REPUBLIQUE TUNISIENNE

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Ministère de l'Enseignement Supérieur
et de la Recherche Scientifique

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Direction Générale de la Recherche Scientifique
Direction des Structures de Recherche

IMPORTANT

- Les chefs des LR et UR, sont priés d'adresser le rapport d'activités 2016 de leurs équipes de recherche selon la modalité suivante :

  1- Remplir soigneusement ce formulaire (caractère Arial, 12) et l'envoyer, par la voie hiérarchique, en **un seul document papier** et relié avec une copie numérique (en PDF sur CD) au Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (Direction Générale de Recherche Scientifique) **avant le 30 Novembre 2016.**

  2- Transmettre le rapport complet avec les justificatives (en PDF) **par mail à l'adresse suivante** :
  Bilan.LRUR@gmail.com

- Pour des raisons d'organisation, toute activité non justifiée ainsi que tout dossier incomplet ou parvenu hors délais ne sera pas pris en considération.
- Le financement au titre de 2017 des LR/UR sera calculé sur la base de la production scientifique de 2016 et le reliquat du budget arrêté au 31/10/2016. La qualité de l'organisation du dossier sera fortement appréciée.

RAPPORT D'ACTIVITES 2016

- Université :					
- Etablissement **:**	**Institut National des Sciences et Technologies de la Mer (INSTM)**				
- Dénomination LR/UR :	Laboratoire Milieu Marin				
- Code LR/UR :	**LR11INSTM04**	- Discipline LR/UR :	**Sciences de la Mer**		
- Chef LR/UR :	**Ali Harzallah**				
- Grade :	**Professeur**	- Fonction :	**Chercheur**	- Etablissement :	**INSTM**
- Tél :	**71730420**	- Fax :	**71732622**	- Mobile:	**53859031**
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J'atteste, sur l'honneur, que les informations déclarées dans le présent rapport sont justes.

Le chef LR/UR (date et signature)

Le 11/01/2017

RESUME DES ACTIVITES DU LR/UR

(Limité au maximum à une page)

HISTORIQUE DU LR/UR (création et évolution)

Le Laboratoire du Milieu Marin (LMM) a été crée en 2002 comme quatrième laboratoire de l'INSTM. Le LMM a été crée suite à un besoin, qui s'était ressenti de plus en pressant, en connaissances approfondies en dynamique marine le long des côtes tunisiennes et des écosystèmes lagunaires tunisiens, pouvant aussi servir les autres laboratoires. Il a aussi été crée pour participer aux différentes études environnementales des écosystèmes marins fragiles ou en évolution rapide anthropogénique ou naturelle. C'est ainsi que les chercheurs de l'INSTM travaillant sur l'environnement marin se sont regroupés au sein du LMM. Le LMM opère grâce aux projets nationaux, mais aussi internationaux qui ont fortement contribué à sa visibilité à l'échelle internationale. Le LMM possède actuellement des groupes de recherche en observation marine avec ses différents aspects mais aussi en modélisation numérique. Ces deux aspects sont devenus nécessaires et complémentaires.

THEMATIQUES ESSENTIELLES DE RECHERCHE

- Ecosystèmes marins, évolution et impact des changements climatiques
- Dynamique des masses d'eau
- Ecologie et exploitation lagunaire
- Modélisation numérique du milieu marin et lagunaire
- Système d'informations géographiques : SIG
- Suivi des paramètres de pollution [métaux lourds – hydrocarbures et pesticides]
- Etude de la dynamique sédimentaire côtière et marine
- Hydrobiologie

BILAN GLOBAL DES ACTIVITES DE RECHERCHE (depuis la création du LR/UR)
(nombre total des publications, diplômes soutenus, brevets, conventions et autres résultats quantitatifs)

Depuis sa création LMM a réalisé plusieurs projets de recherche nationaux notamment sur les milieux lagunaires (lagune de Bizerte) et sur le milieu marin (golfe de Tunis et golfe Gabès). Il s'est aussi intéressé à la problématique des changements climatiques. Une étude des impacts des changements climatiques a permis de fournir une information utile sur l'évolution future du milieu marin tunisien. Le LMM a aussi participé à plusieurs études dans le cadre se son ouverture sur le milieu socio-économique et à plusieurs projets internationaux.

Nombre total de publications : Environ 20*14
Nombre total de diplôme soutenus : Environ 20*14
Nombre total de brevets : Environ 0
Nombre total de conventions : Environ 14

RESUME DU RAPPORT (2016)

Rubrique	Nombre
I- Ressources Humaines et espace de recherche	
I-1- Enseignants-chercheurs du corps A	**8**
I-2- Enseignants-chercheurs du corps B	**12**
I-3- Doctorants	**14**
I-4- Etudiants en mastère de recherche	**4**
I-5- Cadres ayant un grade équivalent au grade d'assistant de l'enseignement supérieur*	**11**
I-6- Espace total de recherche (bureaux et locaux de recherche) en m2	**416**
II- Production scientifique	
II-1- Publications impactées parues en 2016 (JCR)	**24**
II-2- Ouvrages scientifiques édités en 2016	
II-3- Articles (indexés ou nationaux) et chapitres d'ouvrage édités en 2016	**1**
II-4- Brevets d'invention (INNORPI, PCT et autres) déposés en 2016	**0**
II-5- Obtentions végétales enregistrées en 2016	**0**

II-6- Habilitations universitaires et agrégations HU soutenues en 2016	**1**
II-7- Thèses de doctorat soutenues en 2016	**2**
II-8- Mastères de recherche soutenus en 2016	**3**
III- Ouverture sur l'environnement (scientifique et socio-économique)	
III-1- Séminaires, journées et ateliers scientifiques organisés en 2016	**3**
III-2- Conventions signées avec des entreprises et partenaires socio-économiques en 2016	
III-3- Conventions et projets de coopération scientifique internationale singés en 2016	**4**
IV- Reliquat du budget arrêté au 30/10/2016	
IV- Reliquat du budget à l'exception du crédit alloué au titre de 2016 (montant en dinars)	**20580**

** Résidents en médecine, ingénieurs, médecins, médecins vétérinaires et autres.*

I- Composition de l'équipe de recherche (2016)

I-1 - Enseignants-chercheurs permanents (corps A et B) et doctorants

Corps A

(Insérer autant de lignes que nécessaire)

Grade(1)	Nom et prénom	N° C.I.N(2)	Etablissement	Université
Professeurs	Sammari Chérif	03625482	INSTM	
	Harzallah Ali	02944718	INSTM	
	Turki Souad	00118304	INSTM	
Maitres de conférences	Chouba Lassad	04004092	INSTM	
	Malika Belhassen	07007507	INSTM	
	M'zoughi Nadia	05180197	Borj Cedria	
	Messaoudi Sabri	06139797	INSTM	
	Ayadi Sameh	07762272	INSTM	

(I) Nombre total des enseignants-chercheurs (corps A) : ……8

Corps B

(Insérer autant de lignes que nécessaire)

Grade[1]	Nom et prénom	N° C.I.N[2]	Etablissement	Université
Maitres assistants	Hamza Asma	03888762	INSTM	
	Belaaj Amel	05296033	INSTM	
	Brahim Mouldi	01145280	INSTM	
	Bejaoui Béchir	056636898	INSTM	
	Zaaboub Noureddine	05503732	INSTM	
	Amrouni Oula	07031830	INSTM	
	Medhioub Walid	06831912	INSTM	
	Mastouri Abderrazak	03046781	INSTM	
			INSTM	
			INSTM	
			INSTM	
Assistants	Fathalli Afef	02329412	INSTM	
	Ennouri Rym	08376671	INSTM	
	Ben Ismail Hamoud Sana	08309009	INSTM	
	Armi Zina	02798432	INSTM	

[1] et grades équivalents.
[2] Obligatoire.

(II) Nombre total des enseignants-chercheurs (corps B) :……12…

Doctorants (préparant une thèse de doctorat es-sciences)

(Insérer autant de lignes que nécessaire)

Nom et prénom	N°C.I.N(3)	Etablissement-Université	Année de la première inscription	Nom et prénom de l'encadreur
Derouiche	Emna	FST	2008	Chouba
Hachani	Mohamed Amine	FST	2013	Turki
Ziadi	Boutheina	FST	2012	Turki
Fertouna Belakhal	Mouna	FSB	2011	Turki
Atoui	Abdelfattah	FST	2009	Sammari
Khammeri	Yosra	FSB	2012	Belhassen
jebri	Fatma	ENIT	2013	Sammari
Necibi	Mouna	FST	2012	Mzoughi
Dammak	Lamia	FSS	2015	Sammari
Ismail Sabeur	Hamza	FSS	2012	Belhassen
Abdelmouleh	Fatma	FSS	2014	Belhassen
Moncer	Malika	FSS	2015	Belhassen
Dhib	Amel	FST	2010	Turki
Ben Moussa	Thouraya	FST	2014	Amrouni

(III) Nombre total de doctorants :……14

I-2- Cadres ayant un grade équivalent au grade d'assistant de l'enseignement supérieur

(Insérer autant de lignes que nécessaire)

Nom et prénom	N° C.I.N(3)	Qualité(4)	Etablissement
Akrout Fourat		Ingénieur principal	INSTM
Souli Zouhour		Technicien sup	INSTM
Ben Kacem Yassin		Technicien sup	INSTM

Tissaoui Chérifa		**Technicien sup**	**INSTM**
Balti Noura		**Technicien sup**	**INSTM**
Hamdi Leila		**Technicien sup**	**INSTM**
Lahbib Soumaya		**Ingénieur**	**INSTM**
Barraj Nouha		**Ingénieur**	**INSTM**
Sahli Emna		**Ingénieur**	**INSTM**
Mahfoudhi Mabrouka		**Technicien sup**	
Bouali Houaida	**07830708**	**Ingénieur**	**INSTM**

(3)Obligatoire.

(4) Résidents en médecine, ingénieurs, médecins, médecins vétérinaires et autres.

(IV) Nombre total des cadres :……11…

TOTAL GENERAL (I)+(II)+(III)+(IV) : 8+12+14+11= 45

I-3- Etudiants en mastère de recherche

(Insérer autant de lignes que nécessaire)

Nom et prénom	N°C.I.N(5)	Etablissement-Université	Année de la première inscription	Nom et prénom de l'encadreur
Haifa Zaghouani	**08742837**	**ENIT**	**2014**	**C.Sammari**
Yosr Jazzar		**ENIT**	**2014**	**A.Harzallah**
Assia hamdi		**FSB**	**2014**	**B.Béjaoui**
Waiel Kalfallah		**FSB**	**2014**	**N.Zaaboub**

(5)Obligatoire.

II- Production scientifique 2016*

II-1- Liste des publications impactées (JCR) parues en 2016 (les communications ne sont pas demandées)

-Citez les références complètes des publications (auteurs, année, titre, journal, vol. et pages).

-Joindre obligatoirement, en annexes, une copie de la **première page** de chaque publication parue (dans l'ordre de la liste).

1. Llasses J., G. Jordà, D. Gomis, F. Adloff, D. Macías, **A. Harzallah**, T. Arsouze, N. Akthar, L. Li, A. Elizalde, G. Sannino (2016) Heat and salt redistribution within the Mediterranean Sea in the Med-CORDEX model ensemble, Climate Dynamics, doi:10.1007/s00382-016-3242-0

2. **Harzallah, A.,** Jordà, G., Dubois, C. Sannino G., Carillo A., Li L., Arsouze T., Cavicchia L.. Beuvier J., Akhtar N. (2016) Long term evolution of heat budget in the Mediterranean Sea from Med-CORDEX forced and coupled simulations. Clim Dyn (2016). doi:10.1007/s00382-016-3363-5.

3. **Béjaoui B., Armi Z.,** Ottaviani E., Barellib E., Gargouri-Ellouz E., Chérif R., **Turkie S.,** Solidoro C., Aleya L. (2016) Random Forest model and TRIX used in combination to assess anddiagnose the trophic status of Bizerte Lagoon, southern Mediterranean. Ecological Indicators 71 (2016) 293–301.

4. **Drira Z., Chaari D., Hamza A., Bel hassen M**., Pagano M., Ayadi H. **(2016)** Diazotrophic cyanobacteria signatures and their relationship to hydrographic conditions in the Gulf of Gabes, Tunisia. Journal of the Marine Biological Association of the United Kingdom, 1-12. doi:10.1017/S0025315415002210.

5. **Hamza I.S., Feki-SahnounW., Hamza A., BelHassen M. (2016)** Long term characterization of Trichodesmiumery thraeum blooms in Gabès Gulf(Tunisia). Continental Shelf Research124(2016)95–103.

6. **Jebri, F**., F. Birol, B. Zakardjian, J. Bouffard, and **C. Sammari** (2016), Exploiting coastal altimetry to improve the surface circulation scheme over the central Mediterranean Sea, J.Geophys. Res. Oceans, 121, doi:10.1002/2016JC011961.

7. Atoui, A., **M. Brahim, C. Sammari**, and L. Aleya, Surface sediment dynamics along the shore of Hammamet Gulf (Tunisia, southern Mediterranean), J. African Earth Sciences, 121 (2016), 168-179.

8. **Zaaboub N**.,, Helali, M.A., Martin M.V.A., **Ennouri R**., **Béjaoui B.,** da Silva, E.F, El Bour1 M., Aleya L. (2016) Assessing pollution in a Mediterranean lagoon using acid volatile sulfides and estimations of simultaneously extracted metals. Environ Sci Pollut Res. DOI 10.1007/s11356-016-7431-5

9. Maria Virginia Alves Martins, Anita Fernandes Souza Pinto, Fabrizio Frontalini , Maria Clara Machado da Fonseca, Denise Lara Terroso , Lazaro Luiz Mattos Laut, **Noureddine Zaaboub ,** Maria Antonieta da Conceicao Rodrigues , Fernando Rocha (2016) Can benthic foraminifera be used as bio-indicators of pollution in areas with a wide range of physiochemical variability? Estuarine, Coastal and Shelf Science xxx (2016) xxx-xxx

10. Mohamed Amine Helali, Walid Oueslati, *, **Noureddine Zaaboub**, Ayed Added, Lotfi Aleya (2016) Chemical speciation of Fe, Mn, Pb, Zn, Cd, Cu, Co, Ni and Cr in the suspended particulate matter off the Mejerda River Delta (Gulf ofTunis, Tunisia) Journal of African Earth Sciences 118 (2016) 35e44

11. Maria Virgínia Alves Martins ,Mohamed Amine Helali, **Noureddine Zaaboub**, Imen Boukef-Ben Omrane, Fabrizio Frontalini, Darlly Reis, Helena Portela, Iara Martins Matos Moreira Clement,, Leandro Nogueira, Egberto Pereira, Paulo Miranda, Monia El Bour, Lotfi Aleya (2016) Organic matter quantity and quality, metals availability and foraminiferal assemblages as environmental proxy applied to the Bizerte Lagoon (Tunisia) Marine Pollution Bulletin xxx (2016) xxx–xxx

12. MARIA VIRGÍNIA ALVES MARTINS, ULISSES DARDON, FABRIZIO FRONTALINI, EDUARDO FERREIRA DA SILVA, **NOUREDDINE ZAABOUB**, CLEVELAND M. JONES, EGBERTO PEREIRA, SÉRGIO BERGAMASCHI, JOÃO ALVEIRINHO DIAS, FERNANDO ROCHA (2016) RARE EARTH ELEMENTS USED AS FINGERPRINTS OF DIFFERENTIATED SEDIMENT SOURCES IN THE RIA DE AVEIRO (PORTUGAL). Journal of Sedimentary Environments Published by Universidade do Estado do Rio de Janeiro 1(1): 17-42, January-March, 2016

13. Ines Khedhri, Abdelfattah Atoui, **Mouldi Ibrahim**, Ahmed Afli, Lotfi Aleya (2016) Assessment of surface sediment dynamics and response of benthic macrofauna assemblages in Boughrara Lagoon (SW Mediterranean Sea). Ecological Indicators, Elsevier, 2016, 70, pp.77-88.<10.1016/j.ecolind.2016.06.011>

14. Nouha Khiari, Atoui Abdelfattah, **Mouldi Brahim, Chérif Sammari**, Abdelkrim Charef, Lotfi Aleya. Assessing surface sediment dynamics along the north-west coast of Marsa Dhouiba (Tunisia, southern Mediterranean). Journal of African Earth Sciences, Elsevier, 2016,<10.1016/j.jafrearsci.2016.01.015>.

15. **ENNOURI R., ZAABOUB N**., FERTOUNA-BELAKHAL M., **CHOUBA, L.**, ALEYA L. (2016). Assessing trace metal pollution through high spatial resolution of surface sediments along the Tunis coast (Southwestern Mediterranean). Environmental Science and Pollution Research, 23 (6), 5322-5334.

16. MILI S., **ENNOURI R.,** LAOUAR H., BEN ROMDHANE N. & MISSAOUI H. (2016) - Etude des peuplements piscicoles de la retenue du barrage de Sidi Salem. Journ. of New Scien., Agri. and Biotech., 27(1): 1454-1465.

17. **Mili S., ENNOURI R.,** DHIB A., LAOUAR H., MISSAOUI H. & ALEYA L. (2016) - Characterization of fish assemblages and population structure of freshwater fish in two Tunisian reservoirs: implications for fishery management. Environmental Monitoring and Assessment, 188 (364):1-11.

18. MILI S., **ENNOURI R.,** LAOUAR H. (2016) **-** Population status of freshwater fish in Tunisian reservoirs. Saving freshwater fishes and habitats, 11:32-34.

19. Dhib A., Denis M., Barani A., Turki S., Aleya L., 2016. Ultra- and microplankton assemblagesas indicators of trophic status in a Mediterranean lagoon. EcologicalIndicators 64: 59 – 71.

20. Hachani M.A., Ziadi B., Langar H., Djallouli A.S., Turki S., Aleya L., 2016. Mapping of the PosidoniaoceanicaDelilebarriere reef meadow in the southern gulf of Tunis (Tunisie). Journal of Earth African Sciences 121: 358- 364.

21. Dhib A., Fertouna Bellakhal M., Turki S., Aleya L., 2016. Driving factors of Dinoflagellates cyst distribution in surface sediments of a Mediterranean lagoon with limited access to the sea. Marine Pollution Bulletin MPB-07929; No of Pages 10.

22. K. Schroeder, J. Chiggiato, H. L. Bryden, M. Borghini and S. Ben Ismail - Abrupt climate shift in the Western Mediterranean Sea. Sci. Rep. 6, 23009; doi: 10.1038/srep23009 (2016).

23. YAHYAOUI Mohamed, ABDERRABBA Manef, AYADI Sameh, 2016 : Etude DFT des reactions de cycloaddition de type DIELS-ALDER sur la molecule du fullerene». J. MAR. CHIM. HETEROCYCL, 2016, vol 15 (1), 62.

24. Sameh Ayadi, Manef Abderrabba 2016 : Etude DFT et modélisation des reactions d'époxydation de coumarine et de monoterpene (DFT study and modeling of epoxidation reactions from coumarin and monoterpene »., J. MAR. CHIM. HETEROCYCL, 2016, vol 15 (1), 2

Clim Dyn
DOI 10.1007/s00382-016-3242-0

Heat and salt redistribution within the Mediterranean Sea in the Med-CORDEX model ensemble

J. Llasses[1] · G. Jordà[1] · D. Gomis[1] · F. Adloff[2] · D. Macías[3] · A. Harzallah[4] · T. Arsouze[5] · N. Akthar[6] · L. Li[5] · A. Elizalde[7] · G. Sannino[8]

Received: 31 December 2015 / Accepted: 15 June 2016

Abstract Characterizing and understanding the basic functioning of the Mediterranean Sea in terms of heat and salt redistribution within the basin is a crucial issue to predict its evolution. Here we quantify and analyze the heat and salt transfers using a simple box model consisting of four layers in the vertical for each of the two (western and eastern) basins. Namely, we box-average 14 regional simulations of the Med-CORDEX ensemble plus a regional and a global reanalysis, computing for each of them the heat and salt exchanges between layers. First, we analyze in detail the mechanisms behind heat and salt redistribution at different time scales from the outputs of a single simulation (NEMOMED8). We show that in the western basin the transfer between layer 1 (0–150 m) and layer 2 (150–600 m) is upwards for most models both for heat and salt, while in the eastern basin both transfers are downwards. A feature common to both basins is that the transports are smaller in summer than in winter due to the enhanced stratification, which dampen the mixing between layers. From the comparison of the 16 simulations we observe that the spread between models is much larger than the ensemble average for the salt transfer and for the heat transfer between layer 1 and layer 2. At lower layers (below 600 m) there is a set of models showing a good agreement between them, while others are not correlated with any other. The mechanisms behind the ensemble spread are not straightforward. First, to have a coarse resolution prevents the model to correctly represent the heat and salt redistribution in the basin. Second, those models with a very different initial stratification also show a very different redistribution, especially at intermediate and deep layers. Finally, the assimilation of data seems to perturb the heat and salt redistribution. Besides this, the differences among regional models that share similar spatial resolution and initial conditions are induced by more subtle mechanisms which depend on the variable and

This paper is a contribution to the special issue on Med-CORDEX, an international coordinated initiative dedicated to the multi-component regional climate modelling (atmosphere, ocean, land surface, river) of the Mediterranean under the umbrella of HyMeX, CORDEX, and Med-CLIVAR and coordinated by Samuel Somot, Paolo Ruti, Erika Coppola, Gianmaria Sannino, Bodo Ahrens, and Gabriel Jordà.

Electronic supplementary material The online version of this article (doi:10.1007/s00382-016-3242-0) contains supplementary material, which is available to authorized users.

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Published online: 25 June 2016

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DOI 10.1007/s00382-016-3363-5

Long term evolution of heat budget in the Mediterranean Sea from Med-CORDEX forced and coupled simulations

Ali Harzallah[1] · Gabriel Jordà[2] · Clotilde Dubois[3] · Gianmaria Sannino[4] · Adriana Carillo[4] · Laurent Li[5] · Thomas Arsouze[6] · Leone Cavicchia[7] · Jonathan Beuvier[8] · Naveed Akhtar[9]

Received: 25 December 2015 / Accepted: 15 September 2016

Abstract This study evaluates the Mediterranean Sea heat budget components from a set of forced and coupled simulations performed in the frame of the Med-CORDEX project. The simulations use regional climate system models (RCSMs) dedicated to the Mediterranean area and driven by the ERA40/ERA-Interim reanalyses. The study focuses on the period 1980–2010. Interannual variations of the average net heat flux at the sea surface are consistent among models but the spread in the mean values is large (from −4.8 to +2.2 Wm^{-2}) with the coupled models showing the lowest heat loss from the sea. For the heat flux at the Strait of Gibraltar both interannual variations and mean values show a large intermodel spread. The basin average temperature shows positive trends with highest values in the coupled models; it also shows interannual variations that are in good agreement with observations. The heat content rate is calculated based on the derivative of the average temperature and is found to be significantly correlated for most models with the net heat flux at the sea surface (average correlation –0.5) but not with the net heat flux through the Strait of Gibraltar (average correlation –0.2), suggesting that in the considered RCSMs the interannual variability of the heat content rate is mainly driven by the surface heat fluxes. The resemblance between the simulated and observed heat content rates is stronger in the forced models than in the coupled ones. This is explained by the stronger constraint applied to the forced models by the use of the surface temperature relaxation to observations. The temperature of the outflowing water through the Strait of Gibraltar shows positive and significant trends, also higher in the coupled models. It is suggested that the Mediterranean Sea warming found in most models and in particular in the coupled ones, induces a change of the hydrographic conditions that affects the Strait of Gibraltar.

Keywords Mediterranean Sea · Heat budget · Heat content · Strait of Gibraltar · Regional climate models

This paper is a contribution to the special issue on Med-CORDEX, an international coordinated initiative dedicated to the multi-component regional climate modelling (atmosphere, ocean, land surface, river) of the Mediterranean under the umbrella of HyMeX, CORDEX, and Med-CLIVAR and coordinated by Samuel Somot, Paolo Ruti, Erika Coppola, Gianmaria Sannino, Bodo Ahrens, and Gabriel Jordà.

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Random Forest model and TRIX used in combination to assess and diagnose the trophic status of Bizerte Lagoon, southern Mediterranean

Béchir Béjaoui[a], Zina Armi[a], Ennio Ottaviani[b], Enrico Barelli[b], Emna Gargouri-Ellouz[c], Rim Chérif[c,d], Souad Turki[e], Cosimo Solidoro[f], Lotfi Aleya[g,*]

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ABSTRACT

A combined multimetric trophic index (TRIX) and the Random Forest (RF) model were used to characterize the trophic status of Bizerte Lagoon. The RF model was used to build a predictive model of chlorophyll *a* using physicochemical variables (nitrite, nitrate, ammonium, phosphate, oxygen, temperature and salinity) as predictors. The approach is based on physicochemical and biological parameters measured in samples collected twice weekly from January to December 2012 at one representative sampling station located at the lagoon center.

The observed TRIX values vary from 5.18 to 6.12, reflecting waters ranging from moderate to poor quality with a high trophic level. The results of the RF model show that the most important predictor of chlorophyll *a* variation appears to be dissolved oxygen, followed by nitrate and temperature, suggesting a reduced model for this variable. The link between chlorophyll *a* and observed variables was also studied using numerical models, analyzing the linear statistical correlations and a recently proposed non linear model, the Random Forest. Both methods highlight a high correlation between chlorophyll *a* and dissolved oxygen as opposed to chlorophyll *a* and nitrate.

1. Introduction

Lagoons are coastal marine water bodies situated in transitional zones between continental water and the marine environment (Pérez-Ruzafa et al., 2011). Of high socio-economic value, they are usually considered a resource for fishing and aquaculture, as well as a nursery area for many species. They are, however, exposed to pollution and eutrophication (Diaz and Rosenberg, 2008; Martins et al., 2015). In most cases, eutrophication in coastal lagoons is related to anthropogenic activities such as nutrient loading generated by intensive farming (Casabianca et al., 1997; Anderson et al., 2002; Solidoro et al., 2005) and to the expansion of confined areas generally associated with the construction of jetties and marinas (Garcés et al., 2000; Fertouna-Bellakhal et al., 2015).

It is widely recognized that assessment of eutrophication in coastal ecosystems is complex since a number of variables, including cause (nitrate, nitrite, ammonium, phosphate) and response (chlorophyll *a*) variables are interrelated (Ignatiades et al., 1992; Vollenweider et al., 1992).

In addition, these parameters show annual trends and fluctuations depending on local conditions, seasonal variations and hydrodynamic circulation, as well as chemical and biological processes (Strain and Yeats, 1999; Spatharis et al., 2007). It becomes obvious that neither univariate approaches (Karydis et al., 1983; Karydis, 1996), nor derived indices can adequately describe the trophic status of a coastal marine system. Several methods are thus

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Diazotrophic cyanobacteria signatures and their relationship to hydrographic conditions in the Gulf of Gabes, Tunisia

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Changes in the planktonic cyanobacteria structure, composition and diversity were followed over three consecutive years (2005–2006–2007) in the Gulf of Gabes (Eastern Mediterranean Sea, Tunisia). Cyanobacteria abundances, biomasses and cell lengths were measured together with selected environmental variables (pH, salinity, temperature and nutrients). The space and time variations of the cyanobacteria in relation to the environmental factors showed a close relationship between these plankton communities and the hydrographic structure of the water column. Cyanobacteria developed over semi-mixed conditions (May–June 2006) and during the thermal stratification (July 2005). The cyanobacterial abundance and biomass was evident between 20 and 35 m in inshore stations and between 20 and 25 m in deeper stations during the semi-mixing conditions and stratification. This thermocline level coincided with the euphotic layer (21.85 ± 3.76 m) allowing access of light radiation. The cyanobacteria bloom occurred during May–June 2006 when the N/P ratio (<10) was clearly below the accepted standard molar ratio of N/P = 16/1. Commonalities among cyanobacterial genera include being highly competitive for low concentrations of inorganic P (DIP) and the ability to acquire organic P compounds. Our study showed that both diazotrophic (N_2-fixing) cyanobacteria such as Anabaena sp., Chroococcus sp., Trichodesmium erythraeum, Spirulina sp. and Spirulina subsalsa and non-diazotrophic cyanobacteria such as Pseudanabaena sp. and Microcystis display a great flexibility in the N sources which allow formation of blooms.

Key words: Gulf of Gabes, diazotrophic cyanobacteria, water column, inshore area, offshore area, mixing conditions, stratification, thermocline, nutrient compounds, N/P ratio

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INTRODUCTION

Primary production is nitrogen-limited in most marine ecosystems (Grasshoff *et al.*, 1990; Kivi *et al.*, 1993; Tuomainen *et al.*, 2003). Nitrogen fixation, nitrification and denitrification, which are all microbially mediated, are the key processes for determining the availability of nitrogen (Tuomainen *et al.*, 2003; Sorokovikova *et al.*, 2013; Stief *et al.*, 2014). Cyanobacteria are the major biomass producers both in aquatic and terrestrial ecosystems and represent more than 50% of the biomass in many aquatic ecosystems (Häder *et al.*, 2007). Cyanobacteria appear to be responsible for most of planktonic N_2 fixing in aquatic ecosystems and this ability gives a significant competitive advantage to these organisms during periods of nitrogen limitation (Tilman *et al.*, 1982; Howarth *et al.*, 1988; Leppänen *et al.*, 1988; Gallon, 1992; Zehr *et al.*, 2001; Paerl & Otten, 2013).

Diazotrophic (nitrogen-fixing) cyanobacteria are important contributors of new nitrogen to oligotrophic environments and greatly influence oceanic productivity (Berman-Frank *et al.*, 2007). The factors controlling N_2 fixation are still poorly known in the Mediterranean Sea (Ridame *et al.*, 2011). As the Mediterranean Sea has been described as a phosphate-depleted basin, phosphorus can be logically suspected to be the limiting nutrient for diazotrophic activity (Ridame *et al.*, 2011). The Mediterranean Sea is strongly impacted by episodic Saharan dust deposition (e.g. Guerzoni *et al.*, 1999; Guieu *et al.*, 2010). It has been shown that new atmospheric nutrients associated with Saharan dust pulses significantly stimulate N_2 fixation in the Mediterranean Sea and that N_2 fixation is a key process in the carbon cycle in oligotrophic environments such as the Gulf of Gabes (Driss *et al.*, 2008; Ridame *et al.*, 2013; Elloumi *et al.*, 2015). Despite being oligotrophic, the Gulf of Gabes accounts for 65% of Tunisian fish production (DGPA, 2005–2009) and is a well-known habitat for marine turtles such as *Caretta caretta* and *Chelonia mydas* (Maffucci *et al.*, 2006; Lotze & Worm, 2009). We hypothesized that, although the Gulf of Gabes is an oligotrophic ecosystem, the diazotrophic

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Long term characterization of *Trichodesmium erythraeum* blooms in Gabès Gulf (Tunisia)

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ABSTRACT

The present paper reports on a twenty six year monitoring of the diazotrophic cyanobacteria, *Trichodesmium erythraeum* in the Gulf of Gabès associated with environmental parameters and meteorological variables. *Trichodesmium erythraeum* blooms were not recurrent all years and were observed on average 2.11 times per year over the period between 1988 and 2013. Blooms were associated with temperature exceeding 24 °C and wind speed generally less than 5 m s^{-1}. *Trichodesmium erythraeum* reached very high densities fluctuating between 0.12×10^6 and 720×10^6 trichomes dm^{-3}. The wind speed during dust events and the number of dust days per year were highly correlated to *Trichodesmium* abundances. Two wind regimes during dust events were identified. The South–South East direction crossing the Tunisian desert generated the most intensive blooms. High dissolved inorganic nitrogen concentrations (2 – 14.6 μM) and orthophosphate concentrations (0.05–2.79 μM) were observed during bloom events leading to high N/P ratio well above the Redfield ratio and fluctuating linearly as function of *Trichodesmium* abundance. The anomalous N/P ratio could result from *Trichodesmium erythraeum* biological N_2 fixation and/or the contribution of atmospheric deposition.

1. Introduction

Trichodesmium is a photosynthetic, nitrogen fixing cyanobacterium whose importance has been recognized since the seventies (Carpenter and Price, 1977). This filamentous non-heterocystous organism has a unique physiology that employs both temporal and spatial segregation of N_2 fixation and photosynthesis that allow it to simultaneously fix N_2 and CO_2 without heterocyst (Berman-Frank, 2001). *Trichodesmium* spp. can form extensive blooms which range in color from yellow to brown and can be observed by satellite (Capone et al., 1997; Dupouy et al., 2011). *Trichodesmium* blooms generally occur in surface waters of oligotrophic tropical and subtropical oceans (Capone et al., 1997). For a period of 5 years (January 1998 to December 2003), Westberry and Siegel, (2006) showed that a more frequent bloom fell within 20 °N and 20 °S, the latitude range with high occurrence in the Arabian Sea and in the eastern Pacific Ocean, where bloom quantities of *Trichodesmium* can populate in these regions approximately one third of the time. Other areas of less occurrence were also reported in literature as the eastern tropical Atlantic (Tyrrell et al., 2003; Ramos et al., 2005), the southern Indian Ocean, the eastern tropical north Pacific, the north eastern Pacific coast (Westberry and Siegel, 2006) and in the Great Barrier Reef (Australia) (Bell et al., 1999). *Trichodesmium* abundance was roughly limited to waters warmer than 20 °C (Capone et al., 1997; Subramaniam et al., 2002). Several other factors were demonstrated to contribute to this proliferation, such as phosphorus (P) and iron (Fe) availability (Moutin et al., 2005; Lenes et al., 2008). Atmospheric input which provides both natural (Saharan dust) and anthropogenic aerosols can also be considered as an important factor stimulating *Trichodesmium* bloom formation (Lenes et al., 2008).

In the Mediterranean Sea, *Trichodesmium* spp. has barely been detected (Bar-Zeev et al., 2008; Yogev et al., 2011; Le Moal et al., 2011). The first record of *Trichodesmium erythraeum* bloom (1.2×10^7 trichomes dm^{-3}) was recently observed in Lesvos Island Aegean Sea, during September 2010 (Spatharis et al., 2012). The bloom formation in this part of the eastern Mediterranean Sea followed an extended period of the high sea surface temperature and low wind speed (Spatharis et al., 2012).

The Gulf of Gabès is located in the South of Tunisia (NE Mediterranean, 33 °N and 35 °N), bordering the North African coast which is widely considered as the Earth's largest source of dust (N'Tchayi et al., 1997; Prospero et al., 2002; Washington et al., 2003). In July 1988, discolored water was observed in different areas of the Gulf of Gabès. The phytoplankton species responsible

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Surface sediment dynamics along the shore of Hammamet Gulf (Tunisia, southern Mediterranean)

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ABSTRACT

In the summer of 2015 the authors analysed grain size and surface sediment composition through high spatial resolution from samples taken at 53 stations along the Hammamet coast (southern Mediterranean Sea). The Acoustic Doppler Current Profiler deployed in this study showed that the surface current flows toward the north-east, parallel to the coast at a maximum speed along the main axis of about 5.0 cm s^{-1}. Near the bottom the current flows toward the north-west at a maximum speed of 2.2 cm s^{-1}. The tide plays a relatively small role in water circulation in Hammamet Gulf. Spatial distribution of particle size, along with speed and current direction analysis, furnish an overview of the gulf's sediment dynamics and transport. The sands are categorised as moderately sorted, well sorted or very well sorted. Particle size distribution of surface sediments from the coast to a depth of 25 m offshore shows a decreasing trend in the offshore direction. Mineralogical analysis shows that Hammamet's coastal sands are composed of two main minerals: quartz and calcite. Magnesium calcite and aragonite are present in small amounts.

Sediment dynamics along the Hammamet Gulf shores are complex, being subject to the effect of swells and secondarily of tides. We encourage the implementation of responsible environmental management procedures in order to help preserve the site.

1. Introduction

Along its 1300 km coastline, eastern Tunisia is endowed with a wide variety of environments and natural landscapes, along with an archaeological heritage of great value (Hannachi et al., 2011; Anane et al., 2014; Khiari et al., 2016). This stretch of coastline, known as the coast of Enneficha, concentrates more than 60% of the country's population and nearly all of its touristic and industrial activities (Affi et al., 2008). This affects the coastal environment, the landscape and land cover patterns, and intensifies erosion (Ben Romdhane et al., 2002; Trabelsi et al., 2013), yet no information on spatial distribution, composition or size of mineral particles is available, nor have any investigations been undertaken of the influence of the area's currents, winds and waves on particle erosion, transport or deposition. This is unfortunate since it is recognised that, for example, 1) the Enneficha coastline's sediment balance is highly sensitive to any changes occurring in the environment due to human or natural interference, and 2) trace elements causing harm to marine biotas and flora (Galgani et al., 2009; Zaaboub et al., 2015; Martins et al., 2016; Helali et al., 2016) are usually associated with fine-grained sediments due to their high surface-to-volume ratios and adsorption capability (Belabed et al., 2013; Helali et al., 2016).

Located within this eastern coastal zone, the shore of Hammamet Gulf, which harbours the marina of Yasmine Hammamet and the Sahel domain (Fig. 1), concentrates nearly half of the country's tourist potential. The area is currently undergoing a growth in industrial activity which is endangering the environment (Elgharsalli et al., 2015), and shows signs of a precarious balance along the coastline (beach erosion processes and shoreline retreat). In particular, there is a worrying process of erosion on the coastline as 40 of the 500 km of sandy coast are seriously affected. Indeed, between Bouficha and Hergla, the hydrographic network is dense but no streams flow directly into the sea; their waters accumulate in sabkhas—an Arabic word designating a coastal and inland saline mud flat built up by the deposition of silt, clay and sand in shallow depressions—along the coast (Brahim et al., 2015a,b). During floods, the sabkhas overflow and sediment particles transported along the watershed become a valuable source of sediments to the beach. Two dams have been built on Lebna and Chiba Streams. The

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AGU PUBLICATIONS

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RESEARCH ARTICLE

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Key Points:
- Assessment of conventional altimetry over the wide shelf of Tunisia
- Monitoring seasonal variability of the Atlantic Tunisian Current/Atlantic Ionian Stream and associated features from altimetry
- Coastal altimetry is able to detect the slope circulation in the central Mediterranean Sea

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Exploiting coastal altimetry to improve the surface circulation scheme over the central Mediterranean Sea

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Abstract This work is the first study exploiting along track altimetry data to observe and monitor coastal ocean features over the transition area between the western and eastern Mediterranean Basins. The relative performances of both the AVISO and the X-TRACK research regional altimetric data sets are compared using in situ observations. Both products are cross validated with tide gauge records. The altimeter-derived geostrophic velocities are also compared with observations from a moored Acoustic Doppler Current Profiler. Results indicate the good potential of satellite altimetry to retrieve dynamic features over the area. However, X-TRACK shows a more homogenous data coverage than AVISO, with longer time series in the 50 km coastal band. The seasonal evolution of the surface circulation is therefore analyzed by conjointly using X-TRACK data and remotely sensed sea surface temperature observations. This combined data set clearly depicts different current regimes and bifurcations, which allows us to propose a new seasonal circulation scheme for the central Mediterranean. The analysis shows variations of the path and temporal behavior of the main circulation features: the Atlantic Tunisian Current, the Atlantic Ionian Stream, the Atlantic Libyan Current, and the Sidra Gyre. The resulting bifurcating veins of these currents are also discussed, and a new current branch is observed for the first time.

1. Introduction

The circulation of the Mediterranean Sea is relatively complex because of the basin geometry, which is divided into several small subbasins, and its rugged topography (Figure 1). Inflowing Atlantic Water flows at the surface through the Strait of Gibraltar. It is transformed along its path in the basin into denser Mediterranean water that in turns enters the North Atlantic through Gibraltar. Surface currents, strongly influenced by atmospheric forcing, have temporal variability from diurnal to inter-annual scales and follow tortuous paths constrained by the bathymetry [*Millot*, 1999]. Further east of Gibraltar, the Atlantic Water flow forms the coastal "Algerian current," which widens and deepens eastward [*Millot*, 1999]. Part of the Algerian Current continues to flow along the northern coast of Sicily as the Bifurcation Tyrrhenian Current [*Béranger et al.*, 2004; *Sorgente et al.*, 2011]. Downstream of the Algerian Basin, the Tunisia-Sicily Channel and its immediate surroundings are key dynamic regions that modulate the passage of the surface and intermediate water masses between the Eastern and Western Mediterranean Sea [*Sorgente et al.*, 2011]. There, surface circulation shows two main branches. The first branch consists of an Atlantic Water jet (known as AIS, the Atlantic Ionian Stream, Figure 1) that flows along the southern coast of Sicily [*Robinson et al.*, 1999] and meanders around mesoscale vortices such as the Adventure Bank Vortex and the Ionian Shelf Vortex [*Lermusiaux and Robinson*, 2001]. The AIS transports the Atlantic Water into the eastern Mediterranean Sea through the Strait of Sicily. This current flows toward the southeast or can turn northward in an anticyclonic loop when it enters the Ionian Sea [*Lermusiaux and Robinson*, 2001]. The second branch of Atlantic Water is a slope current flowing close to the 200 m isobath until it reaches Lampedusa Island; this current is known as the Atlantic Tunisian Current (ATC, Figure 1) [*Sammari et al.*, 1999] and is still poorly documented except by sparse in situ observations. South of Lampedusa, the ATC also splits into two branches: the first one enters onto the continental shelf in the Gulf of Gabes and the second one directly reaches the African coast and heads east toward Libya [*Alhammoud et al.*, 2004; *Béranger et al.*, 2004; *Hamad et al.*, 2006]. Part of this

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RESEARCH ARTICLE

Assessing pollution in a Mediterranean lagoon using acid volatile sulfides and estimations of simultaneously extracted metals

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Abstract Bizerte Lagoon is a southern Mediterranean semi-enclosed lagoon with a maximum depth of 12 m. After assessing sediment quality, the authors report on the physico-chemical characteristics of the lagoon's surface sediment using SEM (simultaneously extracted metals) and AVS (acid volatile sulfides) as proxies. Biogeochemical tools are used to investigate the environmental disturbance at the water–sediment interface by means of SEM and AVS to seek conclusions concerning the study area's pollution status. Results confirm accumulation of trace elements in sediment. The use of the SEM-AVS model with organic matter in sediment (fOC) confirms possible bioavailability of accumulated trace elements, especially Zn, in the southern part of the lagoon, with organic matter playing an important role in SEM excess correction to affirm a nontoxic total metal sediment state. Individual trace element toxicity is dependent on the bioavailable fraction of SEM_{Metal} on sediment, as is the influence of lagoon inflow from southern water sources on element bioavailability. Appropriate management strategies are highly recommended to mitigate any potential harmful effects on health from this heavy-metal-based pollution.

Keywords Lagoon · Sediment–water interface · Metal analysis · SEM, AVS

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Introduction

Bizerte Lagoon is a semi-enclosed water body located in northern Tunisia, connected to the Mediterranean Sea to the east and to Ichkeul Lake to the west. The lagoon is considered an important ecosystem for shellfish aquaculture, fisheries, and industrial and commercial activities in developing Tunisia (FAO 2015). In recent years, it has suffered considerable anthropic damage, as mass mortality of mussels and harmful algal blooms (HAB) have been recorded (Turki et al. 2014; Fertouna-Bellakhal et al. 2015; Martins et al. 2015). Indeed, with its ten shellfish farms covering a total area of 230 ha, the lagoon has seen its production drop dramatically in recent years: from 1200 tons in 2010, production fell in 2011, 2012, and 2013 to 169, 117, and 85 tons, respectively. Several factors including temperature, HAB, and pathogens have been inferred as the cause of these events (Turki et al. 2014; Fertouna-Bellakhal et al. 2014; FAO 2015). To be noted is the lagoon's biogeochemical water–sediment interface and the heavy sewage input which is trapped in the lagoon hypolimnion, especially in summer when rainfall is absent, thus preventing dilution or elimination (Zaaboub et al. 2015). In addition, marine inflow is strong in summer with the waters moving in a southeastern direction, eventually reaching the eastern sector where the water mass drops to the bottom. Flow direction is then reversed, moving northwest through

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Can benthic foraminifera be used as bio-indicators of pollution in areas with a wide range of physiochemical variability?

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ABSTRACT

The Ria de Aveiro, a lagoon located in the NW coast of Portugal, presents a wide range of changes to the natural hydrodynamical and physicochemical conditions induced for instance by works of port engineering and pollution. In order to evaluate the response of living benthic foraminifera to the fluctuations in physicochemical parameters and pollution (metals and TOC), eight sediment samples were collected from canals and salt pans within the Aveiro City, in four different sampling events. During the sampling events, salinity showed the most significant fluctuations among the physicochemical parameters with the maximum range of variation at Troncalhada and Santiago salt pans. Species such as *Haynesina germanica*, *Trochammina inflata* and *Ecrtia macrescens* were found inhabiting these hypersaline environments with the widest fluctuations of physicochemical parameters. In contrast, *Ammonia tepida* dominated zones with high concentrations of metals and organic matter and in lower salinity waters. Parameters related to benthic foraminiferal assemblages (i.e., diversity and evenness) were found to significantly decline in stations polluted by metals and characterized by higher TOC content. Foraminiferal density reduced significantly in locations with a wide range of physicochemical temporal variability. This work shows that, even under extreme conditions caused by highly variable physicochemical parameters, benthic foraminiferal assemblages might be used as valuable bioindicators of environmental stress.

1. Introduction

Coastal environments such as lagoons, estuaries and bays are transitional areas that commonly display high biodiversity and serve as nursery and refuge for numerous species (Kennish and Paerl, 2010). These areas are also densely populated and influenced by high anthropic pressure (Kennish, 1992) that induces adverse effects on the living organisms and in the ecosystem thereof (Castro et al., 2006). Assessment of the environmental quality in coastal environments can not only be achieved by analyzing the abiotic factors (i.e., metal concentrations, presence of persistent organic pollutants, and amount of organic matter) but also through the evaluation of organisms living therein (e.g., Borja et al., 2009; Hamza-Chaffai, 2014).

Since the beginning of the 1960's, benthic foraminifera have been widely used as environmental bioindicators in coastal areas (Alve, 1995; Yanko et al., 1998; Dimiza et al., 2016a, b). Changes to the abundance and diversity of benthic foraminifera as well as to the composition of the assemblages are commonly used to assess environmental quality in coastal areas (Frontalini and Coccioni, 2011). Among the different types of pollutants, metals are widely reported to negatively impact foraminiferal assemblages (Frontalini and Coccioni, 2008; Martins et al., 2013, 2015a, b).

In the light of previous research on application of benthic foraminifera as bioindicators, this work intends to investigate if foraminifera are suitable to be used as bioindicators in a polluted area with a wide range of physiochemical variability. The Aveiro City canals (Portugal) were selected for this study since they undergo temporal variability of physicochemical parameters and are considerably polluted (Martins et al., 2010). Additionally, two salt pans characterized by low pollution but the highest seasonal variability of physicochemical parameters were also considered in this work. Several researches, aiming to assess the response of foraminiferal assemblages

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Chemical speciation of Fe, Mn, Pb, Zn, Cd, Cu, Co, Ni and Cr in the suspended particulate matter off the Mejerda River Delta (Gulf of Tunis, Tunisia)

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ABSTRACT

Fluxes of suspended particulate matter (SPM) and their associated metals were performed of the Mejerda River Delta during both the wet (March) and the dry (July) seasons in 2012, using sediment traps at study stations at depths of 10, 20 and 40 m. Fluxes nearest to the Mejerda outlet were more significant, especially during winter (3.6 g m^{-2} day^{-1}), but dissipated further offshore, 2.45–6 g m^{-2} day^{-1} at the 20 m and 21.8–4.8 g m^{-2} day^{-1} at the 40 m stations. Many variations observed in seasonal and spatial metal fluxes are similar to those of SPM, in particular Pb and Zn, probably because they are associated with the mining activity characteristic of the Mejerda catchment. Chemical speciation reveals that most of the metals (20–100%) are bound to the residual fraction. The most toxic metals (Pb, Zn) are bound in part to the exchangeable fraction (20–30% for Pb and 5–15% for Zn) making them relatively bioavailable and therefore potentially toxic. While Cu and Cd fluxes are not always clearly established according to season, both metals are apparently sequestered deep in the sediment, bound especially to clays (40–80% for Cd and up to 100% for Cu).

1. Introduction

Suspended particulate matter (SPM) in coastal ecosystems is essential as it contributes to the structuring of water masses along with providing the environmental conditions to support the production and the growth of plankton and fish species. However, SPM can also be loaded with contaminants such as heavy metals, mainly transported as both inorganic and organic suspended particles and deposited along the coast leading to disruption in the delicate food web (Belabed et al., 2013; Islam and Tanaka, 2004; Zaaboub et al., 2015; Martins et al., 2015). Various chemical reactions within the suspended particles occur prior to sedimentation of organic matter. For example, suspended particles are the subject of several physico-chemical processes including flocculation/coagulation (Sholkowitz, 1978; Erisma, 1986; Morris, 1986), desorption from suspended particle surfaces (Van der Weijden et al., 1977) and biological uptake (Turekian, 1977; Kuss and Kremling, 1999). Sediment traps were therefore adopted as a means to measure SPM and metal fluxes along the water column of different marine systems (Broman et al., 1994; Leivuori and Vallius, 1998; Kuss and Kremling, 1999; Matthai et al., 2002; Ergül et al., 2008; Nordmyr et al., 2008; Santos-Echeandía et al., 2011), yet no such studies have previously been conducted in western environments and certainly not in the Gulf of Tunis. Located in the western Gulf of Tunis, the Mejerda River is Tunisia's most important river and the main source of water and sediments for the gulf, with approximately 30 $m^3 s^{-1}$ water flow (Oueslati et al., 2006). As mining is extensive in the Mejerda catchment Mauldenauer et al., 2007), the location appeared ideal for the study of the qualitative and quantitative characteristics of SPM and its associated metals, with the additional hypothesis that clarification of the chemical speciation of metals bound to suspended particles would provide insight into the mechanisms of binding and transport of metals, helping to improve our knowledge as to their sequestration and bioavailability.

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Organic matter quantity and quality, metals availability and foraminiferal assemblages as environmental proxy applied to the Bizerte Lagoon (Tunisia)

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ABSTRACT

This study analyzes the benthic trophic state of Bizerte Lagoon (Tunisia) based on the total organic matter and the bioavailability of biopolymeric carbon including proteins (PTN), carbohydrates (CHO), lipids (LIP), chlorophyll *a*, as well as bacteria counts. The overall simultaneously extracted metals (SEM), and acid volatile sulfides (AVS) as well as the SEM/AVS ratio indicative of the toxicity of the sediments also were analyzed aiming to study their impact in the dimension, composition and structure of both dead and living benthic foraminiferal assemblages.

In the studied sites TOC content is relatively high and the PTN/CHO values indicate that they can be considered as meso-eutrophic environments. The CHO/TOC and C/N values suggest that the OM which accumulated on the sediments surface has mainly natural origin despite the introduction of municipal and industrial effluents in the lagoon and the large bacterial pool.

The living assemblages of benthic foraminifera of Bizerte Lagoon are quite different to other Mediterranean transitional systems studied until now. They are composed of typical lagoonal species but also include several marine and opportunistic species including significant numbers of bolivinids, buliminids, Nonionella/Nonionoides spp. and Cassidulina/Globocassidulina spp. These assemblages seem to benefit from the physicochemical parameters and the sediment stability. They may however face environmental stress in the lagoon related to the AVS production as a result of the organic matter degradation and toxicity in some areas due to the available concentrations of metals. Nonetheless statistical results evidence that the structure and dimension of assemblages are being controlled mostly by OM quantity and quality related mainly to the availability of PTN, CHO and chlorophyll *a*. Results of this work support the importance of considering OM quantity and quality in studies of environmental impact in coastal systems.

1. Introduction

Humans have always relied on the oceans and their resources, first as a food source (fishing), later for transportation of raw materials. Today, our oceans are also exploited for mineral, gas, oil, and other natural resources of great economic importance. It is noticeable that 50% of the world population lives in coastal areas or nearby regions (Sherbinin et al., 2007). Such a high population density along the coastal areas results in high environmental stress due to the multiple activities that take place there (Agardy et al., 2005). The discharge of municipal and agriculture effluents, for instance, may result in functional changes of coastal environments due to the entry of excessive nutrients that

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RESEARCH PAPER

RARE EARTH ELEMENTS USED AS FINGERPRINTS OF DIFFERENTIATED SEDIMENT SOURCES IN THE RIA DE AVEIRO (PORTUGAL)

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Abstract

This work focuses on the distribution and the controlling factors of rare earth element (REE) total concentrations and fractionation patterns in fine sediment fractions of 53 samples collected along the main channels of the Ria de Aveiro, a northern Portuguese coastal lagoon. Total and available concentrations and residual phases of REE and total concentrations in three chemically partitioned fractions (S1 - adsorbed by clay and co-precipitated with carbonates; S2 - adsorbed by organic matter; S3 - adsorbed by amorphous Mn hydroxides) are analysed. These data are jointly analysed with physicochemical, textural and mineralogical and other geochemical data.

Sediment samples mainly consisted of phyllosilicates, quartz, plagioclase and K–feldspars. Cerium (Ce) is the most abundant REE in the residual phase and displays the lowest total available percentage, whereas Yttrium (Y) is the most available. The highest total concentration and residual concentration (R) of Ce, Lanthanum (La), Scandium (Sc) and Y are mostly related to fine grained sediments, suggesting that their distributions are conditioned by lagoon hydrodynamics.

The dissimilar distribution of REE-S1, REE-S2 and REE-S3 indicates differentiated sedimentary processes. The enrichment of REE-S2 and REE-S3 is related essentially to biogeochemical processes inside the lagoon. The REE-S1, as well as Ce-S1/Sc-R, trace sediments supplied from the northern areas suplyed mostly by the Douro River outflow and from the Antuã River. In the past, the sediments suplyed by the Douro River through the litoral drift contributed to the formation of the lagoon islands. Thus the relatatively high Ce-S1/Sc-R values inside the lagoon allowed the identification of: sediments supplied from the litoral drift and deposited near the lagoon mouth, erosional processes of the lagoonal islands and sediments supplied by the Antuã River. This work demonstrates that the available concentrations of rare earth elements can be considered as important tools for investigating sediment sources and dispersion in a coastal system.

Keywords: Rare earth elements. Total concentrations. Sequential chemical extraction. Sedimentary dynamics. Coastal lagoon.

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Assessing surface sediment dynamics along the north-west coast of Marsa Dhouiba (Tunisia, southern Mediterranean)

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ABSTRACT

An investigation was conducted from summer 2012 to winter 2013 at 25 stations along the Tunisian coast near Ras Akhdar at Marsa Dhouiba (north-east Mediterranean Sea) to analyse grain size, sediment mineralogy and currents. Particle-size analysis shows that sand deposits at shallow depths are characterised by S-shaped curves, indicating a degree of agitation and possible transport by rip currents near the bottom. At greater depths (between 10 and 30 m), the bottom is covered by coarse sand and gravel. A current was observed transporting sediment eastward along the coast; another seaward current was also noted. Generated by wind, swell and especially waves from west to north-west, the two currents transport clay and silt-sized sediment seaward. An Acoustic Doppler Current Profiler showed Marsa Dhouiba's coastal current to follow a direction 175° East, with its main axis running north/north-west parallel to the coast and its minor axis also running north/north-west. Analysis of current components indicates that the velocities u and v are oriented north to south. Sediment evolution in shallow waters is dependent on detrital inputs from streams and winds. The coarse fraction of surface sediments in Marsa Dhouiba presents 87% of total sediments and is located at depths of 10–30 m. Sediment dynamics in the Marsa Dhouiba region are closely related to the west/north-west swell.

1. Introduction

It is well known that both anthropogenic and erosive pressures on coastal areas increase over time. Sandy shoreline areas, which constitute about 34% of global coastlines are complex and dynamic, subjected to numerous physical and sedimentary factors (Nourinson and Scapini, 2015). They suffer from human activities, resulting in an alteration of wave processes and longshore exchanges of sediments (Bourgou, 1998; Paskoff, 1998; Robenge and Long, 2003; Paskoff, 2004; Brahim et al., 2014, 2015). This, in turn, can affect intertidal species development leading to beach ecosystem dysfunctions (Spalding and Jackson, 2001; Nordstrom, 2014), and even leading to regrowth of disease-causing microbes, including harmful bacteria, viruses, nematode larva and eggs, and harmful yeast and fungi (Solo-Gabriele et al., 2015).

The coast of northern Tunisia, which is of ecological interest due to its untouched natural environment, is influenced by a regional western Mediterranean current, the Atlantic Water (AT), which enters the Straits of Sicily to split into two branches: one flowing to the south-eastern Mediterranean and the second, called the Atlantic Tunisian Current (ATC), flowing southwards along the Tunisian coast (Ben Ismail et al., 2012, 2014). Geo-morphologically varied, the area includes rocky shorelines, capes, dunes and beaches located along bays encased by steep cliffs of a diverse nature: carbonated sandstones dating from the Tyrrhenian and upper Pleistocene (Oueslati, 2004). The coast, however, has been altered due to expanding urbanization, ports, seaside resorts, and engineering structures such as dams and dikes which pose a threat by reducing the sediment supply (Helali et al., 2015; Ennouri et al., 2015; Zaaboub et al., 2015). Located within this northern coastal zone (Fig. 1), the pristine Marsa Dhouiba area is characterized by successive rocky outcrops that define sandy bays, naturally fed by sediments transported by the flow of its many streams. The area consists specifically of a bay approximately 3 km across and a beach lying between two capes. Furthermore, some of the beaches along

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Assessment of surface sediment dynamics and response of benthic macrofauna assemblages in Boughrara Lagoon (SW Mediterranean Sea)

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ABSTRACT

A study was conducted in the spring of 2009, the winters of 2010 and 2013, and in the summer of 2012 at 13 stations in Boughrara Lagoon, Tunisia (southern Mediterranean). The country's largest lagoon, it is considered to be an anthropogenically stressed area, though a major tourist centre—Djerba Island—is located along its northern shores. The lagoon bottoms were studied via analyses of grain size, surface sediment composition, total organic matter (TOM) and through the trophic and functional organisation of benthic macrofauna. The results indicate that the bottoms are composed of fine, medium or coarse sands and that sediment distribution is controlled by water movement. Estimation of TOM content revealed that the studied samples present both normal and imbalanced sediments. The structure and organisation of the lagoon's benthic macrofauna are dominated by select deposit feeders and underwent significant changes during the period 2010–2013.

Subjected for decades to increased pollution due to growing human activities in the surrounding area, Boughrara Lagoon now appears to be impacted by certain environmental/anthropogenic stressors, as indicated by the presence of pollution-tolerant bio-indicator species in the imbalanced area. The response of the lagoon ecosystem to changes in benthic sediment deposition provides a potential assessment tool for similar habitats elsewhere.

1. Introduction

Shallow coastal lagoons are frequently heavily stressed due to anthropogenic interference (Pérez-Ruzafa et al., 2011). This vulnerability may be exacerbated by natural constraints such as confinement and reduced access to the sea, as in the case of Boughrara Lagoon, Tunisia (southern Mediterranean). Sheltered by the Gulf of Gabes to which it is connected by the El Kantra (160 m wide) and the Ajim-Jorf Channels (2.2 km wide), the lagoon has a higher salinity level than the nearby sea (Abdenadher et al., 2012), ranging on average from 42.19 to 53.3 psu (Khedhri et al., 2015) due to evaporative concentration, with evaporation attaining an average of 147.22 mm in 2010 and 126.87 mm in 2013 (Khedhri et al., 2015). In addition, a considerable amount of organic matter is discharged into the lagoon waters in the harbours of Jorf, Ajim, Boughrara and Hassi Jalleba from aquaculture and other activities such as fishing boat traffic. Also, important quantities of phosphogypsum have been discharged for many years, affecting lagoon biodiversity (Ben Brahim et al., 2010; Drira et al., 2010; Rekik et al., 2012) by provoking repeated blooms of harmful dinoflagellates (Abdenadher et al., 2012). To date, monitoring efforts in Boughrara Lagoon have been focused on the deterministic factors of dinoflagellate blooms (Feki et al., 2013) and hydrology (DGPA: Direction Générale de la Pêche et de l'Aquaculture, 2001; Guetat et al., 2012), with no investigation of the ecosystem's general status being undertaken. Due to a lack of general research prior to the widening of the El Kantra Channel (2004–2007), no reports have appeared on sediment dynamics and grain size composition, or on benthic invertebrates known to be good indicators of the health status of ecosystems: inhabiting the sediment-water interface, such fauna are able to integrate any change occurring there (Warwick, 1986; Khattabi and Aleya, 2007; Blanchet et al., 2008; Extence et al., 2013). Marine sediment is, in fact, an essential part of aquatic life and acts as a receptacle for nutrients, heavy metals and pesticides (Köster and Meyer-Reil 2001; Zheng et al., 2014; Zaaboub et al., 2015). Surface sediment grain size and total organic matter (TOM)

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The mapping of the *Posidonia oceanica* (L.) Delile barrier reef meadow in the southeastern Gulf of Tunis (Tunisia)

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ABSTRACT

Barrier reefs are among the most important ecomorphosis for *Posidonia oceanica* meadows and have long been subjected to anthropic pressures. The authors mapped the entire Sidi Raïs (northeastern Tunisia) *Posidonia oceanica* barrier reef by means of remote sensing based on processing a satellite image acquired via Google Earth © software, coupled with field observations obtained by snorkeling. The map thus produced represents the *P. oceanica* barrier reef in its current state, covering a total area of 156.77 ha, the reef being divided into three distinct sections separated by reverse flows with each section subject to varied anthropic factors and disturbances.

1. Introduction

Posidonia oceanica (linnaeus) Delile is the dominant endemic seagrass in the Mediterranean Sea. Its meadows are considered to be among the most important and productive ecosystems in the coastal waters and are often compared to terrestrial forests (Boudouresque et al., 2012; De Groot et al., 2012; Unsworth et al., 2014). *P. oceanica* meadows are both a spawning site and nursery for many species of crustaceans and fish of commercial importance; they also help to control sediment fluxes and to protect beaches against erosion (Pergent et al., 1994; Francour, 1997; Ruiz et al., 2009; Ben Brahim et al., 2015).

Depending on varying factors (sediment balance and hydrodynamics), *P. oceanica* meadows may be of different morphostructural types (Ben Brahim et al., 2010, 2013). In calm conditions and in relatively shallow waters near the shore, *P. oceanica* may grow vertically, partially emerging from the surface to eventually form barrier reefs. This tends to occur in a pattern parallel to the coastline, leaving a sheltered area between the shore and the barrier, a back-reef area of shallow water where sediment settles under lagoon-like conditions (Bonhomme et al., 2015).

Coastal development has long exacted a heavy price from *P. oceanica* barrier reefs. Indeed, most sheltered bays have been occupied by ports (Peirano et al., 2005; Pergent-Martini et al., 2005; Erftemeijer and Robin Lewis, 2006; Leriche et al., 2006) which have now affected nearly all existing barrier reefs. Today, it is clear that most of the former *P. oceanica* barrier reefs are gone or in decline (Ardizzone et al., 2006; Boudouresque et al., 2009; Montefalcone et al., 2007a, 2010), with many meadows having disappeared in recent decades (Bianchi and Morri, 2000; Leriche et al., 2006; Montefalcone et al., 2007b), unfortunately so, as they are a unique structure in the biosphere.

In Tunisia, barrier reefs are present on many sheltered coastlines. Several works (Ben Alaya, 1972; Ben Mustapha and Hattour, 1992) have reported that, depending on location and, especially, on the extent of human impact, some barrier reef sites present a "poor" status or appear more or less "distorted". It is thus both urgent and useful to assess the conservation status of these reefs and to monitor their evolution. However, these studies are mostly out of date and each one concerns only a relatively small part of the specific barrier reef under study. It is therefore of interest to use mapping techniques (Pasqualini et al., 2005; Maccarrone, 2010)

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Driving factors of dinoflagellate cyst distribution in surface sediments of a Mediterranean lagoon with limited access to the sea

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ABSTRACT

Seasonal distribution of dinoflagellate cysts were studied at five surface sediment study stations in Ghar El Melh Lagoon (GML) (Tunisia) in relation to physicochemical parameters and phytoplankton abundance in the water column. At least sixteen dinocyst types were identified, dominated mainly by *Protoperidinium* spp., *Scrippsiella trochoidea* complex, *Lingulodinium machaerophorum*, *Alexandrium* spp. and *Gymnodinium* spp., along with many round brown cysts. Cyst abundance ranged from 0 to 229 g^{-1} dry sediment. No significant differences in cyst distribution were found among stations, though a significant variation was observed among seasons with cyst dominance in autumn. No significant variation was found between cyst abundance and the different abiotic factors monitored, neither in the water column (physicochemical parameters) nor in the sediment (TOC/TN). Low dinocyst abundance was consistent with the dominance of non-cyst-forming dinoflagellates in the GML water column.

1. Introduction

Dinoflagellates are a major component of the phytoplankton community in coastal ecosystems. At some point during their life cycle certain dinoflagellates produce resting cysts which are dormant stages with reduced metabolism that can survive in stressful conditions (Anderson et al., 1987; Bravo and Anderson, 1994; Fertouna-Bellakhal et al., 2014). Dinoflagellates can also produce temporary cysts for a relatively short period between their benthic and planktonic stages so as to help compensate for losses due to various causes (Anderson and Wall, 1978; Nagasaki et al., 2000). Over the last two decades cyst studies have attracted increasing interest due to the potential of cysts to form seed banks in sediments which are key stages in geographic distribution (Bolch and Reynolds, 2002; Marquardsen and Lechuang-Deveze, 2003) and also for their role in initiating harmful algal blooms (HAB) (Anderson et al., 1982; Garcés et al., 1999; McGillicuddy et al., 2003; Fertouna-Bellakhal et al., 2014). Furthermore, and despite the harm caused by these blooms (Hallegraeff, 1993; Anderson et al., 2002; Davidson et al., 2012, Béjaoui et al., 2016), the nuisance caused by dinoflagellate cysts may be even greater than that provoked by vegetative cells such as cysts of Alexandrium which contain PSP toxin levels several times higher than those found in motile cells (Oshima et al., 1992).

In the Mediterranean Sea, the composition of dinoflagellate resting cyst assemblages in recent sediments has been examined in only a few studies (Rubino et al., 2000, 2002; Giannakourou et al., 2005; Zonneveld et al., 2008; Satta et al., 2013). In Tunisia, two investigations in Bizerte Lagoon (Fertouna-Bellakhal et al., 2014; Zmerli Triki et al., 2014) have been reported, but, as far as we know, no studies have been conducted in Ghar El Melh Lagoon (GML, southern Mediterranean Sea) despite the area's varied and interesting features, as reflected by its large cyst community. For example:

(i) GML has had episodes of harmful dinoflagellate blooms (Rzemhane et al., 1998; Turki et al., 2007; Dhib et al., 2013a, 2015) of toxic cyst-forming species such as *Alexandrium* spp., with concentrations that in 1995–1996 exceeded 1.5–10^6 cells per litre and that have coincided with high fish mortality in the field (Rzemhane et al., 1998);
(ii) GML shelters a benthic vegetation dominated by *Ruppia cirrhosa* meadows (Shili et al., 2002) which spread spectacularly in summer and whose leaves have also been overwhelmed by harmful epiphytic microalgae (Dhib et al., 2013b);
(iii) the dominance of muddy areas in GML (Chalrouni, 2004; Rasmussen et al., 2009) known to harbor enhanced water and organic matter contents and enriched concentrations of dinoflagellate cysts (Fraud-Le-Denn et al., 1993; Yamaguchi et al., 1996); and
(iv) the peculiarity of GML as a semi-enclosed area (only one opening to the sea) with very shallow waters (maximum = 2 m), a substantial rise in salinity (up to 51) usually recorded in hyaline ecosystems (Abid et al., 2008), with no nutrient exhaustion throughout the year (Dhib et al., 2015), and the influence of

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Ultra- and microplankton assemblages as indicators of trophic status in a Mediterranean lagoon

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ABSTRACT

The seasonal abundance distribution of heterotrophic prokaryotes, pico- and nanophytoplankton, was investigated in connection with environmental variables and microplankton abundance at five stations in Char El Meth Lagoon (northeastern Tunisia). Flow cytometry analysis of ultraplankton resolved (i) five heterotrophic prokaryote groups labelled LNA1, LNA2 (low nucleic acid content), HNA1, HNA2 and HNA3 (high nucleic acid content) and (ii) at least 14 ultraphytoplankton groups assigned to picoeukaryotes, picoprokaryotes, nanoeukaryotes, cryptophyte-like cells and some unknown communities. Redundancy analysis (RDA) revealed (i) autumn–summer outbreaks of heterotrophic prokaryotes dominated by HNA groups and (ii) winter–summer proliferation of ultraphytoplankton dominated by nanophytoplankton groups. Generalized additive models (GAM) highlighted the role of (i) water temperature and orthophosphate concentrations in heterotrophic prokaryote distribution and (ii) water temperature and salinity in ultraphytoplankton abundance variation. Based on Spearman's rank correlation, significant negative correlations were established between ultra- and microplankton communities suggesting that, through grazing pressure, microplankton may be behind the drastic decrease in ultraplankton abundances in spring.

1. Introduction

Char El Meth Lagoon (CML, northeastern Tunisia) fulfills the Ramsar criteria (Ramsar, 2007) as a wetland of international importance, representative of lagoons within the southern Mediterranean Sea and as a habitat for migrating fish and birds (Ayache et al., 2009). Unfortunately, and in contrast with the ultra-oligotrophic eastern Mediterranean Basin (Berman et al., 1984; Krom et al., 2003, 2005), CML has mostly exhibited eutrophic conditions due to the combined effects of agricultural drainage from the Utica floodplain, raw sewage discharge from the town of Char El Meth and local summer tourism (Chakroun, 2004; Ayache et al., 2009). This eutrophic status is amplified by the shallowness of CML waters (<2 m) as well as the limited connection with the sea through a single channel that undergoes continuous silting, leading to an exacerbation of both salinity and temperature gradients, which may well allow fair assessment of the ecological role of each specific environmental parameter (Oksanen and Minchi, 2002).

As an expression of this eutrophication, CML is characterized by a remarkable abundance of phytoplankton including harmful species (Turki et al., 2007; Dhib et al., 2013a, 2015), ciliate communities (Dhib et al., 2013b) and macrophytes, all bioindicators of water quality deterioration (Shili et al., 2002; Dhib et al., 2013c). In contrast, and as far as we know, no data concerning the smaller planktonic communities have been reported from this site, nor from any other Tunisian lagoon. Indeed, ultraplankton studies in Tunisian waters have been conducted in open ecosystems (Rekik et al., 2013; Hamdi et al., 2015). In oligotrophic waters, a number of studies using flow cytometry (FCM), showed that ultraphytoplankton (<10 μm) comprise the most abundant phytoplankton fraction (Siokou-Frangou et al., 2010) and is mainly composed of cyanobacteria, with dominance, in the Mediterranean Sea, of *Synechococcus* over *Prochlorococcus* (Martin, 1997; Denis et al., 2000; Casotti et al., 2003) and of eukaryotes belonging to the group of Chlorophyceae, Prasinophyceae and Prymnesiophyceae (Psarra et al., 2005). In a previous study of ultraphytoplankton distribution in 24 Mediterranean coastal lagoons that display wide trophic

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Characterization of fish assemblages and population structure of freshwater fish in two Tunisian reservoirs: implications for fishery management

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Abstract To monitor and assess the state of Tunisian freshwater fisheries, two surveys were undertaken at Ghezala and Lahjar reservoirs. Samples were taken in April and May 2013, a period when the fish catchability is high. The selected reservoirs have different surface areas and bathymetries. Using multi-mesh gill nets (EN 14575 amended) designed for sampling fish in lakes, standard fishing methods were applied to estimate species composition, abundance, biomass, and size distribution. Four species were caught in the two reservoirs: barbel, mullet, pike-perch, and roach. Fish abundance showed significant change according to sampling sites, depth strata, and the different mesh sizes used. From the reservoir to the tributary, it was concluded that fish biomass distribution was governed by depth and was most abundant in the upper water layers. Species size distribution differed significantly between the two reservoirs, exceeding the length at first maturity. Species composition and abundance were greater in Lahjar reservoir than in Ghezala. Both reservoirs require support actions to improve fish productivity.

Keywords Fish assemblage · Multi-mesh gill nets · Fish metrics · Tunisian reservoirs

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Introduction

Freshwater fish farming is a recent activity in developing Tunisia that began with the experimental stocking of reservoirs with mullet. The majority of reservoirs are located in the northern part of the country (DGPA 2013), with 450 fishermen and 232 boats currently involved. The most commonly caught species are as follows: carp (*Cyprinus carpio*), pike-perch (*Stizostedion lucioperca*), mullet (*Mugil cephalus* and *Liza ramada*), eel (*Anguilla anguilla*), catfish (*Silurus glanis*), roach (*Rutilus rutilus*), barbel (*Barbus setivimensis*), and tilapia (*Oreochromis niloticus*). Production increased from 843.5 tons in 2000 to over 969 tons in 2012, with mullet as the most heavily fished species, comprising 35 % of total production and totalling an annual average of about 345 tons (DGPA 2013).

The principal means adopted to ensure continuity and development of fish farming in Tunisia is to stock the reservoirs with Mugilidae. This practice

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RESEARCH ARTICLE

Assessing trace metal pollution through high spatial resolution of surface sediments along the Tunis Gulf coast (southwestern Mediterranean)

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Abstract Tunis Gulf (northern Tunisia, Mediterranean Sea) is of great economic importance due to its abundant fish resources. Rising urbanization and industrial development in the surrounding area have resulted in an increase in untreated effluents and domestic waste discharged into the gulf via its tributary streams. Metal (Cd, Pb, Hg, Cu, Zn, Fe, and Mn) and major element (Mg, Ca, Na, and K) concentrations were measured in the grain fine fraction <63 μm by atomic absorption spectrophotometry. Results showed varying spatial distribution patterns for metals, indicating complex origins and controlling factors such as anthropogenic activities. Sediment metal concentrations are ranked as follows: Fe > Mg > Zn > Mn > Pb > Cu > Cd > Hg. Metals tend to be concentrated in proximity to source points, suggesting that the mineral enrichment elements come from sewage of coastal towns and pollution from industrial dumps and located along local rivers, lagoons, and on the gulf shore itself. This study showed that trace metal and major element concentrations in surface sediments along the Tunis Gulf shores were lower than those found in other coastal areas of the Mediterranean Sea.

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Introduction

Coastal Mediterranean ecosystems are generally threatened by pollution from urban and industrial activities. One resulting problem is observed in the ability of marine surface sediments to accumulate toxic metals, becoming an ecological concern. Sediments are the main sink for metals in aquatic ecosystems and thus constitute a threat to human health and the food web (Simpson et al. 2012; Belabed et al. 2013; Ben Salem et al. 2014). Further knowledge of the spatial distribution of metal concentrations in surface sediments from a specific ecosystem has become essential, especially if the system contains abundant fish resources and is located, like Tunis Gulf, in a hydrodynamically complex region (Brahim et al. 2015; Zaaboub et al. 2014b).

Tunis Gulf, located adjacent to the metropolitan area of the city of Tunis with its growing population, is an area of heavy industry (chemical manufacturing, metal processing, factories, and electronic and mechanic industries). Industrial and domestic waste is discharged into local rivers where it initially affects animal and plant tissues, but once in the gulf, its metal contents settle to the seafloor. Harbor activities (commercial shipping, fishing, and naval repairation) also constitute potential sources of metals for coastal sediments (Warnken et al. 2001; Forman et al. 2003; Weymuth et al. 2010; Zaaboub et al. 2014a). These metals, combined with those of continental origin already affecting the tissues of living sea organisms, may also end up in sediment deposits and thus contribute to a permanent reserve of harmful contaminants for aquatic fauna and flora (Hooda 2007; Bhakta et al. 2014). Spatial distributions of metallic elements in sediments are therefore of

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Etude des peuplements piscicoles de la retenue du barrage de Sidi Salem

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Abstract - The study of fish populations in reservoirs is essential for sustainable management of the freshwater fisheries. The sampling technique used was based on the European standard CEN prEN 14757. This technique (multi-mesh gillnets) was adapted to Tunisian dams. A stratified random sampling was implemented according to the depth and area of the dam. Samplings were conducted in Sidi Salem reservoir between April and May 2014. The fish communities were composed by 7 species: roach, rudd, carp, pike-perch, phoxinel and two species of mullet (*Liza ramada* and *Mugil cephalus*). The weight and numeric yield was average (114 ind / 1000m² and 8.08Kg / 1000m²). The majority of catches were obtained at depths less than 12m. Populations of Mullet and carp show a strong deficit indicating a state of over-exploitation and insufficiency of stocking. Sidi Salem reservoir has a well balanced and abundant population of roach, rudd and pike-perch. However, this dam presents a remarkable deficiency of autochthon fish. Diversity indices indicate a little diversity in this dam. Additionally, we identified that the stock of mullet was declining and of eels was lack in this survey. This reservoir required a support from fisheries managers.

Keywords: Sampling, fish populations, Sidi Salem reservoir, multi-mesh gillnets.

Résumé - La gestion durable de la ressource ichtyque dans les retenues de barrages est basée sur l'étude des peuplements piscicoles qui y sont présents. La technique d'échantillonnage est inspirée de la norme européenne CEN prEN 14757. Cette méthodologie a été adoptée aux barrages tunisiens. Un échantillonnage stratifié aléatoire a été mis en œuvre selon la profondeur et la superficie du barrage de Sidi Salem. Cette retenue a été prospectée entre le mois d'avril et le mois de mai 2014. Les peuplements piscicoles inventoriés sont composés de 7 espèces : le gardon, le rotengle, la carpe commune, la phoxinelle de la calle, le sandre et les deux espèces de mulet (*Mugil cephalus* et *Liza ramada*). Les rendements enregistrés sont moyens sur le plan pondéral et numérique (8,08Kg /1000m² et 114 ind/1000m²). La majorité des captures a été obtenue à des profondeurs inférieures à 12m. Le mulet et la carpe montrent un fort déficit indiquant un état de surexploitation et une insuffisance de l'ensemencement. La retenue de Sidi Salem abrite des populations de gardon, de rotengle et de sandre bien abondantes et équilibrées. Cependant, ce barrage présente une carence remarquable en poissons autochtones. Les indices de diversité indiquent que les peuplements étudiés sont peu diversifiés au niveau du barrage de Sidi Salem. De plus, nous avons décelé un déclin du stock du mulet ainsi que l'absence de l'anguille et du silure dans le barrage prospecté. Cette retenue d'eau nécessite une intervention des gestionnaires de la pêche.

Mots clés: Echantillonnage, peuplements piscicoles, barrage Sidi Salem, filets multi-mailles.

Population status of freshwater fish in Tunisian reservoirs

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Farming of freshwater fishes is a recent activity in Tunisia. It began with an experience of stocking reservoirs with fry of mullet (Mugilidae). The majority of reservoirs are located in the north of the country (Figs. 1 & 2). The fisheries in these reservoirs involve a large number of fishermen and it was considered as an important economic activity, especially in the disadvantaged region of the country (Mili et *al.*, 2015). As these fisheries become increasingly important they must be effectively managed. This exploitation activity can be maintained and developed only by monitoring the fish stocks and the status of populations of freshwater fishes in the reservoirs. Despite the numerous cited studies on the biology of the freshwater fishes in Tunisian reservoirs, no details on population status, distribution and abundance of these species are available.

Figure1: Location of Tunisian reservoirs

Figure 2: Some Tunisian reservoirs: Bekbaka (left) and Sidi Saad (right)

SCIENTIFIC REPORTS

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Abrupt climate shift in the Western Mediterranean Sea

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One century of oceanographic measurements has evidenced gradual increases in temperature and salinity of western Mediterranean water masses, even though the vertical stratification has basically remained unchanged. Starting in 2004, the basic structure of the intermediate and deep layers abruptly changed. We report here evidence of reinforced thermohaline variability in the deep western basin with significant dense water formation events producing large amounts of warmer, saltier and denser water masses than ever before. We provide a detailed chronological order to these changes, giving an overview of the new water masses and following their route from the central basin interior to the east (toward the Tyrrhenian) and toward the Atlantic Ocean. As a consequence of this climate shift, new deep waters outflowing through Gibraltar will impact the North Atlantic in terms of salt and heat input. In addition, modifications in the Mediterranean abyssal ecosystems and biogeochemical cycles are to be expected.

The Mediterranean region is recognized as a hot spot for future climatic changes[1] and can be described as a "miniature ocean", since most oceanographic processes of the global ocean occur with a turnover timescale about one tenth of the global oceans. This makes it a convenient laboratory, more accessible and controlled because of its semi-enclosed nature and its smaller size, where climate changes happen faster and can be observed on scales of human lifetime. Because of the net evaporation and heat loss, the Mediterranean is an engine transforming fresh and warm Atlantic water (AW) into saltier and cooler Mediterranean waters, which eventually outflow in the Atlantic (Fig. 1). In the northern part of the Western Mediterranean Sea (WMED) open ocean convection occasionally occurs, driven by atmospheric cooling due to strong northerly winds, and by the general cyclonic circulation that uplifts isopycnals in the center of the gyre[2], bringing a salty layer of Levantine Intermediate Water (LIW), which comes from the Eastern Mediterranean (EMED), closer to the surface and thus to the influence of the atmospheric forcing. In addition, dense shelf water intermittently forms over the Gulf of Lions shelf, and successively cascades down the continental margin, partially contributing to the ventilation of the deep WMED[3]. The water mass that is formed by both processes, deep convection and dense shelf water cascading, is called Western Mediterranean Deep Water (WMDW).

The homogeneous WMDW has long been considered a stable integrating medium to be used to quantify the effects of climate change, by monitoring its gradual potential temperature (θ) and salinity (S) changes[4]. It was known to be characterized by a smooth stratification, observed for decades in the deep WMED interior, with a gradual monotonic decrease of θ and S with depth, at a nearly constant potential density of $\sigma_\theta \approx 29.1\,kg\,m^{-3}$ (dark grey in Fig. 2A).

Results

For about half a century the deep WMED heat and salt contents increased almost steadily, with an acceleration after the mid-80s, attributed to a variety of forcings as global warming[5,6], increasing temperature and salinity in the inflowing AW[7], changes in large scale atmospheric patterns[8,9], wind dynamics at Gibraltar and river damming[10]. Since 2005 increases in deep water θ and S were three times faster than during 1961–2004 have been reported[11]. Actually, a major deep water formation event in winter 2004/05[12] set the beginning of the Western Mediterranean Transition (WMT)[13]. In the following the main features of the WMT are examined: the observed changes in deep stratification, where this study adds new elements to previously known information, and the (east- and westward) propagation of the anomaly within the basin, an aspect which has not been focused on before.

Changes in deep stratification. The WMT can be defined as a climatic shift which changed the basic structure and properties of the intermediate and deep layers in the WMED. S, θ and σ abruptly increased in the

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ETUDE DFT DES REACTIONS DE CYCLOADDITION DE TYPE DIELS-ALDER SUR LA MOLECULE DU FULLERENE

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Résumé : Dans le but de prédire la possibilité de formation de matériau organique conducteur, nous avons étudié théoriquement les réactions de Diels-Alder à demande inverse d'électrons (DADEI) entre le fullerène C60 et les diènes de type **2a-d**. Nous avons discuté de point de vue thermodynamique et orbitalaire la possibilité et la stéréoselectivité de ces réactions. Les états de transition de la réaction entre le C60 et les diènes **2a-c** ont été déterminés. Nous avons par la suite étudié de point de vue thermodynamique, la possibilité de l'addition d'une deuxième, troisième,… et 7ème molécule des diènes de type **2a-d** sur la molécule de fullerène.
Mots clés : C60, Diels-Alder, méthode DFT, B3LYP/3-21G.

Abstract: In order to predict the possibility of organic conductive material formation, we theoretically study the Diels-Alder reaction (IEDDA) between the fullerene C60 and dienes **2a-d**. From a thermodynamic and orbital point of view, we discuss the possibility and the stereoselectivity of these reactions. Transition states of the reaction between C60 and dienes **2a-c** were determined. We then study from a thermodynamic point of view the possibility of adding a second, third, ... and a seven diene molecules **2a-d** of the fullerene molecule.
Keywords: C60, Diels-Alder, DFT method, B3LYP/3-21G.

I/Introduction

Les fullerènes sont des molécules en forme de cage comportant 2(10+n) atomes de carbone forment 12 pentagones et n hexagones [1-3]. Le buckminsterfullerène (C60) est le plus petit fullerène stable. Ce composé est formé de 12 pentagones et 20 hexagones et chaque pentagone est entouré de 5 hexagones (Fig.1).

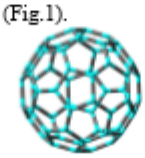

Fig. 1 : Structure du C60

Le C60 a une réactivité chimique similaire à celle d'une oléfine déficiente en électrons. Ainsi, le C60 est un bon électrophile et peut être le siège des réactions d'addition nucléophile. Le C60 réagit par exemple avec différents dérivés nucléophiles tels que des organolithiens ou organomagnésiens [4,5]. Le C60 peut également jouer le rôle de diénophile ou de 1,3-dipolarophile. Ainsi, les cycloadditions de tous types, aboutissant à la synthèse de dérivés cycliques sont possibles : à savoir, les cycloadditions [2+1] de type insertion de carbène ou de nitrène, les cycloadditions [4+2] de type Diels-Alder, les cycloadditions [2+2] thermiquement ou photochimiquement induites, ou encore les cycloadditions [3+2] 1,3-dipolaires [4-8]. Ces différentes réactions développées au cours des premières années après la découverte du C60 ont été utilisées pour préparer de nombreux dérivés, porteurs dans un premier temps de groupes solubilisants, puis, de façon croissante, porteurs également de

ETUDE DFT ET MODELISATION DES REACTIONS D'EPOXYDATION DE COUMARINE ET DE MONOTERPENE (DFT STUDY AND MODELING OF EPOXIDATION REACTIONS FROM COUMARIN AND MONOTERPENE)

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Abstract
In this work, we study the epoxidation reactions of coumarin and monoterpene such as imperatorine **1** and myrcene **2**. Using DFT method with three hybrid functional such as B3LYP and B3PW91 and the basis 6-311G*, we discuss from thermodynamic and kinetic the possibility and the stereoselectivity of these reactions. The study of the frontier orbitals has allowed us to compare the reactivity of these molecules in the epoxidation reactions.

Key words: coumarins, myrcene, epoxydation, 6-311G*.

Résumé
Dans ce travail, nous avons modélisé les réactions d'époxydation de coumarine et de monoterpène tels que l'impératorine **1** et le myrcène **2**. En utilisant la méthode de calcul DFT avec les deux fonctionnelles hybrides tels que B3LYP et B3PW91 et la base standard 6-311G*, nous avons discuté de point de vue thermodynamique et cinétique la possibilité et la stéréoselectivité de ces réactions. L'étude des orbitales frontières nous ont permis de comparer la réactivité de ces deux molécules dans les réactions d'époxydation.

Mots clés: Coumarine, myrcène, epoxydation, 6-311G*.

Introduction

Les réactions d'époxydation des coumarines et des terpènes possèdent des rôles importants à la formation des aérosols organiques secondaires (AOS) [1-9]. Ces (AOS) influent sur le climat et les conditions de vie sur la terre. Plusieurs travaux de recherche ont étudié les mécanismes d'oxydation des terpènes [5-9], pour comprendre l'impact de ces polluants atmosphériques. En effet ces (AOS) sont formés à partir de la réaction de COV avec l'ozone O_3, H_2O, H_2O_2, NO_3, peracide et OH, etc…[2-9].

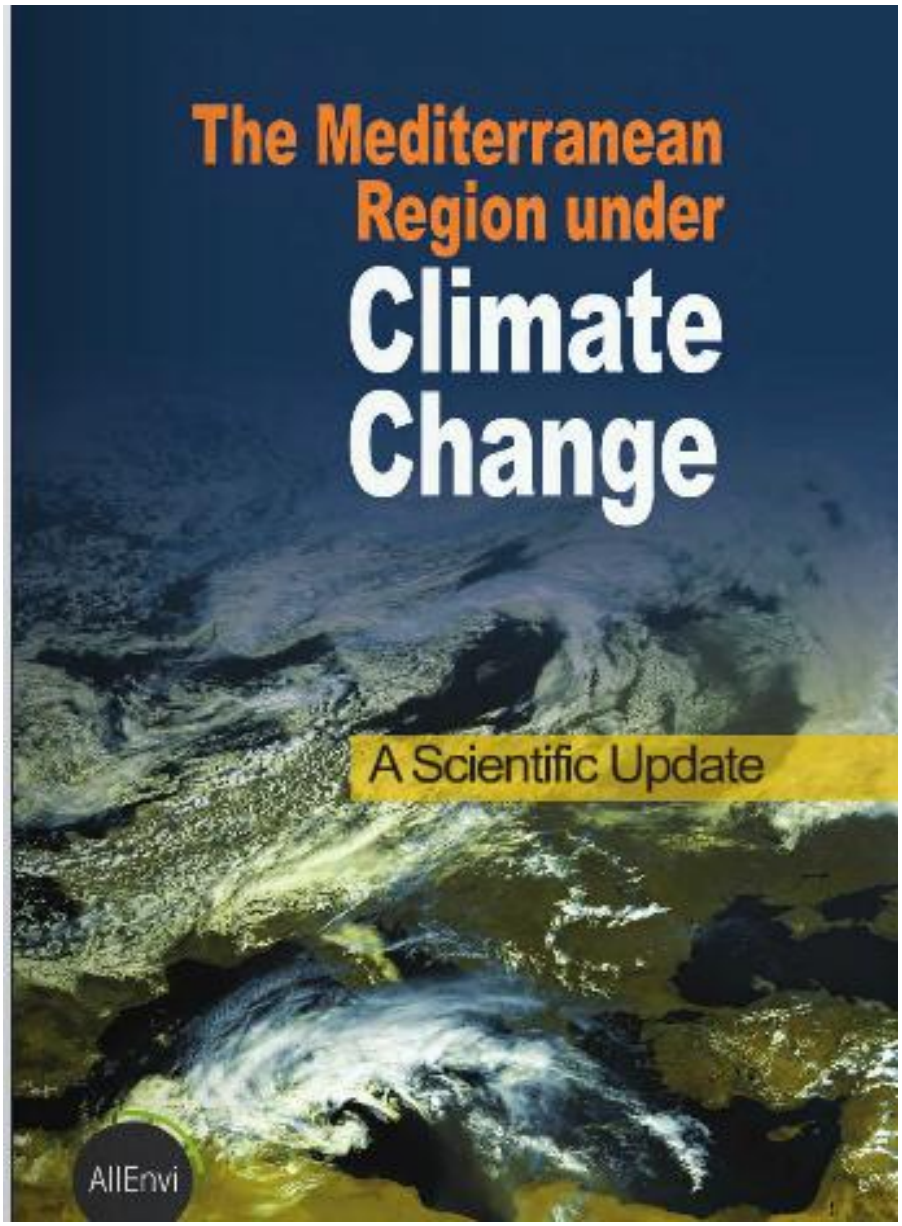
Dans ce travail, nous avons trouvé intéressant de réaliser une étude théorique bien détaillée sur les réactions d'époxydation de coumarine telle que l'impératorine **1** et de monoterpène tel que le myrcène **2** (Figure 1). Ces molécules possèdent chacune trois doubles liaisons, une première double liaison (C1=C2) de type (a) monosubstituée, une deuxième double liaison (C3=C4) de type (b) bisubstituée et une troisième double liaison (C5=C6) de type (c) monosubstituée, dans le cas de la molécule **2**. Dans le cas de la molécule **1**, la liaison C5=C6 est de type (c') trisubstituée, une deuxième double liaison (C3=C4) de type (b') bisubstituée et se trouvant dans un cycle à six carbones. Une troisième double liaison (C1=C2) de type (a') bisubstituée et se trouvant dans un cycle à cinq carbones.

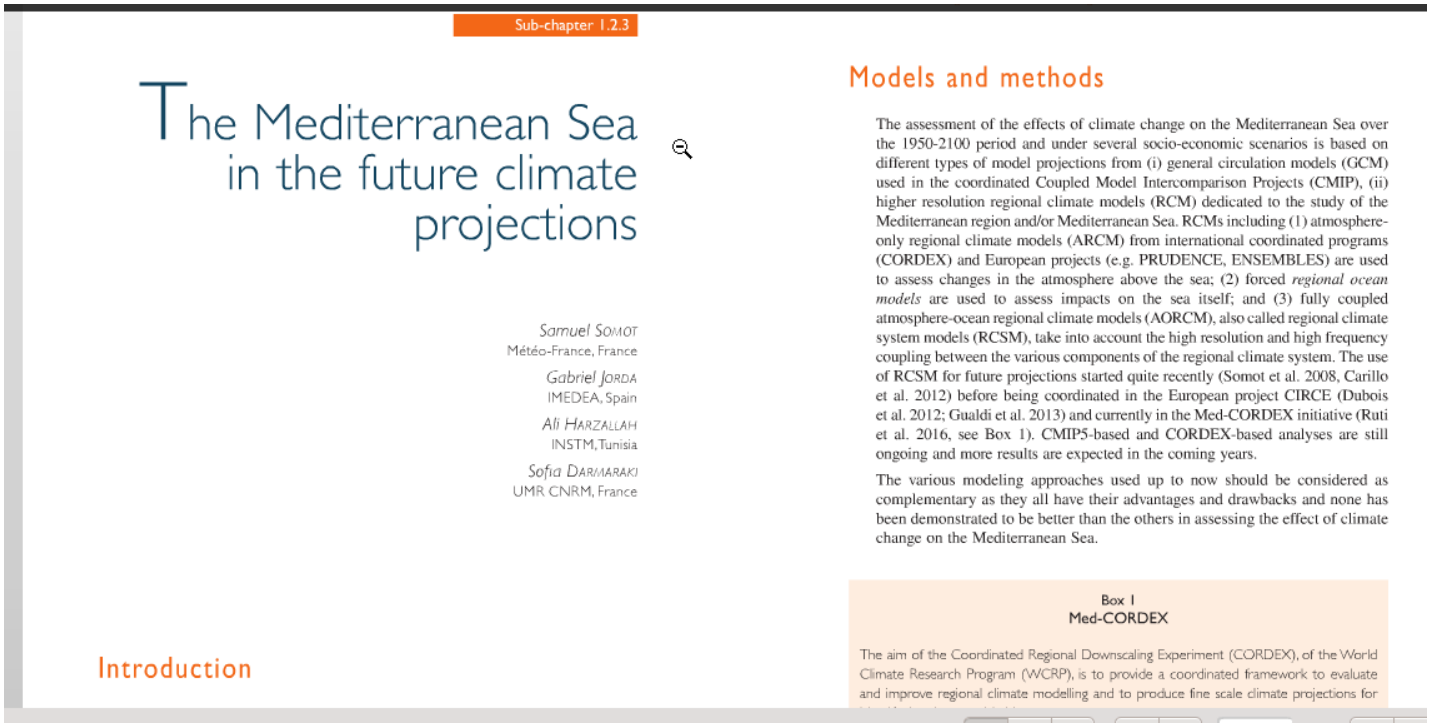
II-2-Liste des ouvrages scientifiques édités en 2016

-Citez les références complètes des ouvrages (auteurs, année, titre, éditeur, édition et pages).

-Joindre obligatoirement, en annexes, une copie de la **première page** de chaque ouvrage édité.

The Mediterranean region under climate change: A scientific update. ALLENVI book, 2016: Chapitre 1.2.3 : The Mediterranean Sea in the future climate projections, Somot S., Jorda G., **Harzallah A.,** Darmaraki, S. pages 94-104.





Sub-chapter 1.2.3

The Mediterranean Sea in the future climate projections

Samuel SOMOT
Météo-France, France
Gabriel JORDA
IMEDEA, Spain
Ali HARZALLAH
INSTM, Tunisia
Sofia DARMARAKI
UMR CNRM, France

Introduction

Models and methods

The assessment of the effects of climate change on the Mediterranean Sea over the 1950-2100 period and under several socio-economic scenarios is based on different types of model projections from (i) general circulation models (GCM) used in the coordinated Coupled Model Intercomparison Projects (CMIP), (ii) higher resolution regional climate models (RCM) dedicated to the study of the Mediterranean region and/or Mediterranean Sea. RCMs including (1) atmosphere-only regional climate models (ARCM) from international coordinated programs (CORDEX) and European projects (e.g. PRUDENCE, ENSEMBLES) are used to assess changes in the atmosphere above the sea; (2) forced *regional ocean models* are used to assess impacts on the sea itself; and (3) fully coupled atmosphere-ocean regional climate models (AORCM), also called regional climate system models (RCSM), take into account the high resolution and high frequency coupling between the various components of the regional climate system. The use of RCSM for future projections started quite recently (Somot et al. 2008, Carillo et al. 2012) before being coordinated in the European project CIRCE (Dubois et al. 2012; Gualdi et al. 2013) and currently in the Med-CORDEX initiative (Ruti et al. 2016, see Box 1). CMIP5-based and CORDEX-based analyses are still ongoing and more results are expected in the coming years.

The various modeling approaches used up to now should be considered as complementary as they all have their advantages and drawbacks and none has been demonstrated to be better than the others in assessing the effect of climate change on the Mediterranean Sea.

Box 1
Med-CORDEX

The aim of the Coordinated Regional Downscaling Experiment (CORDEX), of the World Climate Research Program (WCRP), is to provide a coordinated framework to evaluate and improve regional climate modelling and to produce fine scale climate projections for

II-5-Liste des obtentions végétales enregistrées en 2016

-Citez les références complètes des obtentions végétales.

-Joindre obligatoirement, en annexes, une copie de l'enregistrement de l'obtention végétale.

II-6-Liste des habilitations universitaires et agrégations hospitalo-universitaires soutenues en 2016

-Citez les références complètes des soutenances.

-Joindre obligatoirement, en annexes, une copie de la première page de chaque habilitation et agrégation soutenue.

Brahim Mouldi : Habilitation universitaire : Dynamique Sédimentaire dans le littoral tunisien, le 24 mai 2016.. Faculté des Sciences de Tunis.

FST

INSTM

HABILITATION UNIVERSITAIRE EN SCIENCES GEOLOGIQUES

présentée par :

Mouldi BRAHIM

HYDRODYNAMIQUE SEDIMENTAIRE DANS LE LITTORAL TUNISIEN

Soutenue le 24 mai 2016, devant le Jury composé de Messieurs :

Moncef GUEDDARI	Professeur à la Faculté des Sciences de Tunis	Président
Ameur OUESLATI	Professeur à La Faculté des Lettres, des Arts et des Humanités de la Manouba	Rapporteur
Moncef BOUKTHIR	Professeur à l'Institut Préparatoire aux Etudes d'Ingénieurs de Tunis	Rapporteur
Younes JEDOUI	Professeur à l'Institut des Sciences et Techniques des Eaux de Gabès	Examinateur
Cherif SAMMARI	Professeur à l'Institut des Sciences et Technologies de la Mer à Salammbô	Examinateur

II-7-Liste des thèses soutenues en 2016

-Citez les références complètes des thèses soutenues.

-Joindre obligatoirement, en annexes, une copie de la page de garde de chaque thèse soutenue (dans l'ordre de la liste).

Thèse de A. Abdelfateh Atoui : MODELISATION DE LA DYNAMIQUE SEDIMENTAIRE: APPLICATION AU GOLFE DU GABÈS

Thèse de Fertouna Bellakhal M. (Faculté des Sciences de Bizerte, 15 novembre 2016) : Distribution spatiale des kystes de résistance des Dinoflagellés au niveau du sédiment superficiel de la lagune de Bizerte : cas de l'espèce invasive *Alexandriumpacificum*R.W. Litaker, 2014.

République Tunisienne
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Ministère de l'Enseignement Supérieur, de la Recherche Scientifique
----------*****----------
Université Tunis EL Manar

Thèse de Doctorat

Présentée par :

Abdelfateh Atoui :

MODELISATION DE LA DYNAMIQUE SEDIMENTAIRE:

APPLICATION AU GOLFE DU GABÈS

2016

Encadreur : Moualdi Brahim

Université de Carthage
Faculté des sciences de Bizerte

Institut National des Sciences et Technologies de la Mer

Université de Franche-Comté

THESE DE DOCTORAT

En Sciences Biologiques

Présentée par

Mme Fartouna Bellakhal Mouna

Distribution spatiale des kystes de résistance des Dinoflagellés au niveau du sédiment superficiel de la lagune de Bizerte : cas de l'espèce invasive *Alexandrium pacificum* R.W. Litaker, 2014

Soutenue publiquement le 15 novembre 2016 devant le jury composé de :

- Pr Hèchmi Missaoui (INAT, INSTM) : Président de jury
- Pr Souad TURKI (INSTM) : Directrice de thèse
- Pr Lotfi ALEYA (Université de Franche-Comté) : Directeur de thèse
- Pr Daly Yahia-Kefi Ons (INAT) : Rapporteur
- Pr Michel DENIS (Université d'Aix Marseille) : Rapporteur
- Dr Estelle MASSERET (Université Montpellier/ IRD) : Examinatrice

II-8-Liste des mastères soutenus en 2016

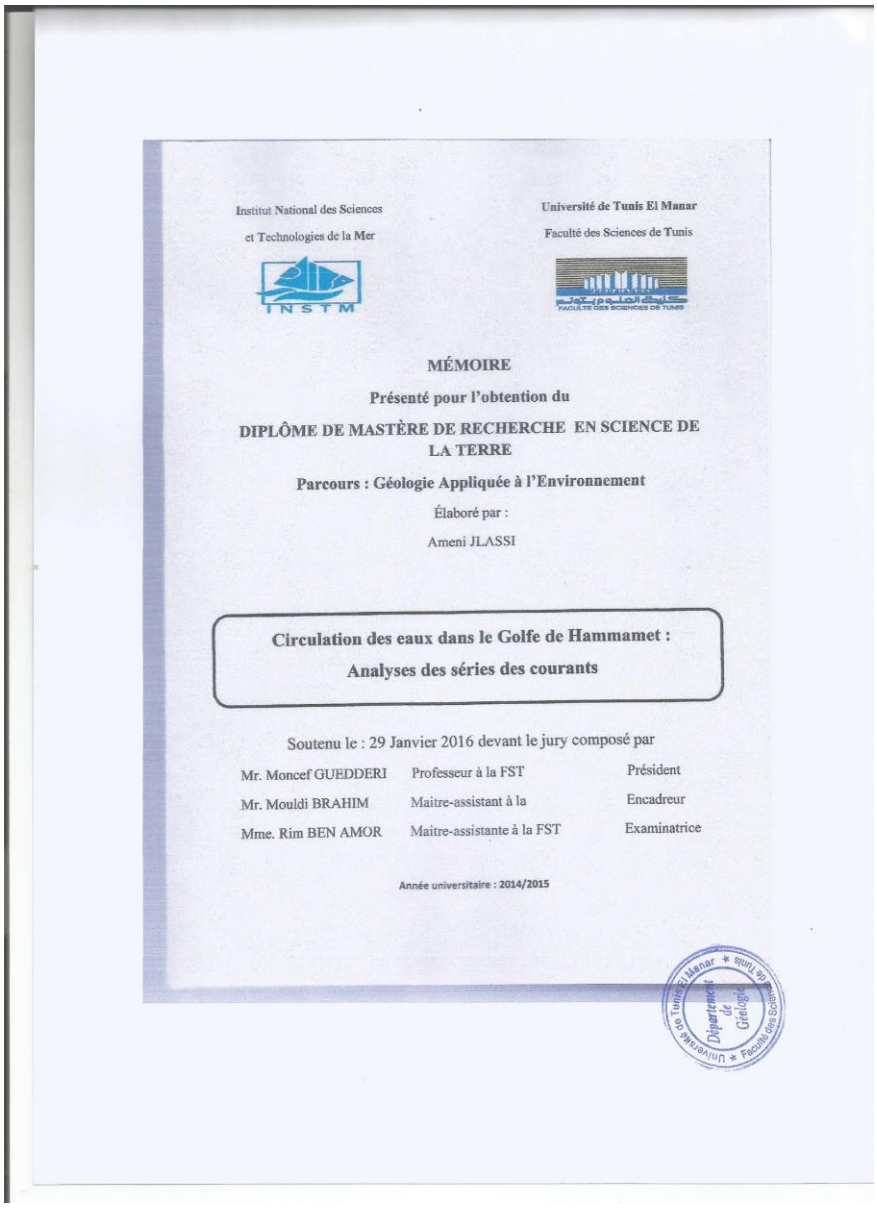
-Citez les références complètes des mastères soutenus.

-Joindre obligatoirement, en annexes, une copie de la page de garde de chaque mastère soutenu (dans l'ordre de la liste).

1. Jlassi Amel, Circulation des eaux dans le golfe de Hammamet. Analyse des séries des courants, FST, 2016

2. Yosr Jazzar Modélisation hydraulique de la circulation de l'eau dans la baie de Monastir, ENIT novembre 2016.

3. Nabli Ahmed, Dynamique sédimentaire dans le golfe de Hammamet. FST, 2016



Institut National des Sciences et Technologies de la Mer

INSTM

Université de Tunis El Manar

Faculté des Sciences de Tunis

MÉMOIRE

Présenté pour l'obtention du

DIPLÔME DE MASTÈRE DE RECHERCHE EN SCIENCE DE LA TERRE

Parcours : Géologie Appliquée à l'Environnement

Élaboré par :

Ameni JLASSI

Circulation des eaux dans le Golfe de Hammamet : Analyses des séries des courants

Soutenu le : 29 Janvier 2016 devant le jury composé par

Mr. Moncef GUEDDERI	Professeur à la FST	Président
Mr. Mouldi BRAHIM	Maitre-assistant à la	Encadreur
Mme. Rim BEN AMOR	Maitre-assistante à la FST	Examinatrice

Année universitaire : 2014/2015

Université de Tunis El Manar * Faculté des Sciences de Tunis * Département de Géologie

République Tunisienne
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Ministère de l'Enseignement Supérieur, de la Recherche Scientifique
----------*****----------
Université Tunis EL Manar

MÉMOIRE

Présenté en vue de l'obtention du

Diplôme de Mastère de Recherche

Spécialité : Modélisation Hydraulique et environnement.

Réalisé par

JAZZAR YOSR

Modélisation numérique de la circulation de l'eau le long des côtes tunisiennes centre-est de la Tunisie- baie de Monastir

Soutenu le 05 décembre 2016 devant le Jury composé de :

Président Mahmoud Moussa
Examinateur : Ghazi Bellakhal
Encadrant : Ali Harzallah
Encadrant : Béchir Béjaoui
Invité : Rafik Ben Charrada

Année Universitaire :2015/2016

Université Tunis El Manar
Faculté des sciences de Tunis
Département de Géologie

l'Institut National des
Sciences et Technologies
de la Mer

MEMOIRE

PRESENTE POUR L'OBTENTION DU

DIPLOME DE MASTERE DE RECHERCHE EN SCIENCE DE LA TERRE

Parcours : géologie appliquée à l'environnement

Présenté par

NABLI Ahmed

Dynamique sédimentaire dans le golfe de Hammamet

Soutenu le 29 janvier 2016 devant le jury composé de

Mr. Moncef GUEDDERI	Professeur à la FST	Président
Mr. Mouldi BRAHIM	Maître-assistant à la INSTM	Encadreur
Mme. Rim Ben AMOR	Maître-assistant à la FST	Examinateur

Année universitaire : 2015 – 2016

III- Ouverture du LR/UR sur son environnement

III-1- Séminaires, journées et altiers scientifiques organisés en 2016

-Citez les références des manifestations organisées (titre, organisée par, date, année et lieu).
-Joindre obligatoirement, en annexes, les pièces justificatives de chaque manifestation organisée.

- Manifestation scientifique : Journée de la mer : Présentation du projet S&TMED, 26 juillet 2016 – Nadi el Tawen Mahdia

- Séminaire de présentation des résultats du projet de recherche RYSCMED : 11-12 octobre 2016

- Participation au Salon de l'Investissement Agricole et de la Technologie (SIAT, Parc des Expositions du Kram Tunis, 19 – 22 octobre 2016). Communication par affiche IRESA/INSTM : Réseau des microalgues toxiques.

Sous le patronage de Monsieur le Gouverneur de Mahdia

Dans le cadre du projet européen S&T MED, l'INSTM organise une journée scientifique en collaboration avec la municipalité de Mahdia et le festival fête de la mer à Mahdia dans sa 22ème édition une journée scientifique concernant les acquis du projet et l'importance de la surveillance du milieu marin à Mahdia.

Vous êtes cordialement invités à assister et à enrichir le débat

Programme de la journée Scientifique (S&TMED)

26 juillet 2016 – Nadi el Tawen Mahdia

9 heures 30- Accueil et inscription des participants
10 heures - Allocution de monsieur le Directeur Général de l'INSTM
10 heures 15-Présentation des acquis et de l'état d'avancement du projet S&TMED : Dr. Hamza Asma & Dr. Sammi Ammari
10 heures 45- Caractérisation de l'état écologique des écosystèmes marins de Mahdia- Dr. Lotfi Mabrouk
11 heures 15 : La recherche marine pour une meilleure gestion et acquis pour la prévision future- Pr. Ali Harzallah
Débats
12 heures : Buffet de dégustation « Association Saveurs de mon pays » : Mme Narjess Snéne & Société FRIGO Port


REPUBLIQUE TUNISIENNE
Ministère de l'Agriculture.
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique.
Institution de la Recherche et de l'Enseignement Supérieur Agricole.
Institut National des Sciences et Technologies de la Mer (INSTM).
Séminaire
Présentation des résultats du projet de recherche
RYSCMED -16G 1005 .
« Risque littoral et dYnamique morpho-Sédimentaire des Corps sableux de l'embouchure du fleuve la MEDjerda, golfe de Tunis. »
Du 11 au 12 octobre 2016, à l'INSTM
(Dar El Hout)
Carthage-Salammbô. Tunisie.
La recherche scientifique ...pour un développement durable ....!!!
Pour la confirmation de participation:
Contact : Mme Oula Amrouni. Email : oulabz@yahoo.fr
Site de l'Institut : http://www.instm.agrinet.tn/index.php/fr/


Ministère de l'Agriculture.
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique.
Institution de la Recherche et de l'Enseignement Supérieur Agricole.
INSTM
IRD
Institut de recherche pour le développement
PHC-UTIQUE-CMCU
16G 1005 (2016/2018)
Séminaire
Présentation des résultats du programme de recherche RYSCMED
« Risque littoral et dYnamique morpho- Sédimentaire des Corps sableux de l'embouchure de fleuve de la MEDjerda, Golfe de Tunis. »
Journée Conférences
Mercredi 12 octobre 2016
A l'Institut National des Sciences et Technologies de la Mer, Salammbô. Carthage. INSTM.
Salle des réunions.
A partir de 9h.
Ali HARZALLAH- 9h. Professeur à L'Institut National des Sciences et Technologies de la Mer, INSTM, Carthage. Tunisie.
« Changements climatiques en Méditerranée et impacts sur le littoral tunisien: évolution actuelle et projections futures ».
Gil MAHE-10:30. Directeur de recherche à l'Institut de Recherche pour le Développement, IRD, HydroSciences Montpellier. France.
« Le rôle de l'homme et du climat dans le changement de l'équilibre terre-mer, exemple du fleuve Medjerda, Golfe de Tunis, Tunisie ».
Contact : Mme Oula Amrouni.
Email : oulabz@yahoo.fr
LMM
HSM
HydroSciences Montpellier UMR 5569

Ministère de l'Agriculture.
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique.
Institution de la Recherche et de l'Enseignement Supérieur Agricole.
Institut National des Sciences et Technologies de la Mer
Laboratoire du Milieu Marin

INSTM IRD

Dans le cadre de *Projet de recherche bilatéral:*

PROGRAMME PHC-UTIQUE GERE PAR LE CMCU (2016/2018)

Entre le Ministère de l'Enseignement Supérieur Tunisien et Campus France.

Séminaire de présentation des résultats du projet de recherche RYSCMED *16G 1005 :*

« Risque littoral et dYnamique morpho-Sédimentaire des Corps sableuxde l'embouchure de fleuve de la MEDjerda, Golfe de Tunis. »
RYSCMED 16G 1005

Du 11 au 12 octobre 2016

A l'Institut National des Sciences et Technologies de la Mer, Salammbô. Carthage. Salle des réunions.

Responsable Tunisien : Mme Oula AMROUNI.

Contact : Email: oulabz@yahoo.fr/ oula.amrouni@instm.mrt.tn
Institut National des Sciences et Technologies de la Mer, Salammbô, Carthage (Tunisie)- Laboratoire du Milieu Marin.
Site web: http://www.instm.agrinet.tn/index.php/fr/

Responsable Français : Mr Gil MAHE.

Contact : Email : gil.mahe@ird.fr
Université de. Montpellier .HydroLabSciences .
Site web : www.hydrosciences.org/ www.ird.fr.

Ministère de l'Agriculture.
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique.
Institution de la Recherche et de l'Enseignement Supérieur Agricole.
Institut National des Sciences et Technologies de la Mer
Laboratoire du Milieu Marin

INSTM IRD

Programme

Journée 1 : Présentation des résultats du projet de recherche RYSCMED

Mardi 11 octobre 2016

- **8h30 : Accueil**
- **9h – 9h10** : Ouverture => Mr **Hechmi MISSAOUI** (Directeur Général de l'Institut National des Sciences et Technologies de la Mer INSTM).
- **9h10 – 9h40** : **RYSCMED : Projet de recherche en vue d'un développement durable (Littoral de Ghar El Melah_Kalâat Andalous, Medjerda et Raoued).**
  - **Oula AMROUNI**, Chercheuse à l'INSTM / Chef du projet tunisien.
  - **Gil MAHE**, Directeur de Recherche à l'Institut de Recherche pour le Développement IRD, Montpellier / Chef du projet français.
  - **Laurent DEZILEAU**: Expert International en Géochronologie Climatique et partenaire scientifique/ La reconstitution des évènements météorologiques extrêmes (crues et tempêtes) avec les changements climatiques passés et récents (au cours des derniers milliers d'années).

- **9h40 - 9h40** : **Fatma Kotti** / Approche paléohydrologique pour étudier Impact anthropique et climatique sur les apports solides du fleuve Medjerda.
- **9h40 - 9h50** : **Thouraya BEN MOUSSA** / Morphodynamique sédimentaire d'une plage microtidale à barres sur la côte ouest du golfe de Tunis (Cap Farina-cap Gammarth), Tunisie.
- **9h50 – 10h**: **Abderraouf HZAMI** / Satellite images survey for identification of the coastal sedimentary system changes and associated vulnerability along the western bay of the Gulf of Tunis (Northern Africa).
- **10h – 10h30 : Temps d'échange.**
- **10h30 – 10h45** : Pause-café.

- **10h45 – 10h55** : **Wiem OUERTENI** / Caractérisation de sédiments de dragage du port de pêche de Kalâat Andalous.
- **10h55 – 11h05** : **Rabeb MAHFOUDHI** / Etude et suivi des caractéristiques physico-chimiques et bactériologiques des eaux et des sédiments de la basse vallée de la Medjerda.
- **11h05 – 11h15** : **Najmedine AKROUT** / Etat de la contamination de la frange littorale à l'embouchure de Medjerda Raroued Et Kalâat Andalous.
- **11h15 – 11h25**: **Ahmed Ben Rahal /Biologie marine du la baie oust du Golfe de Tunis.**
- **11h25 – 11h55 : Temps d'échange et débats avec les partenaires socio-économiques et décideurs.**

- **14h – 16h : Table ronde: discussion et programme du projet RYSCMED 2017.**

Mardi 12 octobre 2016

Journée 2 : Conférences

Audience : Ecole doctorale de la Faculté des Sciences de Tunis (FST)

Mastère de GéoRessources et Développement Durable GRDD (FST).

Institut National Agronomique de Tunis (INAT)

- **8h30 : Accueil**
- **9h – 10h30 : Ali HARZALLAH** / Changements climatiques en Méditerranée et impacts sur le littoral tunisien: évolution actuelle et projections futures
- **10h30 – 10h45** : pause-café
- **10h45 – 12h15** : **Gil MAHE** / Le rôle de l'homme et du climat dans le changement de l'équilibre terre-mer, exemple du fleuve Medjerda.
- **12h15 :** Déjeuner.

III-2-Liste des conventions signées avec des entreprises et partenaires socio-économiques en 2016

-Citez les références complètes des conventions (nationales et internationales) signées.
-Joindre obligatoirement, en annexes, une copie de chaque convention signée.

III-3-Liste des conventions et projets de coopération scientifique internationale signés en 2016

-Citez les références complètes des conventions signées (bilatérales et multilatérales).
-Joindre obligatoirement, en annexes, une copie de chaque convention signée.

- Programme régional Envi-Med (MISTRALS) : Effet des forçages physiques sur la structure des communautés zooplanctoniques côtières : Etude du cas atypique d'un écosystème méditerranéen fortement tidal.

- Programme régional Envi-Med (MISTRALS) : TAGRAM : Vers des modèles numériques de nouvelle génération.

- PEER : **Tunisia - Project 5-195: Potential of currents along the Tunisia coasts for renewable power generation.**
  PI: Ali Harzallah, National Institute of Marine Science and Technologies
  U.S. Partner: Wassila Thiaw, National Oceanic and Atmospheric Administration
  Durée 2016-2019. Montant 150 M$.

- Projet Méditerranéen : LAGUNOTOX (20143-2016 : LAGUNes méditerranéennes et risque d'espèces TOXiques émergentes)

IV- Situation du reliquat de budget

- Université :	
- Etablissement :	**Institut National des Sciences et Technologies de la Mer (INSTM)**
- Dénomination du LR/UR :	**LR11INSTM04**
- Chef du LR/UR :	**Ali Harzallah** **(chérif Sammari était le chef de laboratoire avant renouvellement)**

Reliquat du budget arrêté au 31 octobre 2016

(sans compter le budget alloué au titre de 2016)

Rubrique	Crédits disponibles (1)	Crédits engagés (2)	Reliquat des crédits (3) (3=1-2)
Equipements	28 000	27 000	1000
Sous-traitance	3000	3000	00
Consommables et petits matériels	29 000	21 000	8000
Missions	11000	3120	7880
Stages	4000	2800	1200
Déplacement et hébergement	2000	2000	00
Manifestations scientifiques	1500	1500	00
Vacations	27 000	26 850	150
Documentation et réseaux	1500	450	1050
Maintenance et divers	3000	1700	1300
Total	**110000**	**89420**	**20580**

Date, cachet et signature

- Le chef LR/UR : Ali Harzallah

- Le financier de l'établissement :

- Le responsable de l'établissement :

NB : Les trois signatures sont obligatoires.