



## In situ continuous real-time monitoring and 3D modelling of hydrodynamics and eutrophication in the Berre Lagoon (France)

Emma Gouze (1), Laurent Martin (1), Nathalie Durand (1), Jean-Michel Hervouet (1), Chi-Tuan Pham (1), Emile Razafindrakoto (1), and Agnès Bourret (2)

(1) EDF (Electricité de France), R & D, Chatou, France (laurent-stephane.martin@edf.fr), (2) IXSurvey SAS, La Ciotat, France

The Berre lagoon is one of the biggest Mediterranean lagoon. Its only connection to the Mediterranean Sea is the Caronte channel in the South West which allows tidal-driven water exchanges. The lagoon receives fresh water and nutrients from natural tributaries that drain high anthropised catchment basins. Moreover, a hydroelectric power plant became the main tributary of the lagoon since 1966. As a consequence, the Berre lagoon became particularly unstable, showing considerable salinity drop and variations (2 to 30) depending on seasonal electricity needs. Nutrients loads by both anthropised rivers and power plant led to frequent colored waters and development of macroalgae. Haline stratification favored anoxia and led to benthos disappearance.

In 2004, the European Court of Justice condemned the French State for not respecting the Athens Protocol (advocating Mediterranean protection against telluric pollution) and requested managing strategies. The hydroelectric power plant (EDF Electricité de France) has to respect severe salinity constraints favorable to the establishment of a balanced ecosystem.

In this context, EDF started an in situ continuous monitoring of the lagoon: CTD probes have been installed at 10 stations and currents have been measured in the Caronte channel. Moreover, the three central buoys have been real-time remote transmitting to control instantaneously the impact of fresh water discharge on salinity. Since 2008, these three buoys have been also equipped with nitrate, chlorophyll and oxygen probes.

Thanks to these measurements, a 3D hydrodynamic model (TELEMAC<sup>©</sup>) has been developed and validated to better qualify and quantify the relationships between the salinity of the lagoon, the fresh water inputs (from the powerplant and from the rivers), the water exchanges through the Caronte channel and the wind mixing. This model is currently used by the electricity producer to manage fresh water discharges complying with salinity indicators fixed by the European Court of Justice. Then, a biogeochemical model (DeIWAQ<sup>©</sup>) coupled with the hydrodynamic model has been developed to understand the ecosystem functioning and to assess the hydroelectric powerplant implication in the eutrophication of the lagoon. A 11 years-simulation (1998-2008) was launched after compiling and suggesting various hypothesis to build the whole data set at the boundary conditions over the period (meteorological conditions, power plant, rivers, industries, and water treatment plants discharge). The coupled model does not drift, neither calculate aberrant values for the 11 years then is robust for further relative long periods calculation. Simulations reproduce quite well: 1/ the interannual and seasonal variations of nutrients, 2/ biogeochemical processes, 3/ anoxia events in connection with stratification periods at deep stations and 4/ are able to calculate nutrients budgets over a year. The results show that the allochthonous nutrients sources are not sufficient to feed the phytoplanktonic demand (less than 1%). Current high primary production rates are based on high dynamical mineralization processes. However, we suggest an improvement of the benthic processes. Indeed, we currently do not represent the organic matter burial neither the phosphorus adsorption/desorption in the simple modelled sediment. The representation of these processes could be of major importance in nutrients budgets for further decennial simulations.

This models coupling is a tool aiming at a better assessment of the high complexity of the lagoon nutrients cycles. It will help us to understand the powerplant implication for the eutrophication with respect to the anthropised rivers. Moreover we would be able to test various managing scenarii (e.g. drop of nutrients loads) and to suggest new rehabilitation strategies.