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Basic physical and chemical properties of some coastal Mediterranean lagoons

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Abstract - In the present study, the physical and chemical properties of some coastal lagoons which include water temperature, salinity pH, dissolved oxygen, phosphate, nitrate, nitrite and ammonia were evaluated to study their environmental status. The water temperature was high in summer and it reached about 28.07 °C at Kalige Um-Alshawsh inlet and then it was drop to 14.39 °C at the Gulf of Bomba. Salinity was found to be high (41.95 ppt) in Autumn at the Gulf of Bomba and less salinity value (38.20 ppt) was recorded in Summer at Marsa El-Katayta. The highest concentration of dissolved oxygen was recorded as 9.59 ppm in Winter at Um Alshawsh inlet and a lower concentration recorded was 5.69 ppm in Summer and was measured at the same station. Highest pH value (8.62) was recorded in Summer at Um Alshawsh inlet while the lower value was observed as 7.84 in Winter at the Gulf of Bomba. Higher value of phosphate was recorded as 2.152 µg-at.P-PO_4^{3-}.l^{-1} in Summer at the Gulf of Bomba and a lower concentration of phosphate was recorded as 0.369 µg-at.P-PO_4^{3-}.l^{-1}. Higher value of nitrate was observed as 4.795 µg-at.N-NO_3^-.l^{-1} in Summer at Marsa El-Katayta and the lower value was recorded as 0.577 µg-at.N-NO_3^-.l^{-1} in winter at port Bordia, while the higher value for nitrite was recorded as 0.741 µg-at.N-NO_2^-.l^{-1}in Summer at Um El-Shows inlet and the lower value was observed as 0.242 µg-at.N-NO_2^-.l^{-1}at the same station. Higher ammonia value (1.044 µg-at.N.l^{-1}) was noticed in the Autumn season at the Gulf of Bomba where non detectable level had been noticed in Summer season at Marsa El-Katayta. The results of the present research exhibited the basic addition to understand these environmental conditions for future activities such as the possibility to exploit, develop and to predict the environmental variables.

Keywords: Coastal lagoon, nutrients, Mediterranean Sea, Libya.

Introduction

Coastal lagoons are inland water bodies generally found on all continents, usually oriented parallel to the coast, separated from the ocean by a barrier, and connected to the ocean by one or more restricted inlets, which remains open at least intermittently, and have water depths, which seldom exceeds a few meters. A lagoon may or may not be subjected to tidal mixing and salinity can vary from that of a coastal fresh-water lake to a hyper saline lagoon depending on the hydrologic balance. Lagoons formed as a result of rising sea level mostly during the Holocene and the building of coastal barriers by marine processes. They are often highly productive and ideal systems for aquaculture projects but at the same time, highly stressed by anthropogenic inputs and human activities (Kjerfve, 1994).

The significance of small systems such as lagoons, enclosed gulfs and costal lakes having physicochemical characteristics was recognized but less frequently studied (Mihopoulos *et al.*, 2000) and can be those water characterized as being areas for eutrophication (Al-Imarah *et al.*, 2008). A seasonal study had been conducted by Al-Asadi (2012) to examine the levels of oil residues from some coastal lagoons in the eastern part of Libya. Information based on the biological, physical and socio-economic features were selected as known universal criteria for Libyan Marine Protected Areas (Haddoud and Rawag, 2007).

Mediterranean coastal lagoons commonly are not effected by significant tidal influences, as tides in the Mediterranean Sea are very low. This avoids the dual inputs of sea water that are common in oceanic salt marshes, because Mediterranean coastal lagoons commonly are not affected by significant tidal of the relatively increased isolation from the sea and their location within a hydrological catchment these lagoons also become more susceptible to changes in salinity, dissolved oxygen, nutrient content, largely owing to the increased effect of evaporation in a restricted area leading to increased salinity (Ghai *et al.*, 2012).

Materials and Methods

Water samples were collected by clean glass bottles seasonally throughout the period from July 1998 to April 1999 at nine stations (Fig. 1). The selected stations were empirically chosen for covering each lagoon.

Water temperature was measured by using a mercury thermometer. Salinity was measured by using Digital Salinometer (Tsurmi Sleik E-202). The pH value was measured in the Laboratory using a pH-meter. Dissolved oxygen (DO) was measured using a portable meter (Hana H19143).

For the determination of dissolved nutrients, analysis were done upon reaching the MBRC Lab. employing methods described by Strickland and Parsons (1972). All the results were expressed as µg at/l. Nutrient salts (NH_4, NO_3, NO_2 and PO_4) were determined colourimetrically by using the spectrophotometer CICIL 6000.

Results and Discussion

Water temperature of the costal lagoons was investigated and the results showed that the temperature was low in the Winter season (14.39-16.80 °C) and high in Summer season (25.3-28.07 °C) (Fig. 2-a).

The distribution pattern of salinity in the four seasons studied was recorded in Figure (2 b). The salinity values were registered high in Autumn season than the Winter season which reflects that the predominant weather conditions supported the higher evaporation rate in hot seasons. It seems that the high salinity could not only related by high temperature only but also depend on the water column depth (Al-Farawati *et al.*, 2008).

Salinity is one of the most important factor and it exerts various effects on the vitality of marine organisms (Abdo, 2005) and can be used as a good tool to evaluate lagoon status (AbdEllah and Hussein, 2009). Salinity inside the lagoon varied within a narrow interval value was closest to those found in the coastal water except during warmer periods when values were slightly higher (37‰).

The salinity values in the studied lagoons was ranged from 38.15 ppt in Spring at Marsa El Katayta to 41.95 ppt in Autumn at Gulf of Bomba. This underlines the evaporation process in the distribution of salinity and the control that it represents on water circulation inside the lagoons.

The lagoon system displays little fluctuations in their local concentration of salts and varying between S<40 gl^{-1} and S>40 gl^{-1}. They are included in class C3 or C4 depending on the season considered following the Venice-system of classification of brackish waters (Lopez and Tomas, 1989).

The pH values were consistent across the lagoons sampling stations and average values were ranged from 7.84 in Winter at Khalige Bombato 7.99 in Autumn at Katayta (Fig. 2-c).

Dissolved oxygen values were fall within a relatively limited range from 5.69 mgl^{-1} in Summer to 8.09 mgl^{-1} in Winter (Fig. 2-d) and all the locations reflected little influence of seasons with slightly higher values during the dry season than the wet season (Ladipo *et al.*, 2011). Although, the lagoons in question are shallow and the samples were taken close to the water surface. Some variations were observed in the oxygen concentrations. The most frequently found values are between 8 to 9 mgl^{-1} but lower levels are observed in Summer seasons.

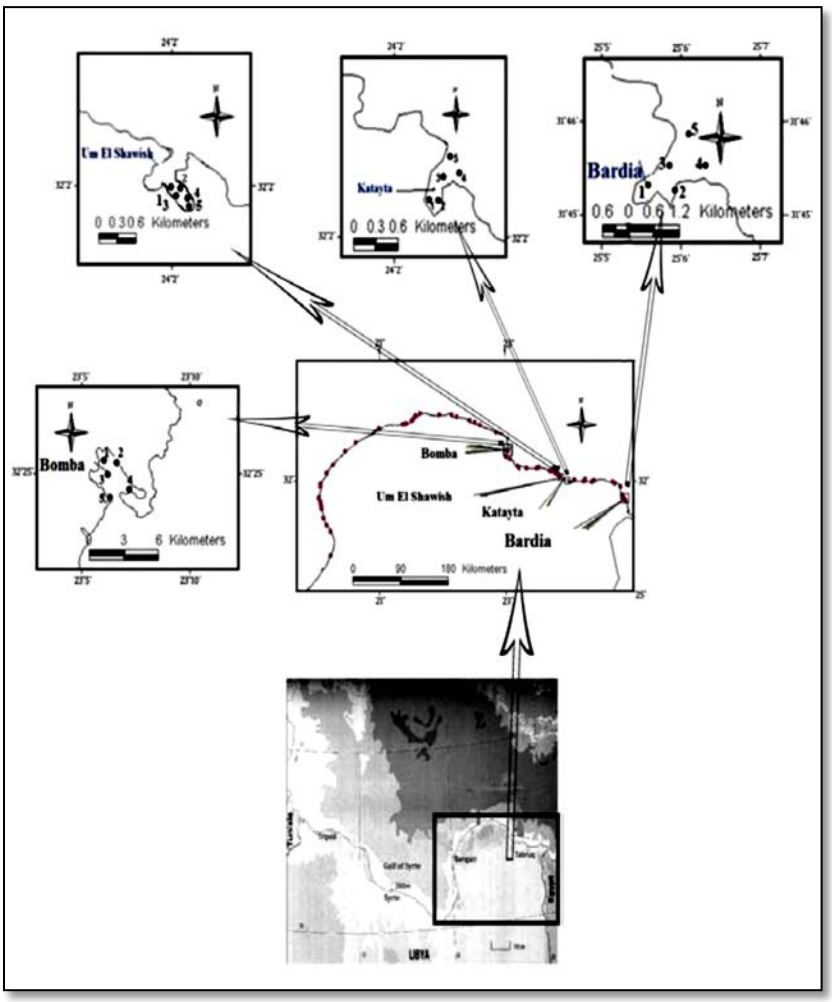

Figure 1. Map of the sampling sites.

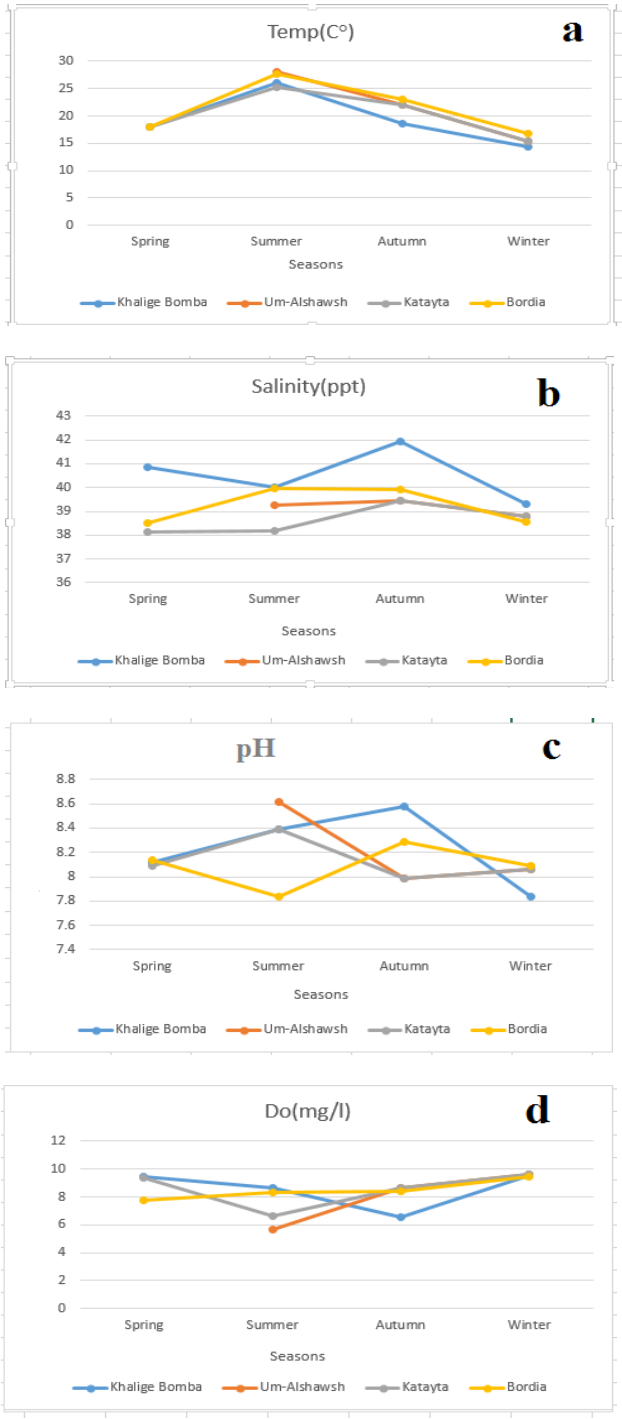

Figure 2. Fluctuations of physical and chemical properties in coastal lagoon.

The sampling schedule followed in this present study was resulted in the formation of nutrient concentrations in the lagoons waters at different seasons. The concentration of dissolved inorganic nutrients are low during the warmer months due to uptake by phytoplankton (Kennish *et al.*, 2010) and fall within a range of variability ($N\text{-}NO_3^-$ from 0.577 to 4.636 µg-at I^{-1}; $P\text{-}PO_4^{-3}$ from 0.303 to 3.187 µg-at I^{-1}; $N\text{-}NO_2^-$ from 0.211 to 0.862 µg-at l^{-1}; $N\text{-}NH_4^+$ from 0.245 to 1.158 µg-at l^{-1}as shown in Figure (3, a-d).

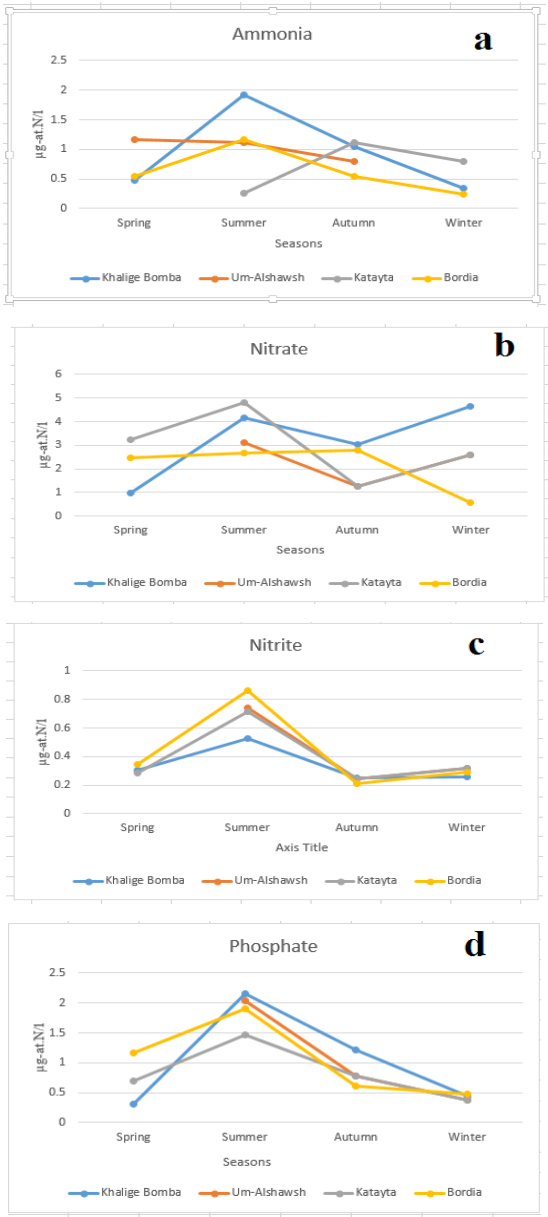

Figure 3. Fluctuations of dissolved nutrients in the coastal lagoons.

Nutrient concentrations in the lagoon water are greatly influenced by exchanges with the adjacent seawater and by the bottom, sediment and its horizontal distribution which were generally consistent with the surface salinity distribution (Li *et al.*, 2014).

Concentration of phosphate in the lagoons was higher in summer except values recorded at Marsa El Katayta (Fig. 3-d).

Nitrate seems to be an imported thing from the coastal waters, while benthic regeneration was probably the major factor controlling the levels of phosphates and ammonium in the lagoon.

Bacterial decomposition of organic matter by the abundant filter feeder of the bottom may both contribute to the domination of ammonium. As the nitrate increase in Winter and phosphate in warmer periods, the nitrate/phosphate ration will varies seasonally.

These results suggested that the coastal lagoons act as nitrogen transformers, importing dissolved oxidized forms and exporting nitrogen as reduced form (Nixon, 1980).

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الخصائص الأساسية الكيميائية والفيزيائية في بعض البحيرات الساحلية الليبية - شرق ليبيا

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المستخلص - تم اختيار دراسة الخصائص الفيزيائية والكيميائية والأملاح المغذية التي أجريت لتقييم الوضع البيئي لبعض البحيرات البحرية الساحلية. ولتحقيق الهدف أعلاه تم قياس درجة حرارة المياه، الملوحة، الاوكسجين المذاب، درجة الاس الهيدروجيني، النترات، النتريت، الامونيا والفوسفات. كانت درجة حرارة مياه خليج ام الشاوش عالية حيث بلغت 28.07 °م بينما تناقصت في الشتاء إلى 14.39 °م في خليج البومبا. وجدت الملوحة في أعلى قيمها في خريف البومبا إذ وصلت إلى 41.95 جزء بألف وسجلت أقل قيمة في صيف مرسى الخطيطة فقد وصلت بحدود 38.20 جزء بالألف. سجل أعلى تركيز للأوكسجين المذاب 9.59 جزء بالمليون في شتاء البحيرة الشاطئية ام الشاوش وسجل أدنى تركيز له 5.69 جزء بالمليون في صيف نفس البحيرة الشاطئية. كما سجلت أعلى قيمة لدرجة الاس الهيدروجيني بحدود 8.62 في مدخل ام الشاوش في فصل الصيف في حين سجل أدناها في 7.84 في خليج البومبا في فصل الشتاء. سجلت أعلى قيمة للفوسفات الذائبة 2.152 ميكروغرام ذرة/لتر في الصيف في خليج البومبا واقل تركيز 0.369 ميكروغرام ذرة/لتر، كانت أعلى قيمة للنترات 4.795 ميكروغرام ذرة/لتر في صيف مرسى الخطيطة وأدنى قيمة لها 0.577 ميكروغرام ذرة/لتر في فصل الشتاء في ميناء البردي، أما النتريت فكانت اعلى قيمة لها 0.741 ميكروغرام ذرة/لتر

سجلت في فصل الصيف في مدخل ام الشاوش وكانت اقل قيمة لها 0.242 في نفس المحطة. سجل الأمونيا أعلى قيمة في فصل الخريف 1.044 ميكروغرام ذرة/لتر وذلك في خليج البومبا بينما كانت القيم غير محسوسة في مرسى الخطيطة في فصل الصيف. النتائج الحالية هي إضافة اساسية لفهم مثل هذه البيئات الخاصة والتي قد تساهم في إمكانية استغلالها وتطويرها والتنبؤ بالمتغيرات البيئية التي من الممكن ان تتعرض لها مستقبلاً.