

## FINAL REPORT PROGRAM LEFE

Program LEFE/ EVOLECO-vp	Project Title	Years 2019-2021
	<b>Long-term variability of coastal ecosystems – nutrients, phytoplankton and their drivers</b>	

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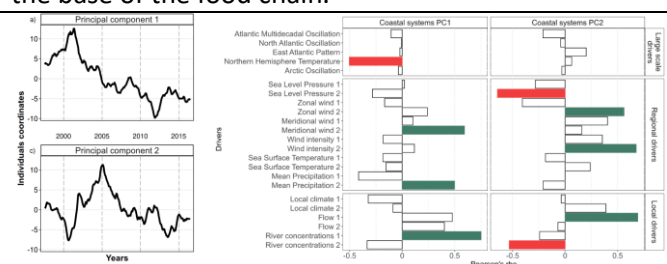
Contribution to  
  
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 MESRI, Univ. Bordeaux

### Context

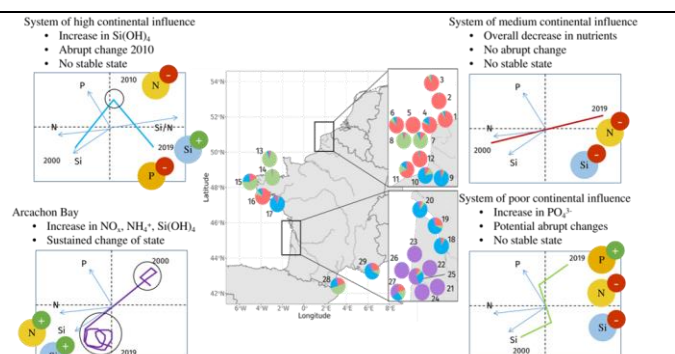
The climate change and the change in human activities — i.e. the two components of the global change — affect the physical, biogeochemical and ecological functioning of the coastal ocean.

### Objectives / scientific questions

The main objective of the project was to evidence the bi-decadal variability of coastal ecosystems and to determine its drivers, with a specific emphasis to nutrients and phytoplankton, two compartments that constitute the base of the food chain.



*Illustration 1: left panel: PCA of the SOMLIT data set – temporal variability of the individuals coordinates on the first and second axis; right panel: Pearson correlation between SOMLIT PC1 and 2 and drivers.*



*Illustration 2: central panel: proportion of belonging of each station to the groups determined by the long-term variability of nutrients; other panels: schematic view of nutrients long-term variability of each group in the plan (axes 1 and 2 of the Within Group CO-Inertia Analysis).*

### Main results

A first study (Illustration 1; Lheureux et al., 2021) indicated that the bi-decadal changes in physico-biogeochemical characteristics of temperate coastal ecosystems were related to changes in large-scale and regional climate, detected through proxies of temperature and atmospheric circulation, as well as through river discharge. Ecosystem trajectories tended to move towards an increase in temperature and salinity, and/or a decrease in chlorophyll *a*, nutrients and particulate matter.

A second study was dedicated to bi-decadal changes in nutrients concentrations and ratios of temperate coastal ecosystems (Lheureux et al., 2022, 2023; illustration 2). A typology of ecosystem trajectories was highlighted. Most of the ecosystems exhibited trajectories towards a decrease in nutrients concentrations. Three types of trajectories were detected, depending on the strength of the continental and human influences as well as on climatic regimes. One single ecosystem exhibited very different trajectories, the Arcachon Bay, with an increase in most of nutrients concentrations due to the regression of the seagrass meadow. It constitutes the fourth type.

At last a third study was dedicated to phytoplankton taxonomic and functional diversity (Lheureux et al., in prep.). Similarly to what was performed for nutrients, a typology of ecosystem trajectories was highlighted. For taxonomic diversity, three types of trajectories appeared. These types were discriminated by the geographical location of the ecosystems (North Sea and English Channel, Northern Bay of Biscay, Southern Bay of Biscay and Mediterranean Sea). The two northern types showed a shift in the 2000s or 2010s whereas the trajectories of the southern type were somewhat linear. The trajectories are mainly due to changes in some dinoflagellate and one diatom taxonomic units. They are related to climate change. For functional diversity, four types were detected.

Two types showed no clear trend and two types showed again a shift in the 2000s or 2010s in relation to climate change.

#### *Future of the project :*

The project EVOLECO-vφ dedicated to nutrients and phytoplankton led up to the project EVOLECO-BEST (Long-term variability of coastal ecosystems – bivalves under estuarine influence; OFB, 2021-2024). The project EVOLECO-BEST investigates how the influence of continental and estuarine waters on coastal zone functioning has change over the last four decades. This is scrutinized through the prism of bivalve trophic resources and physiology along the French coasts. Both the methodology development (statistical analyses) and the results from the project EVOLECO-vφ are used for the project EVOLECO-BEST.

#### *Number of publications, communications and theses*

##### Articles

Lheureux A., David V., Del Amo Y., Soudant D., Auby I., Bozec Y., Conan P., Ganthy F., Grégori G., Lefebvre A., Leynard A., Rimmelin-Maury P., Souchu P., Vantrepote V., Blondel C., Cariou T., Crispi O., Cordier M.-A., Crouvoisier M., Duquesne V., Ferreira S., Garcia N., Gouriou L., Grosteffan E., Le Merrer Y., Meteigner C., Retho M., Tournaire M.-P., Savoye N., 2023. Trajectories of nutrients concentrations and ratios in the French coastal ecosystems: 20 years of changes in relation with large-scale and local drivers. *Science of the Total Environment*, 857, 159619. doi.org/10.1016/j.scitotenv.2022.159619

Lheureux A., David V., Del Amo Y., Soudant D., Auby I., Ganthy F., Blanchet H., Cordier M.-A., Costes L., Ferreira S., Mornet L., Nowaczyk A., Parra M., D'Amico F., Gouriou L., Meteigner C., Oger-Jeanneret H., Rigouin L., Rumebe M., Tournaire M.-P., Trut F., Trut G., Savoye N., 2022. Bi-decadal changes in nutrient concentrations and ratios in marine coastal ecosystems: the case of the Arcachon Bay, France. *Progress in Oceanography*, 201, 102740. doi.org/10.1016/j.pocean.2022.102740

Lheureux A., N. Savoye, Y. Del Amo, E. Goberville, Y. Bozec, E. Breton, P. Conan, S. L'Helguen, L. Mousseau, P. Rimbault, P. Rimelin-Maury, L. Seuront, R. Vuillemin, J. Caparros, T. Cariou, M.-A. Cordier, A.-M. Corre, L. Costes, O. Crispi, M. Crouvoisier, H. de Lary de Latour, H. Derriennic, J. Devesa, M. Durozier, S. Ferreira, N. Garcia, E. Grossteffan, A. Gueux, M. Lafont, V. Lagadec, E. Lecuyer, C. Leroux, E. Macé, E. Maria, L. Mornet, A. Nowaczyk, M. Parra, F. Petit and V. David, 2021. Bi-decadal variability in physico-biogeochemical characteristics of the temperate coastal ecosystems: from large-scale to local drivers. *Marine Ecology Progress Series*, 660, 19-35. doi.org/10.3354/meps13577

##### Communications

- 4 communications au Colloque EVOLECO, 3-5 novembre 2021, La Rochelle : Lheureux et al., Evolution bi-décennale des nutriments dans les écosystèmes côtiers ; Cazeret et al., Evolution spatio-temporelle de la diversité du microphytoplancton sur le littoral Atlantique français: réponses aux forçages environnementaux ; David V. et al, Comment combiner recherche scientifique et données issues de réseaux d'observation et de surveillance? difficultés et limites : une étude de cas sur la réponse à long-terme du phytoplancton aux forçages environnementaux ; Savoye N. et les équipes EVOLECO-vφ et EVOLECO-BEST, 2021.
- L'heureux A., Savoye N., Del Amo Y., Soudant D., Goberville E., Auby I., D'Amico F., Ganthy F., Gouriou L., Meteigner C., Oger-Jeanneret H., Rigouin L., Rumebe M., Tournaire M.-P., Trut F., Trut G., David V. (2019). The influence of global and local drivers on the long-term changes of the nutrients in the Arcachon Lagoon. CHEERS: Global changes in estuarine and coastal systems: innovative approaches and assessment tools. November 4th-8th, 2019, Bordeaux, France.
- Lheureux A., Savoye N., David V., Del Amo Y., Soudant D., Goberville E., Auby I., Bourasseau L., Cordier M.-A., Costes L., Ferreira S., Nowaczyk A., Parra M., D'Amico F., Ganthy F., Gouriou L., Meteigner C., Oger-Jeanneret H., Rigouin L., Rumebe M., Tournaire M.-P., Trut F., Trut G., 2019. The influence of global and local drivers on the long-term seasonality and variability of the nutrients in the French marine coastal ocean: the case study of the Arcachon Lagoon. Future Oceans2 IMBeR Open Science Conference, 17-21 June 2019, Brest, France.

Thèse: Lheureux A., 2022. Les nutriments dans les écosystèmes côtiers : évolution à long terme, forçages du changement global et conséquence sur la biomasse et la diversité du phytoplancton. Université de Bordeaux.

#### *Data availability*

The data sets used during the project EVOLECO-vφ come from numerous time series that are freely available on websites (SOMLIT, PHYTOBS, Quadriga<sup>2</sup>, METEO FRANCE, EAUFRANCE, NASA, CPERNICUS, etc.).

