygen levels below the pycnocline, and finally lead to the development of the anoxic zone near the bottom. After a long period of isolation, in combination with the strong stratification because of the existence of both halocline and thermocline, in summer and with the increased biological oxygen demand due to the decomposition of the organic material by aerobic benthic microbes, the area of the anoxic layer increased and extended in almost the entire bottom of the gulf. In autumn, because of the dominated winds with higher speeds and less solar radiation, the upper water layer started to mix with deep waters and the oxygen concentrations increased until a specific depth but the bottom waters remain anoxic. Finally, in winter, because of the weak stratification in late autumn, the low solar radiation and the fact that the system gets energy from the dominated winds to break the pycnocline, the water column mixes. As a result oxygen from surface waters riches the deep hypoxic and anoxic waters, but an area near the bottom still remains hypoxic with higher oxygen levels than those in previous seasons.

In conclusion and in comparison with the last 20 years, the seasonally hypoxic eastern area converted into a seasonally anoxic area, and the western well oxygenated part of the gulf, converted into a seasonally hypoxic area, in summer and autumn, a change which indicates the degradation of the gulf's environmental state through the years.