# Annexes

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ORIGINAL PAPER

# A Naïve Bayesian network approach to determine the potential drivers of the toxic dinoflagellate *Coolia monotis* (Meunier, 1919) in the Gulf of Gabès, Tunisia

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**Abstract**
The blooms of the toxic epibenthic dinoflagellate *Coolia monotis* can be predicted with accuracy derived from knowledge of the main forcing variables. A naive Bayesian network modeling framework was developed to predict the most impacting variables on both *Coolia monotis* occurrences and blooms. The proposed model took into account the physical environment effects (salinity, temperature, and tide amplitude), the meteorological constraints (evaporation, air temperature, insolation, rainfall, atmospheric pressure, and humidity), the phytoplankton community structure (diatoms, dinoflagellates, Cyanobacteria, and Euglenophyceae) and the sampling months and stations on both *C. monotis* occurrences and blooms. The study was based on an 11-year survey of the presumed toxic species at 15 sampling stations monitored in the framework of the national phytoplankton monitoring program along the Gulf of Gabès coast. *C. monotis* occurred mainly in the northern and the southern Gulf during winter, spring, and autumn. The blooms (concentrations up to $10^4$ cells $dm^{-3}$) were recorded almost exclusively in three sampling stations, which constitute the hotspot of *Coolia monotis* blooms in the Gulf of Gabès with reduced spread over the surrounding areas. The blooms occurred in spring, winter, and summer. The shift to the highest salinity, associated with reduced rainfall, low atmospheric pressure, low tide amplitude, and low water and air temperature are the most favorable conditions for the species blooms and occurrences. This study is useful for the management of this ecosystem so as to plan for the setup of an early warning system for the prediction of potential toxic events.

**Keywords** *Coolia monotis* · Proliferation · Naïve Bayesian network · Environmental factors · The Gulf of Gabès

**Abbreviations**

| | |
|---|---|
| Cool | *Coolia monotis* (*C. monotis*) |
| NB | Naive Bayes DGPA |
| INM | Tunisian National Meteorological Institute |

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*Research Article*

# Bioavailability and Assessment of Metal Contamination in Surface Sediments of Rades-Hamam Lif Coast, around Meliane River (Gulf of Tunis, Tunisia, Mediterranean Sea)

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The total concentration and the speciation of heavy metals (Pb, Cd, Cu, Zn, Ni, and Cr) in surface sediments of Rades-Hamam Lif coast were determined, with particular focus on the effect that urban and industrial waste in the Meliane river has on the estuary and coastal surface sediments of the Rades-Hamam Lif coast, off the Mediterranean Sea. Several geochemical indices were applied to assess the risk of contamination and the environmental risks of heavy metals on surface sediments. The total concentrations of these heavy metals are influenced by runoff, industrial, and urban wastewater. The Cd, Pb, Zn, and Ni are affected by anthropogenic sources, especially at the mouth of the Meliane river. The sequential extraction of Cd was presented dominantly in the exchangeable fraction and thus the high potential bioavailability. In contrast, Cr and Cu were mostly bound to the residual fraction indicating their low toxicity and bioavailability. The order of migration and transformation sequence was Cd > Pb > Ni > Zn > Cr > Cu, and the degree of pollution was Cd > Pb > Ni > Zn > Cr > Cu.

# Biological Study from Ruta Plants Extracts Growing in Tunisia

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**ABSTRACT:** *Ruta species are known as a potential source of natural products with biological activities. They are used in several fields such as in therapeutic and traditional medicine. In order to contribuate to the valorization of these plants, this work investigated the chemical composition and antibacterial activity of the essential oils of Ruta montana and Ruta gravelons growing in tunisia (north of tunisia). The total phenolic content of these two essential oils was also studied. The antibacterial activities of essential oils were assessed against Escherichia coli (ATCC7625), Staphylococcus aureus (ATCC76110), Pseudomonas aeruginosa (ATCC 7624), Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Pseudomonas aeruginosa. Results show that the chemical composition of essential oils was dominated by 2-undecanone (86.77%), followed by 2-decanone (4.91%) and 2-nonanone (23.62%). Furthermore, the total phenolic content in essential oil of Ruta gravelons is more important than the total phenolic content in essential oil of Ruta montana. Indeed, the value of total phenolic content is 41.70 mg Gallic acid equivalents per gram of dry extract, in essential oil of Ruta gravelons but the total phenolic content in essential oil of Ruta montana is a 7.50 mg Gallic acid equivalents per gram of dry extract. Besides, the ruta montana essential oil has the most important antibacterial activity than the Ruta gravelons essential oil especially against Staphylococcus aureus (ATCC76110) and Pseudomonas aeruginosa (ATCC 7624).*

**KEYWORDS:** *Ruta montana; Ruta gravelons; Essential oil; Antibacterial.*

## INTRODUCTION

Ruta species have a wide distribution in the word. They are more distributed in the tropical and temperature countries, such as tropical america, south africa, mediterranean region, and australia. The Rutaceae family has about 150 genders and over 1600 species [1-3]. The ruta species present a strongly aromatic due to the presence of essential oils [4]. In fact, many research groups are interested in the several therapeutic and pharmacological properties of ruta species. Indeed, Ruta species are used in traditional medicine for the treatment of variety diseases such as menstrual disorders, skin inflammations, cramps and earaches [5-7]. Thus, Ruta has several therapeutic properties such as anti-inflammatory, antiulcer,anti-diabetics, anti-diarrheic,

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# Cellulose modified diatomite for toluene removal from aqueous solution

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ABSTRACT

The presence/existence of harmful aromatic compounds, such as toluene in water poses a significant environmental hazard. Thus, their elimination from water is required. In this regard, here we found an efficient methodology for the removal of toluene using diatomite-cellulose (modified diatomite). The chemical treatments were used to obtain cellulose from sisal fibres and to modify the diatomite. All the adsorbents were characterised via X-ray florescence (XRF), Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), Thermogravimetry (TGA) and Brauner-Emmett-Teller (BET) techniques. The impact of adsorption parameters, such as pH, contact time and initial toluene concentration on the adsorption (%) of toluene was evaluated. The maximum percentage removal of toluene on the natural diatomite was observed to be 79.33% (142.30 mg/g) at pH 6, temperature 22°C, an agitation speed of 150 rpm, adsorbent dosage of 0.1 g and initial concentration of $3x10^{-3}$ mol/L toluene. Furthermore, under the same conditions, the percentage increase to 97.45% (161.43 mg/g) was observed for the modified diatomite. The kinetic data was conforming to the pseudo-second order model with good correlation. The results showed that the adsorption of toluene could be described by Freundlich isotherm model on the natural and modified diatomite. Thus, our work revealed that the diatomite-cellulose could be used as an effective adsorbent to remove toluene from water.

*Keywords:* Diatomite; Sisal fibers; Cellulose; Kinetics; Toluene; Adsorption

## 1. Introduction

Despite, the huge efforts of the scientific community, environmental pollution still causes the major problems of health and environment, especially through water contamination [1]. One of the principal water polluting agents is volatile organic compounds, such as toluene. It is one of volatile organic compounds that are frequently used in the manufacturing process and chemical production [2]. Its complex aromatic molecular structural and xenobiotic proprieties make it difficult to degrade spontaneously [3]. Therefore, its removal is critical to ensure the safety of water supplies and to protect the human health. Different types of technologies were proposed to remove the aromatic compounds from water. However, adsorption is the most used method in the industry. For this purpose, various adsorbents were applied to adsorb the aromatic compounds. Recently, an extensive attention was paid to the biological adsorbents with high capacity of adsorption, for easy regeneration and low price. Currently, silicas, zeolites, metals oxides, polymeric resins, cellulose, diatomite and modified clays, as cost-effective and green materials, were investigated widely. For example, acid-activated palygorskite has

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# Dinoflagellates encystment with emphasis on blooms in Boughrara Lagoon (South-Western Mediterranean): Combined effects of trace metal concentration and environmental context

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# Effects of acute mercury exposure on fatty acid composition and oxidative stress biomarkers in *Holothuria forskali* body wall

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ABSTRACT

Mercury is one of the most harmful pollutant that threat marine biota. This study assessed the Hg impact on the fatty acid (FA) composition and the antioxidant statues in *Holothuria forskali* body wall tissue. Specimens were exposed to $HgCl_2$ graded doses (40, 80 and 160 $\mu g\,L^{-1}$) for 96 h. A decrease in linoleic, arachidonic and eicosapentaenoic acid levels and an increase of docosahexaenoic acid were mainly observed at the nominal tested dose. The exposure to the upper dose promoted oxidative stress with an increase of malondialdehyde, hydrogen peroxide, advanced oxidation protein product, glutathione and non-protein thiols levels. Moreover, a decrease in catalase and an increase in superoxide dismutase and glutathione peroxidase activities were observed. Yet, an increase of the metallothionein level was registered in all treated groups. This study confirmed the Hg toxicity on the redox statue of *H. forskali* and highlighted the usefulness of the FA composition as an early sensitive bioindicators.

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# Magnetically-induced current density investigation in carbohelicenes and azaheliceneś†

Emna Cherni,[abc] Benoît Champagne,[c] Sameh Ayadi[b] and Vincent Liégeois[*c]

A computational study of the magnetically-induced current (MIC) density has been carried out for a variety of ortho fused polycyclic aromatic molecules at the density functional theory level with the gauge including magnetically induced current (GIMIC) method. With this method, the aromatic character of each ring in a homologous series of carbohelicenes with an increasing number of fused benzene rings is assessed and compared with other aromaticity criteria such as the Nucleus Independent Chemical Shift [NICS(0), $NICS_{zz}(0)$] and Bond Length Alternation (BLA) parameters. All criteria indicate that the two outer rings are the most aromatic ones [i.e. higher induced current, more negative NICS(0) and $NICS_{zz}(0)$ values, and smaller BLA values]. For the large helicenes ($n > 10$), the current drops along the following four rings and then rises again. Additionally, we have proven that this behavior is not due to a difference of the local magnetic field coming from a difference of orientation of the ring with respect to the external magnetic field (oriented along the helical axis). Upon fusing additional benzene rings to form hexa-peri-hexabenzo[7]helicene, some rings (B, D, and F) are a lot less aromatic (even non-aromatic) than the others. The NICS(0) and $NICS_{zz}(0)$ values exaggerate this behavior because they are all positive values, which is a signature of antiaromaticity. Then, when substituting one, three, or four benzene rings with pyrrole ones to form mono-aza-[7]-helicene, tri-aza-[7]-helicene, and tetra-aza-[7]-helicene, remarkable changes in the electronic structures of the helicenes are observed. Indeed, the induced currents are always smaller in the pyrrole rings than in the benzene ones. This has been further investigated using the streamline and the color map representations, which indicate that the diatropic current density passing through the plane cutting the C–N bonds in the pyrrole rings is stronger but is more localized than the current density passing through the plane cutting the C–C bonds in the benzene rings. This gives a positive but smaller total induced current for the pyrrole rings than for the benzene ones. For these systems, the NICS(0) and even more the $NICS_{zz}(0)$ values are not fully reliable to probe the local aromaticity, contrary to the induced current. Indeed, the $NICS_{zz}(0)$ values for the tri-aza-[7]-helicene molecule range from −14.23 to 1.14 ppm, which cannot lead to the same conclusion as the induced current values (10.03 to 12.87 nA $T^{-1}$).

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## 1 Introduction

The magnetically induced current (MIC) density is one of the most tackled properties to assess aromaticity since it provides deep insights about electronic motions in molecular systems when they are subjected to external magnetic fields,[1–10] in particular because this information is not easily obtained experimentally. Once exposed to an external magnetic field, aromatic ring-shaped molecules exhibit a net diatropic ring current, *i.e.* a current which, in turn, induces a magnetic field that is opposite to the applied external one. Inversely, in antiaromatic molecules, a paratropic ring current (which is opposite to the diatropic one) is expected to dominate, while in nonaromatic molecules, both the diatropic and paratropic components are practically equivalent, leading to a vanishing net ring current strength. Thereby, diatropic and paratropic currents are associated with aromatic and antiaromatic character, respectively. However, so far and in most investigations, the nucleus independent chemical shifts (NICS) are computed for probing the MIC-based aromaticity. In fact, NICS values are averages evaluated at a given point in space and therefore they provide only indirect information on the MICs.[11] To the best of

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# Metal transfer budgets in a Mediterranean marine environment subjected to natural and anthropogenic inputs: case of the Mejerda River Delta (Gulf of Tunis, northern Tunisia)

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**Abstract** Deltaic sediments are important for biogeochemical metal cycling since they are hotspots for metal inputs. In addition, they are potential sites for diagenetic processes leading to either the burial of inorganic contaminants or their release. Diffusive fluxes of certain metals (Fe, Mn, Pb, Zn, Cu and Cd) in the sediments of the Mejerda River Delta (MRD) (Gulf of Tunis, Tunisia) were quantified by modeling the available concentration profiles in the pore water. The metals' burial and sedimentation fluxes were also calculated using both the asymptotic concentrations of available metal profiles and sediment trap results. These fluxes were assembled with the exchange fluxes at the sediment-water interface in order to develop complete metal transfer budgets. The results showed that budgets of Cu and Zn are almost neutral. The sediment appears to be a good trap for iron since its average burial flux at the three studied stations is about 332.6 g $m^{-2}$ $year^{-1}$. Organic matter degradation, carbonate dissolution, and oxyhydroxide reduction are the main mechanisms which accelerate the release of metals associated with the suspended particle matter once they reach the pore water in the seabed.

**Keywords** Marine sediments · Metals · Burial flux · Suspended particulate matter · Chemical speciation · Transfer budget

**Electronic supplementary material** The online version of this article (https://doi.org/10.1007/s10661-019-7521-1) contains supplementary material, which is available to authorized users.

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## Introduction

Coastal systems include marine and terrestrial zones (Aleya et al. 2019). Though each has its own characteristics, they nevertheless share the same socio-economic issues. The coastline is increasingly under anthropogenic stress according to the International Union for Conservation of Nature (IUCN), with more than 60% of the world's population living along 150 km of a coastline.

Deltas comprise a highly specific part of coastal territories. They are the ultimate receptacle for several organic and inorganic contaminants, such as trace metals (Nriagu 1988; Sánchez-Chardi et al. 2007; Martins et al. 2013).

The Gulf of Tunis in general and the Mejerda River Delta (MRD) in particular have been the subject of several investigations, including studies of currents

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# Mixing efficiency from microstructure measurements in the Sicily Channel

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**Abstract**

The dissipation flux coefficient, a measure of the mixing efficiency of a turbulent flow, was computed from microstructure measurements collected with a vertical microstructure profiler in the Sicily Channel. This hotspot for turbulence is characterised by strong shear in the transitional waters between the south-eastward surface flow and the north-westward deep flow. Observations from the two deep passages in the channel showed a contrast in turbulent kinetic energy dissipation rates, with higher dissipation rates at the location with the strongest deep currents. This study investigated the dissipation flux coefficient variability in the context of mechanically driven turbulence with a large range of turbulence intensities. The dissipation flux coefficient was shown to decrease on average with increasing turbulence intensity $Re_b$, with median values of 0.74 for low $Re_b$ (<8.5), 0.48 for moderate $Re_b$ ($8.5 \leq Re_b < 400$) and 0.30 for high $Re_b$ (≥400). The dissipation flux coefficient inferred from the measurements was systematically higher on average than the parameterisation as a function of turbulence intensity suggested by Bouffard and Boegman (Dyn Atmos Oceans 61:14–34, 2013). A plateau at moderate turbulence intensities was observed, followed by a decrease in the dissipation flux coefficient with increasing turbulence intensity as predicted by the parameterisation, but at higher turbulence intensity. The dissipation flux coefficient showed a strong variability with the water column stability regime for the different water masses. In particular, high dissipation flux coefficient (median 0.40) was found at $Re_b$ between 400 and $10^4$ for the transitional waters at the northeastern passage, where dissipation rates were high, stratification and shear were strong but the Richardson number $Ri$ was sub-critical. Vertical diapycnal diffusive fluxes were computed, and upward salinity sustained density fluxes of the order of $9 \times 10^{-6}$ and $4 \times 10^{-6}$ kg m$^{-2}$ s$^{-1}$ were found to be characteristic of the transitional ($28 < \sigma < 29$ kg m$^{-3}$) and intermediate ($\sigma > 29$ kg m$^{-3}$) waters, respectively. Turbulent mixing led to a lightening of the transitional and intermediate waters, which was consistent with previous estimates (Sparnocchia et al. J Mar Syst 20:301–317, 1999), but an order of magnitude lower when inferred from the (Bouffard and Boegman Dyn Atmos Oceans 61:14–34, 2013) parameterisation.

## 1 Introduction

The mixing efficiency is a measure of the efficiency with which turbulent mixing transforms the density field (Peltier and Caulfield 2003). Its expression was established by Osborn (1980) assuming a steady state and negligible advection. In such conditions, the turbulent kinetic energy equation reduces to a balance between the shear production term and the dissipation and buoyancy fluxes:

$$-\overline{u'w'}\frac{\partial U}{\partial z} = \varepsilon + \frac{g}{\rho_0}\overline{\rho' w'}, \tag{1}$$

where $u = U + u'$ is the horizontal velocity component aligned with the mean flow, $U$ is the mean horizontal velocity, primed quantities are fluctuations from the mean, $w$ is the vertical velocity, $g$ is the gravitational acceleration,

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# Photogrammetric assessment of shoreline retreat in North Africa: Anthropogenic and natural drivers

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ABSTRACT

Shoreline retreat along extended semi-arid areas of North African coasts are indicative of the imbalance of coastal sedimentary processes due to modern abrupt changes in precipitation patterns and urban growth. Monitoring of the diachronic shoreline position and land-use from 1952 to 2018 in the coast of the Hammamet Bay in central-east Tunisia, using both aerial and orbital photogrammetric scenes and the Digital Shoreline Analysis System from 1887 to 2018, suggests shoreline retreat rates ranging from −1.3 to −5.6 m/yr. Such rates are abnormal when compared to the average of −0.07 m/yr suggested by global-scale assessment modeling for sandy beach evolution. These abnormal erosions extend over 65 km of sandy beaches, resulting from a severe deficit of sediment transport caused primarily by rapid coastal urban growth that obstructs sediment flow to the shoreline. We suggest that the high retreat rates observed in the low-population period of 1884–1931 originated mainly from storm surges and tsunamis, or potentially subsidence in the coastal substratum. Moreover, our analysis of the salinity of shallow coastal aquifers and land coverage suggests that shoreline retreat coupled with rapid urban growth accelerated seawater intrusion ~5 km inland, causing soil desiccation, the development of salt lakes, and reduction of vegetation coverage by ~18%. These abrupt environmental changes have a severe, adverse impact on crop production and food security in these densely populated and economically important areas across significant parts of the North African coasts, sharing similar key environmental parameters with our study site. We conclude that anthropogenic drivers are the major source of shoreline retreat rather than natural ones.

## 1. Introduction

Shoreline dynamic is a key parameter in understanding the stability and evolution of coastal environments. It is also an important factor in measuring sea-level rise. It is governed by both anthropogenic and natural drivers, such as urban development and variations in coastal sedimentation dynamics, respectively, where the latter arises from changes in precipitation patterns as well as other sedimentation processes (Stive et al., 2002; Hakkou et al., 2018; Luijendijk et al., 2018). Indeed, ~80% of coastlines world-wide are eroding at rates ranging from a few centimeters to 10 m/yr (Pilkey and Hume, 2001). Moreover, Luijendijk et al. (2018) suggest the occurrence of decades-long coastal erosion (defined as hot spots), with rates ranging from −0.05 to −0.07 m/yr for the kilometers-long sandy beaches that constitute the predominant coastal landscape of North African shores.

The semi-arid areas of the North African coasts in the central Mediterranean basin are among the key areas where these drivers are rapidly evolving over the last few decades, causing major changes in the sedimentation processes that affect coastline evolution. In these urbanized coastal regions, sandy beaches exhibit a variety of observed rates of shoreline retreat originating from the sedimentation imbalance that fluctuates with variations in precipitation patterns and the obstruction of sediment flow and transport to the shoreline by man-made obstacles (e.g., dams and extended concrete-covered areas).

Hence, understanding the origins and magnitude of shoreline retreat along the North African coast is of high importance for quantifying the environmental evolution of highly dense urban areas, especially in semi-arid regions where such phenomena are sparsely observed, let alone understood. The extensive sandy coasts of Tunisia offer a unique opportunity to address this deficiency, as they offer several

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# Progradation and retrogradation of the Medjerda delta during the 20th century (Tunisia, western Mediterranean)

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ABSTRACT

The aim of this study is the reconstitution of the recent morpho-sedimentary evolution of the Medjerda River delta. We examine the spatio-temporal evolution of the Medjerda shoreline between 1936 and 2016 using satellite images, complemented by sedimentological and geochemical analyses and $^{210}Pb_{ex}$ and $^{137}Cs$ radiometric data. The general tendency of the shoreline evolution shows an increasing progradation (300 ± 12 m) between 1936 and 2016. Yet the mesoscale Net Shoreline Movement position (NSM) and the End Point Rate (EPR) reveal an erosion pattern estimated to be −20 m ± 0.15 m/yr during the period 1988–1999.

The sedimentological analyses reveal four main lithostratigraphic units. The fine sand substratum layer (Md = 0.08 mm) decreases toward clay and silt facies (Md < 0.063 mm), rich in continental plant debris. The geochemical results reveal gradual incoming of the terrigenous component instead of marine deposits. The $^{137}Cs/^{210}Pb_{ex}$ radiometric dating confirms the functioning of the new river flow by the 1950s with the highest sedimentation rate being 3.3 cm/yr. Our results show that the Sidi-Salem dam impoundment (1981) led to a dramatic reduction of sediment discharge, a decrease of the grain size with nearly no more sand reaching the coast, and the shoreline retreat.



## 1. Introduction

On a global scale, coastal environments have been strongly impacted by rivers (Stanley, 1997; Stanley and Warne, 1994). Rivers are considered the principal sediment delivery method towards marine environments and are closely dependent on climatic and human pressure (Syvitski, 2003; Syvitski and Kettner, 2011). In this context, several studies have been carried out in the Mediterranean basin to reconstruct the historical evolution of the river system (Bourrin, 2007; Duboul-Razavet, 1956; Guillen and Palanques, 1997; Roussiez et al., 2005). The increase of the Mediterranean population from 276 million in 1970 to 466 million in 2010 (GRID, 2013) is highly concentrated in coastal and deltaic areas and is associated with multiple human activities.

The decrease in sediment discharge caught by dams and water quality deterioration are some examples of the anthropogenic pressure suffered by the river. Similarly, deltaic coasts suffer from sediment loads restriction as their equilibrium is regulated by river feeds (Sánchez et al., 2010; Walling, 2006). The coastline regression and the coastal

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# REPARTITION GRANULOMETRIQUE ET MINERALOGIQUE DES SEDIMENTS DE SURFACE DANS LA FRANGE LITTORALE DE GABES ENTRE OUED MELAH ET OUED GABES

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**ملخص**

**التوزيع الحبيبي و المعدني للرواسب السطحية في ساحل قابس بين واد المالح وواد قابس** : لفهم ديناميكية الرواسب للشريط الساحلي الممتد من وادي ملاح ووادي قابس ، أخذنا عينات من الرواسب السطحية التي يتراوح عمقها بين 0.3 و 23 مترًا لدراسة علم الحبيبات ومعادن الرواسب. تبين تحليلات المعلمات الحبيبية للرواسب السطحية أن رمال الشاطئ البحري لمنطقة قابس مغطاة بالرمال الناعمة والرمال المتوسطة والرمال الخشنة. تقع الرمال ذات الخشونة وضعيفة التدرجات في أعماق كبيرة ، بينما تصطف الرمال الجميلة ذات الحبيبات السفلية بالقرب من الشاطئ. رمال الضحلة لها حجم حبة موحد. لقد تحركوا بالملح والتعليق المتدرج في الأعماق الضحلة بين منطقة الانكسار (من 5 إلى 7 أمتار). ومن ناحية أخرى ، تحركوا عن طريق الدفع والتداول في أعماق أكبر من 7 أمتار.

يوضح التحليل المعدني أن أكثر المعادن غير الصلابة وفرة هي الجبس والكوارتز والأراغونيت والكالسيت والكالسيت المغنيسيوم والدولوميت الأقل أهمية

**الكلمات المفتاحية**: علم الحبيبات ، علم المعادن ، الرواسب ، ساحل قابس

## RESUME

Pour comprendre dynamique sédimentaire dans la frange littorale entre Oued Melah et Oued Gabès, des échantillons de sédiments de surface ont été prélevés entre 0.3m et 23 m de profondeurs pour étudier la granulométrie et la minéralogie des sédiments.

Les analyses des paramètres granulométriques des sédiments de surfaces, montre que la plage sous-marine de la région de Gabès est tapissée par des sables fins, des sables moyens et des sables grossiers. Les sables grossiers et mal classés sont localisés dans les milieux profonds aux niveaux des isobathes -20m et -23m, alors que les sables fins et bien classés tapissent les fonds inférieurs à 15m. Les sables des petits fonds entre 0.3 m et 23 m des petits fonds présentent une granulométrie uniforme. Ils se sont déplacés par saltation et par suspension gradée dans les faibles profondeurs entre la zone de déferlement (5-7 m) et le trait de côte. Par contre, ils se sont déplacés par charriage et par roulement dans les profondeurs supérieures à 7 m.

L'analyse minéralogique montre que les minéraux non argileux les plus abondants sont le gypse, le quartz, l'aragonite, la calcite, la calcite magnésienne et de moindre importance la dolomite.

***Mots clés :*** granulométrie, minéralogie, sédiments, littoral de Gabès

## ABSTRACT

**Granulometric and mineralogical distribution of surface sediments in the littoral fringe of Gabes between oued Melah and Oued Gabes :** To understand Sedimentary dynamics in the littoral fringe between Oued Melah and Oued Gabès, sub-surface marine sediments were collected between the isobaths 0.3 and 23 m in order to study the grain size characteristics and the mineralogy of the sediments.

Analyses of the granulometric parameters of surface sediments show that the sands of the submarine beach of the Gabès region are covered by fine sands, medium sands and coarse sands. The coarse and poorly graded sands are located at great depths, while the fine and well-graded sands cover the bottom less than 15 m depth. The sands of the shallows have a uniform grain size. They moved by saltation and suspension graded in the shallow depths between the breaking zone (5-7m). On the other hand, they moved by thrusting and rolling in more than 7 m depth.

Mineralogical analysis shows that the most abundant non-clay minerals are gypsum, quartz, aragonite, calcite, magnesian calcite and less important dolomite.

***Keywords:*** granulometry, mineralogy, sediments, Gabès coastline

## PRESENTATION DE LA ZONE

Le golfe de Gabès fait partie de la côte orientale de la Tunisie en mer Méditerranée. Il occupe la plus grande partie du littoral Est tunisien compris entre la ville de Sfax et l'île de Djerba. Il est limité au Nord par l'archipel et les hauts fonds des Kerkennah, à l'Ouest et au Sud par le continent, sa limite Est étant délimitée par la rupture de pentes du plateau continental aux environs de 200 m. Notre secteur d'étude se localise au niveau du littoral de la région de Gabès et se limite au nord par l'oued El Malah et au sud par l'oued Gabès. Il est situé à entre 34°00.552' et 33°53.007' de latitude Nord et entre 10°02.930' et 10°19.940'de longitude Est (Figure 1).

Ce littoral est influencé directement par des oueds et notamment les oueds : El Melah, Demna, Ettine, Gabès, Essouareg, et El Fard.

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# Synthesis review of the Gulf of Gabes (eastern Mediterranean Sea, Tunisia): Morphological, climatic, physical oceanographic, biogeochemical and fisheries features

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## 1. Introduction

Several oceanographic surveys have been done in the Gulf of Gabes since the beginning of the twentieth century. The aim of the study by the "*Pourquoi Pas*"? in 1923 was to investigate sea bottom features (Dangeard, 1924). The benthos research began with Le Danois (1925) and Seurat (1924, 1929, 1934), who studied the habitats on the intertidal floor. Later, De Gaillande (1970a, b) and Poizat (1970a, b) studied the benthic sands, the hydrodynamics and sediments of the Gulf, while Ktari-Chakroun and Azouz (1971) focused on the bottom typography to identify areas suitable for trawling. During the same period, Ben Othman (1971) published hydrobiological observations on the southeast Tunisian coast. The potential of pelagic fish exploitation was investigated in the frame of the research and development project of fisheries during three combined hydroacoustic and oceanographic cruises (June–July and September–October 1972 and April–May 1973) that enabled a detailed description of oceanographic properties (Brandhorst and Messaoud, 1977). The latter study could be considered the first of its kind, given the investigated geographical space and the subject matter addressed.

Water circulation highly influences the biological, chemical and sedimentological features in the Gulf of Gabes. Previous studies showed that water circulation in the Gulf is closely associated with the Atlantic waters circulating through the Strait of Gibraltar (Béranger et al., 2004; Ben Ismail et al., 2012, 2014) and with tidal effects (Tsimplis et al., 1995; Gasparini et al., 2004). Tides observed in the Gulf of Gabes are among the highest in the Mediterranean Sea (up to 2 m in height) and are mostly semidiurnal (Gasparini et al., 2004; Sammari et al., 2006). In addition to tides, anticyclonic winds also drive water circulation (Hattour et al., 2010), bed sediment texture and seagrass density (Ben Brahim et al., 2010).

The Gulf of Gabes is considered highly productive (D'Ortenzio and d'Alcalà, 2009; Ben Brahim et al., 2010), contributing approximately 40% of the national fish production in Tunisia (DGPA, 2015) and thus constituting an anomaly in the eastern Mediterranean Basin, which is known to be oligotrophic, as it is governed by the inflow of usually nutrient-poor Atlantic surface waters coming from Gibraltar (Berman et al., 1984; Krom et al., 2010). The Gulf was recently identified as one of the eleven consensus ecoregions of the Mediterranean and is considered, together with the Venetian shelf region, as a shallow and phytoplankton bloom region (Ayata et al., 2017). Additionally, this area is usually considered an important nursery for several fish species (Hattour et al., 1995; Derbel et al., 2012; Enajjar et al., 2015).

Since the industrialization in 1970, which involves discharge from large-scale phosphate production plants in Sfax and Gabes (Béjaoui et al., 2004; Ghannem et al., 2010), the phosphogypsum discharge (~12000 ton per day) has become the main cause of the disequilibrium of this ecosystem. Recent studies has shown a decrease in fish resources (Zairi and Rouis, 1999; Hamza-Chaffai and Pellerin, 2003); a loss of marine biodiversity (Drira et al., 2008; Barhoumi et al., 2009; Rabaoui et al., 2013) and a degradation of water quality (Bel Hassen et al., 2008; Drira et al., 2014a, b; Ben Salem et al., 2015). The discharges of phosphogypsum led to a drastic decrease in the seagrass areas, as observed for *Posidonia oceanica* assemblages, which were shown to be

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# Sensitivity assessment of the deltaic coast of Medjerda based on fine-grained sediment dynamics, Gulf of Tunis, Western Mediterranean

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## Abstract

As coastal areas become increasingly vulnerable to climate change, the study of nearshore sediment textures along the littoral cell of the Medjerda delta in the Gulf of Tunis, southern Mediterranean coast can provide valuable information (i) on the origin (continental or marine) of the sediment, (ii) its transport direction, and (iii) constitutes an important tool in the assessment of coastal sensitivity. A total of 120 sediments samples underwent grain size analysis and statistic parameters have been calculated. These allowed the identification of five different Sedimentary Types (ST). Accordingly, using grain size indexes (i.e. Mz, SKI and Ku), Sediment Trend Analysis (STA) modeling tools were applied to define the seasonal sediment transport pathways throughout the nearshore of the Medjerda sedimentary cell. Results show that grain size distribution (GSD) and STA model pathways are determined by cross-shore geomorphology, location of the sediment-cell, seasonal incident wave and local terrestrial supply. The appearance in an atypical seabed location of the finer (Mo = 0.1 mm) and the coarser STs (Mo = 0.8 mm) can be indicative of human influence since the coarser particles are usually retained by dam structures. Moreover, the bimodality and the increased distribution of mud are also related to the seasonal incident wave winnowing of the historic deltaic plain submerged by the relative rise in sea level. The evolution of the sediment pattern towards a greater proportion of very fine grains indicates a deficit of sediment supply, particularly of the coarser grains, and demonstrates the coastal vulnerability of the Gulf of Tunis due to anthropic effects.

**Keywords** Grain size distribution · Sedimentary type · Sediment transport analysis · Sensitivity · Medjerda coast · Gulf of Tunis

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## Introduction

Rivers carry the products of both natural geological processes and anthropogenic pollutants to the sea (Presley et al. 1980) contributing for ~90% of the total seaward transport of dissolved and suspended solids (Garrels and Mackenzie 1971). The sandy coast of the Gulf of Tunis bordering the River plain of Medjerda is mainly the result of a terrestrial sediment transport driven by Medjerda River during the last ~1700 y (Paskoff and Trousset 1992; Paskoff 1994; Delile et al. 2015). The deltaic plain of this River also contains a mixture of riverine mud and sand supplied by long-shore transport from the surrounding coast (Kalai 1985; Paskoff 1994). In this context, the Tunisian coast has been a subject of scientific interest since the mid-nineteenth century (e.g. Paskoff 1981; Paskoff and Sanlaville 1983; Kouki 1984; Oueslati 1993; Maghrebi 1995; El Arrim 1996; Amrouni 2002, 2008; Gargouri 2009; Bardi 2010; Saidi 2013; Louati 2014; Hzami 2015). Building on these previous studies, characterization of the textural parameters of the sediment and their evolution

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# Theoretical Assessment of the Second-Order Nonlinear Optical Responses of Lindqvist-Type Organoimido Polyoxometalates

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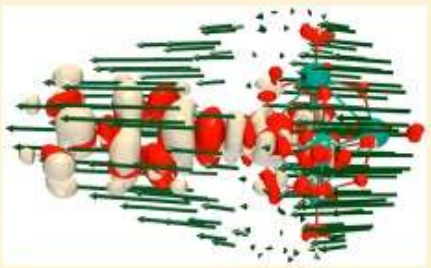
Supporting Information

**ABSTRACT:** The second-order nonlinear optical properties of Lindqvist-type organoimido polyoxometalates bearing donor and acceptor substituents are evaluated by employing density functional theory and time-dependent density functional theory using the ωB97X-D range-separated hybrid exchange-correlation functional to describe accurately the field-induced effects. The hyper-Rayleigh scattering responses, $\beta_{HRS}$ $(-2\omega; \omega, \omega)$, and the depolarization ratio are the targeted quantities. They are analyzed by resorting to the two-state model, which reduces the full summation-over-state expression to a single diagonal term and relates the response to a few spectroscopic quantities. The validity of this model is demonstrated by its ability to reproduce the $\beta_{HRS}$ variations as a function of the nature of the ligand, owing to the dominant 1D character of these organic−inorganic hybrids. The calculated values are in good agreement with the recent experimental work of Al-Yasari et al. (*Inorg. Chem.* **2017**, *56*, 10181−10194), which demonstrates that the hexamolybdate moiety plays the role of an electron acceptor group. On the contrary, they contradict previous studies, which attributed an electron donor character to the polyoxometalate moiety. Calculations highlight that (i) combining the hexamolybdate unit with an organic ligand bearing a strong donor substituent leads to an enhanced first hyperpolarizability, associated with a dominant low-energy excited state, characterized by a large excitation-induced electron transfer from the donating ligand to the hexamolybdate, therefore coupling the polyoxometalate (POM) and its substituted ligand; (ii) in the case of weaker donor substituents, the hexamolybdate still behaves as an electron acceptor, but the first hyperpolarizability is smaller and the coupling has a reduced spatial extension; and, on the contrary, (iii) in the presence of an acceptor substituent, there is a competition between the hexamolybdate and this group so that the first hyperpolarizability becomes very small. The whole set of results demonstrates that polyoxometalate moieties are good candidates to achieve large second-order nonlinear optical (NLO) responses while keeping a rather large transparency window and also that there remains space to improve their integration into NLO efficient organic−inorganic hybrids.



## INTRODUCTION

Nonlinear optical (NLO) materials have received much attention over the last several decades because they can be widely used in laser modulation, optical information processing, optical computing, optical data storage, and optical transmission technologies.[1] The performance of these applications strongly depends on the NLO activity of matter and therefore of its constitutive units, so that many investigations have been devoted to designing new compounds with remarkable NLO responses. Studies on organic and organometallic compounds, which can present high second-order NLO responses combined with short response times, have led to compounds with a broad range of size, shape, and composition[2−7] as well as with switchable units.[8−11] Among these polyoxometalate-functionalized organic−inorganic hybrids is an interesting class of compounds with potentially large second-order NLO responses.[12−14] Polyoxometalates (POMs) have also been used as noninnocent anions with an NLO active cation (e.g., stilbazolium) to prepare charge-transfer salts that exhibit large second-harmonic generation (SHG) activity.[15]

POMs are anionic metal−oxygen clusters, built from $MO_z^{y-}$ transition-metal oxyanion polyhedra linked together by shared O atoms. M is typically a group 6 metal atom (Mo or W, low-cost earth-abundant elements) in a high oxidation state.[16] POMs are mostly known for their catalytic activities associated with their redox properties. Besides measurements of the second-order NLO activity of a few POM derivatives by hyper-

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# Theoretical investigation of the heterocyclic molecules type dioxolane obtained from the protection reactions between carbonyl compounds and diols

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## Abstract

We reported in this work the addition reactions between a series of carbonyl compounds types 1a-d and 1a'-d' and (Z) and (E) diols 2 and 3 (Figure1, Figure2). The reactions between diols and series of carbonyl compound types 1a''-c'' protonated by Lewis acid are also studied (Figure3).This study of reactivity have explored by the theoretical study using the program Gaussian 09 using SCF calculations with 6-311G standard basis set. Then, we studied from thermodynamic and orbital point of view, the possibility and the stereoselectivity of reactions between substituted diols 3α-γ with carbonyl compound type 1a and 1d (Figure4).

## 1. Introduction

The protection [1,2] and deprotection of the functional group remain crucial challenges for organic chemists, while protection of the carbonyl group is done using different diols [3,4], as protective agents. Indeed, this reaction is catalyzed by different types of catalysts such as a protic acid or Lewis acid [5-11] to form cyclic dioxolane [12-14]. This cyclic compound can be hydrolyzed to reform both the diol and the starting carbonyl compound according to the deprotection process. Therefore, the protection of a carbonyl function becomes necessary when the reagent has several functional groups [15]. This carbonyl must be protected against nucleophilic attack until its electrophilic properties can be exploited [16]. Indeed, the protection plays an important role in organic, medicinal, drug design chemistry [17] and atmospheric photochemistry [18].

In this paper, we found interesting to carry out a theoretical study on the protection reactions of between carbonyl compounds and diols, which allow access to heterocyclic molecules such as dioxolane. To put this study in evidence, we studied in the first part of this work the addition reactions between (Z) and (E) diols and carbonyl compounds 1a-d and 1a'-d' (Figure1) and (Figure 2). Later, we determined the addition reactions between diols and carbonyl compounds 1a''-c'' protonated by Lewis acid $H^+$ (Figure3). In the second part of this work, we studied the influence of the substituted diols 3α-γ on the reactivity of compounds 1a and 1d (Figure 4).

## 2. Computational methods

This study was carried out using the Gaussian 09 program [19]. The calculations were performed using the ab-initio method of quantum chemistry with 6-311 G standard basis set.

Indeed, this method has been used to provide structural and energy properties for heterocyclic conjugated molecules [20, 21].

# Traitements des séries chronologiques dans le littoral de Gabès

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**ملخص**
معالجة السلاسل الزمنية في ساحل قابس : أظهر تحليل السلسلة الزمنية التي تم الحصول عليها في منطقة غنوش مدى المد والجزر الكبير (230 سم) ووجود التيارات المدية القوية إلى حد ما في حدود 15 سم. -1 والذي يتناوب اتجاهه بين الشمال الغربي والشمالي الشرقي. بالإضافة إلى ذلك ، فإن التيارات ذات التردد المنخفض (الامواج والرياح والضغط) هي في حدود 10 سم - 1 خلال فترة التسجيل. التيارات بالقرب من القاع لها اتجاه الشمال / الجنوب و لها سرعة تقدر ب 15 صم في الثانية
**الكلمات المفتاحية:** السلاسل الزمنية ، السرعة ، الاتجاه ، التيار ، ساحل قابس

**RESUME**
L'analyse des séries temporelles obtenues dans la zone de Ghannouch a permis de montrer le marnage important (230cm) et la présence des courants de marée assez forte de l'ordre de 15 $cm.s^{-1}$ et dont la direction s'alterne entre le Nord-ouest et l'Est-Nord-est. En outre, les courants de basse fréquence (houle, vent et pression) sont de l'ordre de 10$cm.s^{-1}$ lors de la période de l'enregistrement. Les courants de la dérive littorale près du fond, de l'ordre de 15 $cm.s^{-1}$, ont une direction Nord/Sud.
***Mots Clés*** **;** Séries chronologiques, vitesse, direction, courant, littoral de Gabès.

**ABSTRACT**
**Time series processing in the Gabès Coastline :** The analysis of the time series obtained in the Ghannouch area has shown the significant tidal range (230cm) and the presence of fairly strong tidal currents in the order of 15 $cm.s^{-1}$ and whose direction alternates between Northwest and East-Northeast. In addition, the low frequency currents (swell, wind and pressure) are of the order in 10 $cm.s^{-1}$ during the period of recording. The currents of the littoral drift near the bottom, of the order in 15 $cm.s^{-1}$ have a North / South direction.
***Keywords*** **:** Chronological series, speed, direction, current, coast of Gabès

## INTRODUCTION

Les littoraux sont souvent soumis à une érosion importante pouvant atteindre, par endroits, plus de 20 m par an, ce qui met en péril une partie du patrimoine national que représente la frange littorale (Paskoff, 2004). La côte de la région de gabès n'échappe pas à la conjoncture mondiale de déséquilibre sur les plans sédimentaire et morphologique, puisqu'elle est soumise à une dégradation et à une perturbation de son budget sédimentaire (Miossec & Paskoff, 1979; Oueslati, 2004 ; Paskoff, 2004 ; Masmoudi et al, 2005). Ce déséquilibre sédimentaire est la résultante des effets naturels, tels que les paramètres hydrodynamiques (vents, houles et marée), la topographie sous-marine, l'augmentation du niveau de la mer, le couvert végétal sous-marin et des interventions multiples de l'homme, tels que l'urbanisation touristique et balnéaire près de la mer et le déficit des apports terrigènes des sédiments par les cours d'eaux exoréiques (Paskoff, 2004).
Nous nous proposons d'étudier la circulation (vitesse et direction des courants) des eaux dans le littoral de Gabès afin d'identifier et d'analyser les causes qui sont à l'origine de l'érosion de ces côtes et de contribuer à la prise de décisions concernant sa protection et son aménagement. Parmi les paramètres qui servent pour calibrer le modèle numérique du transport des sédiments figurent celles de l'hydrodynamique notamment les courants associés à la houle et à la marée. Dans ce cadre nous avons installé un ADCP dans la zone à étudier. Le présent travail, traite les séries chronologiques des niveaux d'eau et les vitesses des courants dans ce littoral.
Ces travaux sont déroulés dans le Laboratoire du Milieu Marin de l'INSTM. Ils s'intègrent dans un projet de recherche international et financé par MISTRALS-MERITE avec l'institut « Mediterraneen Institut of Oceanologie »

## PRESENTATION DE LA ZONE

Le golfe de Gabès fait partie de la côte orientale de la Tunisie. Il occupe la plus grande partie du littoral Est tunisien compris entre Sfax et l'île de Djerba. Il est limité au Nord par l'archipel et les hauts fonds des Kerkennah, à l'Ouest et au Sud par le continent, sa limite Est étant délimitée par la rupture de pentes du plateau continental aux environs de 200 m.
Ce littoral est influencé directement par des oueds et notamment les oueds : El Melah, Demna, Ettine, Gabès, Essouareg, et El Fard.

Journal of Sea Research 158 (2020) 101875

Contents lists available at ScienceDirect

Journal of Sea Research

journal homepage: www.elsevier.com/locate/seares

# Ultraphytoplankton community composition in Southwestern and Eastern Mediterranean Basin: Relationships to water mass properties and nutrients

Yosra Khammeri[a,b,*], Amel Bellaaj-Zouari[a], Asma Hamza[a], Walid Medhioub[a], Emna Sahli[a], Fourat Akrout[a], Nouha Barraj[a], Mohamed Yassine Ben Kacem[a], Malika Bel Hassen[a]

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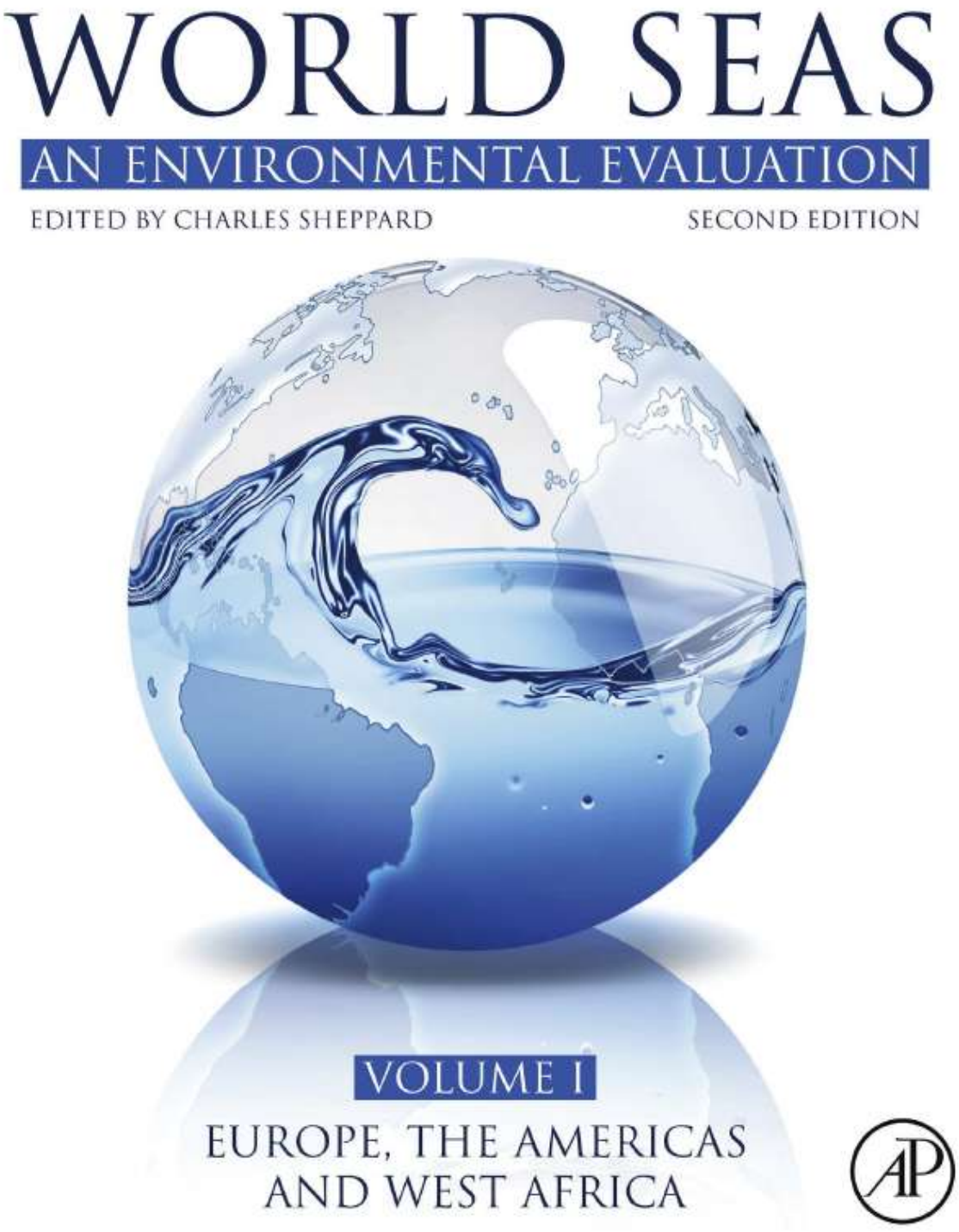
AYADI Sameh

# Chimie des solutions et ses applications: Cours et exercices résolus

**Liste des chapitres d'ouvrage édités en 2019**



# Grain Size Distribution and Enrichment Evaluation of Trace Metals in the Mediterranean Harbor Lagoon (Kalaât Andalous, Tunisa)

Samia Khsiba, Oula Amrouni, Chrystelle Bancon-Montigny, Karim Ben Mustapha, Lassaad Chouba, Nadia Gaâloul, and Gil Mahé

**Abstract**

Sediments are important carriers of pollutants and they help greatly in describing the aquatic ecosystem relating state. The aim of this study is to characterize the Kalaât Andalous harbor lagoon sediments' grain size, their spatial distribution as well as their relating quality. To this end, a study of their trace elements content has been conducted to highlight the associated natural and anthropogenic contribution. Hence, twelve subsurface lagoon sediment samples were extracted at the level of six radials and subjected to a granulometric analysis. The calculation of such indexes as the average mean size (MZ), sorting index ($\sigma$) and asymmetry index (SKI) helped greatly in defining the grain size-distribution character. Samples underwent different analyses in a bid to evaluate seven trace metals relevant rates (As, Cd, Cr, Cu, Ni, Pb, Zn). The obtained metal concentrations were compared to the American Oceanic and Atmospheric Administration (NOAA) guidelines, ERL and ERM. The enrichment factor (EF) analysis is used to assess the contamination level, and distinguish both of the relating natural and anthropogenic origin sources. The reached results proved to display that the sediments turn out to be predominantly sandy, with fine sand dominating the area, while medium sand is being located at the channel and the south-western section of the quay. The latter is characterized with a muddy facies. The majority of trace elements' concentrations are discovered to be lower than the ERL values. The implemented enrichment factors proved to indicate that the lagoon is mainly enriched in As and Cd.

**Keywords**

Kalaât Andalous lagoon • Grain size distribution • Trace metals • Enrichment factor

## 1 Introduction

The Mediterranean coastal areas are often threatened with the predominance of metallic contamination [1]. Trace metals prove to penetrate into the aquatic ecosystems from natural sources including pedogeochemical background [2], weathering processes and erosions [3] as well as anthropogenic sources originating from the increase of human activity [1]. In fact, the port relating activities are associated with a particular contamination of aquatic areas and bottom sediments [4]. The accumulation of trace metal in sediments participate noticeably in engendering different changes in the environmental conditions, due mainly to potential remobilization and bioaccumulation in biocenosis [5]. Several researchers have used sediments as environmental indicators whereby trace metal contamination assessed [1, 6, 7]. The purpose of this study is threefold. In a first place, it is designed to characterize the Kalaât Andalous lagoon sediments' related grain size and spatial distribution. In a second place, it is aimed to evaluate the pollution status affecting the study area with respect to the sediment quality guidelines. Finally, It is focused on evaluating the contamination level and differentiating between both of the associated natural and anthropogenic sources by means of the Enrichment Factor (EF) analysis.

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D. M. Doronzo et al. (eds.), *Petrogenesis and Exploration of the Earth's Interior*,
Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-030-01575-6_24

# Multidisciplinary Approaches for the Study of Sediment Discharges to the Mediterranean Sea to Mitigate the Impact of Climate and Anthropogenic Activities on Coastal Environments

Oula Amrouni, Gil Mahé, Saâdi Abdeljaouad, Hakim Abichou, Abdallah Hattour, Nejmeddine Akrout, Chrystelle Bancon-Montigny, Thouraya Benmoussa, Kerim Ben Mustapha, Lassâad Chouba, Domenico Chiarella, Michel Condomines, Laurent Dezileau, Claudine Dieulin, Nadia Gaaloul, Ahmed Ghadoum, Abderraouf Hzami, Nabil Khelifi, Samia Khsiba, Fatma Kotti, Mounir Medhioub, Hechmi Missaoui, François Sabatier, Alberto Sánchez, Alessio Satta, Abdelaziz Sebei, and Wième Ouertani

**Abstract**

The present work is based on The RYSCMED project supported by PHC-UTIQUE *2016–2018* (*16G 1005–34854QC*). The RYSCMED is an interdisciplinary project which gathers different disciplines (e.g. sedimentology, hydrology, geochemistry, ecology, paleontology, biochemistry, archeology) to quantify the sediment flow of the land-sea. This research aims at identifying coastal sediment dynamics (via the sand supply sources; i.e. Medjerda River) and hydrodynamic parameters to understand the local environmental problems in an urbanized coastal framework. The outcome is expected to produce original and new findings about the link between dams, river hydrology and sediment origin to the sea with the impact of climate and anthropogenic activities on the coastal geomorphology and ecosystem sensitivity. The main scientific outcome will be addressed to the socio-economic actors to implement necessary solutions for remediating the Mediterranean coastal vulnerability.

**Keywords**

RYSCMED • Mediterranean • Medjerda River • Sediment • Coast • Sensitivity

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M. Boughdiri et al. (eds.), *Paleobiodiversity and Tectono-Sedimentary Records in the Mediterranean Tethys and Related Eastern Areas*, Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-030-01452-0_84

# Recent Geochemical and Grain Size Distribution of Terrestrial Sediment in Coastal Area from the Watershed of Medjerda River, Gulf of Tunis

Thouraya Benmoussa, Oula Amrouni, Laurent Dezileau, Gil Mahé, Domenico Chiarella, and Saâdi Abdeljaouad

**Abstract**

The geochemical and grain size analysis were carried out on surface and down core sediments from the present-day alluvial-coastal plain of the Medjerda River, Gulf of Tunis, Tunisia. The aim of this paper is to characterize the geochemical and grain size distribution of sediments and its relationship with the hydrodynamics extreme events occurring during the last century. Using a multi proxy approach, six turbidities layers have been identified in down core sediment (i.e. TL-1, TL-2, TL-3, TL-4, TL-5, TL-6, TL-7 and TL-8) characterized by multimodal grain size distribution. The terrestrial sediment which feeds the northern coastal of the Gulf of Tunis is characterized by very fine-grained sediment (clay and silt). The geochemical signature shows a highly concentration of Rb, Ti, Zn and Pb. The Medjerda River is the mainly source of silts and clay sediment. Besides, the mining pollution (Zn and Pb) is relatively strong in the coastal area, especially during the great floods events of Medjerda watershed recorded in the 1953; 1957; 1969 and 1973. Even during high frequency events, the sediments are devoid of any coarse fraction.

**Keywords**

Coastal • Medjerda river • Extreme floods
Turbidities layers • Mining pollution

## 1 Introduction

Rivers are sources of water for social and economic development with the alluvial plain of offering a relatively flat area for urban and agricultural activities. However, human societies have to deal with the fact that the flow of water in river basins is never constant. An often high flow of water during the extreme floods events is one of the more types of natural disasters. Moreover, the sediment leaching from the watershed causes coastal contamination through urban, industrial and agricultural discharges. Rivers are considered as the principal sediment delivery toward the marine environments and are closely depended on the climatic and the human pressure [1, 2]. The Medjerda River basin in NE-Tunisia is one of the largest basins in the northern zone of Africa. It is located in the northern bay of the Gulf of Tunis between 37°10'N–10°16'E and 37°55'N–10°18'E. The aim of the present study is to characterize the recent geochemical and grain size distribution of the terrestrial sediment in coastal area.

## 2 Settings and Analytical Methods

We collected short cores sediment core (CEM-1; 168 cm) at the new delta of Medjerda River. Six surface samples were collected at the coastal area (MED-2, MED-3, MED-North, O10, and O20) and the sediment deposits of the riverbanks of Medjerda (MED-1). The grain size analysis was carried

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Séminaires, journées et ateliers scientifiques organisés en 2019

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Tachanat Bhatrasataphew, Yasra Ehammad, Omaru Marquez, Deepika Sahoo, Jenike Schmidt, Yawei Sheh, Paop Nicolas Incco Pignata, Yanan Zhao

# Best Scientific Report

at the first GO$_2$NE Summer School

State Key Laboratory of Marine Environmental Science

Xiamen University, Xiang'an Campus, China

2 – 8 September 2019

Directors GO$_2$NE Summer School:

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Institut de Recherche
pour le Developpement

Mission pour la Promotion de
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Mme. Amel Zouari

Institut National des Sciences et
Technologies de la Mer
LMI COYSMED

Tunis, Tunisie

Marseille, 30 Octobre 2019

Objet : Attestation de Participation à l'atelier Sustainability Science « Consommation & Production durables – Biodiversité – Eau »

Je soussigné, Maxime Thibon, Chargé de mission à la Mission pour la promotion de l'interdisciplinarité et l'intersectorialité de l'IRD, certifie que Mme. Amel Zouari de l'Institut National des Sciences et Technologies de la Mer-Tunis et membre du LMI COSYSMED a participé à l'atelier de réflexion IRD autour des enjeux du champ disciplinaire de la « Sustainability Science » et du nexus autour des ODDs « Consommation & Production durables – Biodiversité – Eau »

Cet atelier s'est déroulé les 28 & 29 Octobre 2019 à Rabat (Maroc)

En espérant une participation de Mme Zouari dans la poursuite de ces réflexions sur ce sujet, nous vous adressons nos plus sincères salutations.

La Mission pour la promotion
de l'interdisciplinarité et l'intersectorialité

Maxime Thibon

I. R. D.
INSTITUT DE RECHERCHE POUR LE DÉVELOPPEMENT

Fabrice Armougom, PhD -Genomics & Bioinformatics- IRD
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# ATTESTATION DE FORMATION

Je soussigné Dr. **Armougom Fabrice**, IRD,

certifie que **Amel zouari** a suivi l'action de formation suivante :

- Intitulé de la formation: Analyse de Données de Séquençage haut débit, 16S rDNA barcoding Miseq

- Dates de la formation: Du 1 au 4 Juillet 2019

- Lieu de réalisation de la formation: Laboratoire ISSBAT, Tunis, Tunisie

- Durée en heures : 20

Fait à Marseille, le 02/09/2019

Armougom Fabrice

COastal Management and MOnitoring Network

for tackling marine litter in Mediterranean sea

**Communiqué de presse** **19 décembre 2019**

## Démarrage du Projet Européen COMMON: Vers la création d'un réseau inédit de gestion et de suivi côtier pour le traitement des déchets marins en Méditerranée

Le 19 décembre 2019 l'Institut National des Sciences et Technologies de la Mer de Tunis, partenaire du projet COMMON, lance le projet avec une réunion d'information à Monastir réunissant les autorités locales, les ONG environnementales, les scientifiques et la presse afin de présenter le projet COMMON, ses objectifs et de discuter le rôle de la coopération des différents acteurs dans le cadre de la gestion intégrée.

**Le projet COMMON, (COastal Management and MOnitoring Network for tackling marine litter in Mediterranean sea), financé par l'Union Européenne dans le cadre du programme de coopération transfrontalière en Méditerranée ENI CBC MED et coordonné par l'ONG italienne Legambiente, est doté d'un budget de 2,2 millions d'euros et vise à créer une plateforme pour la gestion intégrée des déchets marins en Méditerranée. Ce projet européen et réunit l'Institut National des Sciences et Technologies de la Mer (Tunisie), l'Université de Sienne (Italie), l'Institut Agronomique Méditerranéen de Bari (Italie), l'ONG environnementale Amwaj (Liban), l'Université de Sousse (Tunisie) et le parc naturel de Tyr (Liban).**

De nos jours, la pollution marine est reconnue comme un problème de pollution global, en particulier dans le bassin Méditerranéen. Cependant, l'impact de cette pollution dans les parties sud et est de la Méditerranée est moins connu. En outre, il devient de plus en plus évident qu'il est nécessaire de réagir collectivement pour traiter les déchets marins avec une approche intégrée, dans laquelle les différents acteurs scientifiques, politiques et la société civile peuvent travailler ensemble et de manière coordonnée.


INSTM

## Présentation-Discussions

## Baie de Monastir : Modélisation et Observations

### Mardi 5 mars 2019 à 11:00

### Salle de conférences de l'INSTM Monastir

Le Laboratoire Milieu Marin organise une rencontre scientifique sur la baie de Monastir le 5 mars 2019 à 11:00. Au cours de cette rencontre Mlle Sana Chaouch, en thèse au Laboratoire nous fera une présentation sur ses premiers résultats numériques issus du modèle de circulation des eaux des côtes est de la Tunisie avec un zoom sur la baie de Monastir. Elle nous fera aussi une comparaison aux observations disponibles. Sa présentation sera suivie d'une séance de discussions sur différents aspects en relation avec la baie de Monastir.

Cette recontre est ouverte à toutes et à tous.

Apportez votre collation.

Ali Harzallah

LMM

# Summer School Second Call

## Dynamics and Predictability of the Ocean-Atmosphere System and Computational Aspects

July 22 - August 2, 019 at the National Institute of Marine Science and Technology (INSTM)
28, rue du 2 mars 1934, 2025 Salammbô, Tunisia.

**Application deadline: June 30, 2019**

Atmospheric and oceanic sciences constitute an excellent interdisciplinary example where mathematical physics, statistics, numerical methods and scientific computing meet. Weather and ocean forecasting are used by many customers including weather centres, insurance and energy companies. This Summer School brings together scientists from weather forecasting, oceanography and computing and aims to educate and motivate young postgraduates and researchers from mathematics and numerical analysis to climate and environmental science.

The Summer School consists of courses and seminars given by international and local scientists. The courses of the Summer School will be given by scientists from Stockholm University (MISU), The University of Reading, Leiden University and the Swedish Meteorological and Hydrological Institute (SMHI), and will take place in the attractive and historical city of Salammbô/Carthage on the Mediterranean Gulf of Tunis, 22 July - 2 August 2019.

The Summer School discusses various topics ranging from ocean circulation to numerical weather prediction and data assimilation and stochastic simulation. The school is open to international and local science postgraduates and is particularly suitable for young researchers including Master and PhD students from mathematics, physics, atmospheric and oceanic sciences, environmental sciences and related disciplines.

**Speakers**

**Course 1**: Numerical weather prediction and data assimilation (A. Hannachi, Stockholm University)
**Course 2**: Statistical climatology (A. Hannachi, Stockholm University)
**Course 3**: Ocean circulation: wind-driven and thermohaline circulations (Keith Haines, The University of Reading)
**Course 4**: Practical aspects of data assimilation, ensemble- and convection-based data assimilation (N. Gustafsson, SMHI)
**Course 5**: Stochastic simulation and MCMC methods (Moritz Schauer, Leiden university).

**Local guest lectures**

**Lecture 1**: Coupled dynamical-ecological modelling (Béchir Béjaoui, INSTM).
**Lecture 2**: Sea dynamics modeling: From the regional scale to the local one (Ali Harzallah, INSTM).
**Lecture 3**: On some inverse problems in heat transfer (Emna Ghezaiel, Faculty of Sciences, University of Monastir)
**Lecture 4**: The inverse problem of Submarine Groundwater Exchange (Nejla Harigal, INAT-ENIT)
**Lecture 5**: Sensitivity of the WRF model, case study for northern Tunisia (Sawssen Dhib, ENIT)

**Scientific Committee members**

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# La Journée du LMM 2019

25 avril 2019 Hôtel Ramada Plaza Gammarth

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Journée du LMM 2019
25 Avril 2019
Hôtel Ramada Plaza Gammarth


يوم إعلامي تشاركي
حول ظاهرة المد الأحمر بالسواحل التونسية
بتنظيم من جمعية أزرقنا الكبير بالتعاون مع مخبر الوسط البحري
بالمعهد الوطني لعلوم وتكنولوجيا البحار
المنستير 26 نوفمبر 2019
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# Co-evolution of coastal human activities & Med natural systems for sustainable tourism & Blue Growth in the Mediterranean

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**18th - 20th of September 2019**

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Diplôme de Mastère de Recherche en Géologie
Parcours : GéoRessources et Développement Durable

Présenté par
**Yasmine Beji**

# *Dynamique sédimentaire du littoral de Ghar El Melah : Evolution naturelle et impacts anthropiques*

Soutenu le : 24/01/2020 devant le jury composé de :

| | | |
|---|---|---|
| Mr Saïdi ABDELJAOUED | Professeur Emérite (FST) | Président de Jury |
| Mme Ouls AMROUNI | Maître Assistante (INSTM) | Directrice de mémoire |
| Mme Zeineb GARGOURI | Maître Assistante (ENIS) | Examinatrice |
| Mr Faouzi MAAMOURI | Directeur WWF | Invité |

*En collaboration avec l'Institut National des Sciences et Technologies de la Mer Salammbô, Tunis.*

Année Universitaire : 2018/2019

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**INSTITUT NATIONAL AGRONOMIQUE DE TUNISIE**

Département GENIE HALIEUTIQUE ET ENVIRONNEMENT

**MEMOIRE DE MASTER DE RECHERCHE**

Présenté par

**SOULEIMA DHAHBI**

**Master 2 :** Fonctionnement et Gestion des Ecosystèmes Aquatiques

# Distribution des Eléments Traces et Incidences Eco-toxicologiques sur les Produits de la Pêche dans le Golfe de Gabès

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| | | |
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UNIVERSITY OF TUNIS EL MANAR

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# Mémoire

Présenté pour l'obtention du diplôme de mastère de recherche

en chimie analytique

Par

**Sirine SMAIEN**

# Elimination des colorants par adsorption : Valorisation des noyaux des dattes polluants

Soutenue le 04/05/2019 devant le jury composé de :

| | | |
|---|---|---|
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| **Mr MESSAOUDI Sabri** | **Maître de conférences à FSB** | **Examinateur** |
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**Structure de recherche : Laboratoire matériaux molécules et applications (IPEST)**


**THÈSE**

Présentée pour obtenir le titre de

**DOCTEUR EN CHIMIE**

Par


**CHERNI Emna**


**Intitulée :**

# Etude théorique et expérimentale de la réactivité et des propriétés magnétiques des hétérocycles en milieu homogène et milieu hétérogène

Soutenue le 25 décembre 2019 devant le jury composé de :

| | | |
|---|---|---|
| Mr Rachid REZGUI | Président | Professeur à la faculté des sciences de Tunis |
| Mr Youssef ARFAOUI | Rapporteur | Maître de conférences à la faculté des sciences de Tunis |
| Mme Wajda SMIRANI | Rapporteur | Professeur à la faculté des sciences de Bizerte |
| Mr Nejmeddine JAIDANE | Examinateur | Professeur à la faculté des sciences de Tunis |
| Mme Sameh AYADI | Directeur de thèse | Maître de conférences à l'INSTM |
| Mr Noji BESBES | Invité | Professeur au CNRSM |

*Année universitaire : 2018/2019*

## Liste des Habilitations soutenues en 2019


République Tunisienne
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique
Université de Tunis El Manar
Ecole Nationale d'Ingénieurs de Tunis


# Habilitation Universitaire

# En Génie Hydraulique

**(Rapport)**

Présenté par :


**BECHIR BEJAOUI**
**Maitre Assistant à l'INSTM**


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## CARACTERISATION & FONCTIONNEMENT DES ECOSYSTEMES MARINS PAR UNE APPROCHE DE MODELISATION NUMERIQUE

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**Soutenue le 06 Septembre 2019**

**Devant le Jury :**

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|---|---|---|
| **MOUSSA Mahmoud,** | Professeur à l'ENIT : | Président |
| **ROMDHANE Mohamed Salah,** | Professeur à l'INAT : | Rapporteur |
| **BOUKTHIR Moncef,** | Professeur à l'IPEIT : | Rapporteur |
| **BOUHLILA Rachida,** | Professeur à l'ENIT : | Examinatrice |
| **HARZALLAH Ali,** | Professeur à l'INSTM : | Examinateur |