NUTRIENTS, OXYGEN AND CO_2 FLUXES IN COASTAL ALGERIAN WATER (ALGIERS AND BOU-ISMAIL BAYS).

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Abstract
Climate change, population increase, industrialization and agricultural activities are effecting eutrophication in estuaries and coastal waters. The Mediterranean Sea, as a semi-enclosed sea must be very sensitive to global change and is impacted by human activities. Coastal cities has been identified as hot spots for several pollution types. Along the Algerian coast we present the evolution of nutrients and oxygen in two bays : Algiers and Bou-Ismail. We also present the distribution of pH and CO_2 air-sea exchange in these areas. This work is part of the international "MerMex, MISTRALS" program which aims at studying the viability of the Mediterranean Sea for the next century.

Keywords: Coastal waters, Eutrophication, Oxygen, Algerian Sea, Air-sea interactions

Introduction
The world's climate has changed, and human activities are continuously contributing to greenhouse gases emission and water pollution. The drivers causing coastal eutrophication are set within a large framework of multiple human-induced stressors, including overfishing, chemical contaminants, coastal habitat degradation and invasive species [1]. Eutrophication is a global phenomenon with significant effects on food webs, water quality, and biogeochemical cycles [1]. The Mediterranean Sea showing short-term response to anthropogenic forcing can be considered as an ocean model. In this context, acidification, eutrophication status, sea water warming and change in biodiversity are the key topics in assessing the viability of the Mediterranean Sea for the next century. The Algerian coastal areas characterized by high biodiversity are very sensitive to human activities. For instance, every year, millions of cubic meters of untreated wastewater pour into the bay of Algiers, the latter being also influenced by the fresh water input from 2 rivers. The Bou Ismail bay extends on about 50 kms in the west of Algiers, and presents an accelerating process of degradation following the development of anthropogenic activities since the last 10 years. Few data are actually available concerning the distribution of pCO_2 in surface waters for the Algerian basin of the Mediterranean sea. In this work, we present sea water nutrient content and dissolved oxygen and how these parameters have evolved over 20 and 10 years respectively for Algiers and Bou Ismail bays, taking advantage of historical data collected in the same zones [2] and present day cruises. We also present the role of these areas as source or sink for atmospheric CO_2 in spring 2012.

Material and method
More than 20 stations were sampled in the two bays between 3 and 100 m depth. The dissolved O_2 was measured using the Winkler method [3]. The mean and standard deviation on the replicate is 2±0.2 µmol/kg. The nutrients (nitrogen, phosphorus) were measured with the auto analyzer SAN PLUS (Skalar, 1996). The mean and standard deviation on the replicate was 0.03±0.0001 µmol/kg. The pH and Total alkalinity (TA) were measured according to Dickson recommendation [4]. TCO_2 and pCO_2 were calculated using Mehrbach dissociation constants for carbonate system in sea water [4]. Accuracies are, 0.002 for pH, 4µmol/kg for TA, 5 µmol/kg for TCO_2 and 6 µatm for pCO_2.

Results and discussion
Averaged phosphorus concentration has increased in the two bays over time. That explains a decrease in N/P ratio. The N/P ratio decreases from 1.6 in 1989 to 0.79 in 2012 in the Algiers bay and from 4 in 1996 to 0.4 in 2011 for the Eastern part of the Bou Ismail bay. Boulahdid et al [5] have shown a difference in N/P distribution between the western part (N/P=16) and the Eastern part (N/P=2) of Bou Ismail bay in 1996, probably caused by higher demography on the eastern coast of the bay. Recent observations do not show this difference as the demography and urbanization have gained the western part of the bay as well. Therefore, we suppose that N/P ratio decrease is a consequence of an increasing trend in the volumes of untreated domestic waters that reach the bay, as well as a change in river inputs following some rainfall changes over the years.

Tab. 1. Data for Algiers and Bou-Ismail bay: mean and (standard deviation) for nitrogen, phosphorus and dissolved oxygen. Air-sea CO_2 fluxes (FCO_2), the negative value indicate sink for atmospheric CO_2, positive value indicate source of CO_2 for the atmosphere.

	Bou-Ismail bay		Algiers bay		
	Mai-2002	April-2012	1989	April-2011	April-2012
Nitrogen (µmol/l)	0.83 (1.2)	0.26 (0.14)	0.63 (0.3)	0.17 (0.08)	0.82 (0.4)
Phosphorus (µmol/l)	0.13 (0.02)	0.52 (0.54)	0.39 (0.25)	0.39 (0.05)	0.48 (0.02)
O_2 (mg/l)	8.62 (0.28)	6.22 (0.65)	No data	6.98 (0.63)	6.99 (0.88)
FCO_2 mmol/m^2/day	No data	-15.79	No data	+ 0.37	- 0.27

Dissolved O_2 is of about 8 mg/l on average for Bou Ismail bay in 2002 and around 6 mg/l for 2012 in the two bays. The dissolved oxygen is a good indicator of eutrophication for coastal waters. According to IFREMER [6], an oxygen decreasing trend is an indicator for eutrophication risk. However, the Bou Ismail bay is also under a strong influence of the Algerian current hydrodynamics which may contribute to the ventilation of these waters. Concerning the sea surface pCO_2, the distribution is controlled by the temperature, and river inputs. In spring 2012, the eastern part of Bou Ismail bay acts as a sink for atmospheric CO_2 (-15.8 mmol/m^2/day on average). In the Algiers bay, the pCO_2 distribution shows a clear contrast: near-shore waters are influenced by river input with low pH and low TA and therefore act as a source of CO_2 for the atmosphere (+4.35 mmol/m^2/day on average), while the waters off the coast, more influenced by the Algerian current, act as a sink with a mean flux of -2.75 mmol/m^2/day.

References
1 - Rabalais, N.N., 2004. Eutrophication, chapter 21 in Global Coastal Ocean: Miltiscale Interdisciplinary Process. The sea , 13, pp. 819-865. Ed. by 1. R. Robinson, J. McCarthy, and B.J. Rotschild. Havard University Press, Cambridge. MA.

2 - Boulahdid M., Eddalia N., Boudjellal B. and Azzouz M., 2003. Les eaux de la Baie d'Alger: quelques aspects physico-chimiques et environnementaux. Annales de l'institut national agronomique, V 24, N° 1 et 2.

3 - Aminot A., Kérouel R., 2004. Hydrologie des écosystèmes marins. Paramètres et analyses. Ed. Ifremer, 336p.

4 - DOE (1994) Handbook of methods for the analysis off the various parameters of the carbon dioxide system inn sea water, version 2, A.G. Dickson and C. Goyet, eds ORNL/CDIAC-74

5 - Boulahdid, A. Brinis, A. Brahmia, B. Boudjellal and N. Eddalia, (2007). Hydrological and environmental aspects of waters of the Bou Ismaïl bay between the continental influence and the open sea waters. Geophysical Research Abstracts, Vol. 9, 05623. European Geosciences Union 2007

6 - Rapport de l'IFREMER, 2010. Rapport pour la commission Européenne sur l'autrophisation dess eaux Marines et saumâtres en Europe, en particuler en France