

In the last decades wastewater discharge and human activities as aquaculture and agriculture have produced a cascade of negative effects on aquatic ecosystems, from the river networks to the coastal zones. The most evident effect of these anthropogenic pressures is the process of eutrophication, which translates into excess concentrations of nutrients such as nitrogen and phosphorus in the water, favoring the growth of cyanobacteria. Excessive algal blooms turn the water turbid and affect the quality, recreational and economic value of the coastal zones. The algal biomass in fact enriches the sediments with organic matter, and requires large oxygen amounts for its decomposition, often exceeding oxygen availability. Ultimately, this sequence of events may lead to water anoxia and loss of species and may threaten the capacity of ecosystems to react and to recover from such pressures. Some coastal zones of the Baltic Sea are seriously affected by eutrophication, even though European Directives have improved agricultural practices, the efficiency of wastewater treatment plan and limited the use of fertilizers. The expected, positive effects of these measures can be delayed by climate change, a new menace that act in synergy and worsen the impacts of eutrophication, by affecting the intensity and patterns of precipitation, the ice cover periods and the water temperatures. Climate change can increase nutrient transport to the coastal zone and can favor water stratification and heating. This synergic impacts of eutrophication and climate change may affect water chemistry and the biodiversity of large coastal areas, to an extent that is poorly known but potentially dramatic.

The main aim of BUFFER project is to investigate the impact of the interaction between climatic anomalies and eutrophication on the capacity of the sediments to process and retain nutrients and contrast their regeneration to the water column (*the buffer capacity*). BUFFER will analyze if and how the capacity of sediments to control eutrophication consequences is menaced by climate change and will disentangle underlying mechanisms.

The main study site of BUFFER is the Gulf of Gdańsk (southern Baltic Sea), as it has been threatened by the combined effects of climate change and eutrophication. BUFFER project will investigate the buffer capacity of specific areas in the Gulf along multiple gradients of oxygen availability, freshwater input, depth and light. The buffer capacity will be also analyzed with respect to the presence of different organisms, including primary producers as aquatic plants and algae and different functional groups of macrofauna, including filter-feeding bivalves and burrowing worms, to understand whether living macroorganisms also represent a natural buffer. Sampling campaigns will be carried out in two additional sites: the Sacca di Goro lagoon in Italy and the Kongsfjorden and Porsangerfjorden in Norway. Both sites are affected by high freshwater discharge, the former from the Po River and the latter from the ice melt from land, and both sites can encounter bottom water anoxia. The comparison among study areas will allow to understand whether the climate-eutrophication effects produce larger impacts in the northern latitudes.

The main working hypothesis is that the synergic impact of eutrophication and climate change will affect also coastal zones at northern latitudes, which have been always characterized by low temperature regimes that represented a natural buffer counteracting nutrient regeneration, algal growth and oxygen shortage. Contrarily, southern sites should address better climatic extremes such as high temperatures and high freshwater discharge. This should be possible since those areas are normally exposed to a wide range of temperatures and precipitations. In the northern region, we expect therefore higher vulnerability to climate change, but also a higher capacity to restore and recover the buffer capacity of sediments, due to longer cold season.

Results from BUFFER will allow to outline the impacts of climatic anomalies and eutrophication along a wide latitudinal gradient and the quantification of how local biogeochemical buffers are affected by such anomalies. Furthermore, BUFFER will identify the critical zones in the Gulf of Gdańsk in terms of limited or null buffer capacity of the benthic system. Additional and important outcomes will be the identification of effective measures aimed to contrast the enhancement of nutrient enrichment. Such actions will be useful for the management of coastal areas, not only in Poland, but also in other threatened aquatic environments.