Soil Salinity Dynamic and Water Quality in a Ramsar Saline Inland Wetland: Case Study—Bazer-Sakra Sabkha, Setif (North-East Algeria)

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Abstract

Salinization affect ecosystem to a level where it cannot provide environmental services to its full potential. Therefore, understanding the dynamics of salt in the soil and the quality of water resources is of utmost importance. The aim of this study is the assessment of the dynamic of soil salinity and the quality of water (saline lake, groundwater) in RAMSAR wetland (Bazer-Sakra sabkha: northeastern Algeria). 6 water samples were sampled in April 2016) and 8 soil profiles sampled at three depths (0–20 cm, 20–40 cm; 40–60 cm) across a toposequence in April 2016 and 2017. The results show that groundwater r samples range from saline to very saline. The saline lake presents a high risk of eutrophisation because of its high nitrate (128 mg/L) and phosphorus (1031 mg/L) content. For soil salinity, the results reveal two patterns of evolution in salinity profile. The first one is an evolution from shape B (High salinity in the middle) in 2016 to a salinity profile of Shape A (Ascending) in 2017. The second pattern is an evolution from a descending salinity profile (shape C) in 2016 to an ascending salinity profile (Shape A) in 2017.

1 Introduction

Salinization is the accumulation of water-soluble salts in the soil solum (the upper part of a soil profile, including the A and B horizons) or regolith to a level that impacts on agricultural production, environmental health, and economic welfare [1] In general, salinization develops in places where the following conditions occur together: presence of soluble salts, high water table, high rate of evaporation and low annual rainfall [2]. It is projected that soil salinization is likely to be increased with future climate change scenarios like sea level rise and impact on coastal areas and rise in temperature that will subsequently increase evaporation and salinization [2]. The knowledge of soil salinity and the temporal changes of its distribution in the soil profiles can give warnings for the protection of saline habitats [3]. In this respect, the aim of this study is to understand the dynamic both in space and time of soil salinity and to assess the quality of surface water (the lake) and groundwater of the bazer-sakra saline wetland (Northeastern Algeria).

2 Materials and Methods

2.1 Description of the Study Area

Bazer-Sakra Sabkha is located in south-east of the province of El-Eulma (Sétif), in the East of Algeria. The Wetland is characterized with semi-arid climate. It is a permanent endorheic saltwater depression fed by rainwater, domestic and industrial wastewater carried by three tributaries from the nearby town of El Eulma. The wetland consists of three

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Table 1 Analytical results of the groundwater samples (April 2016)

Samples	Depth (m)	pH *	EC$_{25}$* (dS/m)	Calcium (mg/L)	Chloride (mg/L)	Nitrates (mg/L)	Phosphorus (mg/L)
1	17	7.19	3.02	162.7	1420	2.652	0.793
2	107	7.48	1.22	29.85	1420	5.608	0.996
3	14	7.8	1.92	88.176	1065	6.913	0.961
4	175	7.5	2.53	76.95	1420	2.217	1.108
5	10	7.78	5.75	89.77	2130	11.782	0.540
6	12	7.83	9.66	158.71	3550	7.869	0.4

Table 2 Salinity profile dynamic (2016/2017)

	EC s.p *(2016) dS/m	EC s.p (2017) dS/m
Soil profile 1	0.484 7.856 3.995	2.38 1.18 1.44
Soil profile 6	0.957 2.673 9.447	0.729 0.545 0.624

*ECs.p: electrical conductivity of saturated paste extract

areas; the flooded central part which is devoid of vegetation. It extends along Oued El Melah. Its peripheral belt is plenty with sparse vegetation on which cattle and sheep graze. Added to that the saline wetland hosts more than 1% of the common shelduck's biogeographic population showing the importance of saline conditions for some wintering species (Ramsar 2004). According to soil taxonomy classification (2004), the soils of the wetland are mainly composed of saliorthid (northern and south of the sabkha) and calciorthid (western part of sabkha).

2.2 Sampling and Laboratory Analysis

7 Water samples had been taken from the lake or its nearby wells during the first year of the investigation (April 2016). These water samples have been characterized by measuring the Electrical conductivity EC (dS/m), pH (potentiometric method), calcium content (complexometric titration), the chloride concentration (Mohr Method) and Nitrate and Phosphorus (spectrometric measurement). 8 soil profiles have been sampled for two successive years (April 2016 and April 2017 across a toposequence N- S according to 3 sampling depths: H1 (0–20 cm), H2 (20–40 cm) and H3 (40–60 cm). The soil salinity have been assessed in this work by means of electrical conductivity (EC) with the reference method (saturated paste extract)

3 Results and Discussion

3.1 Water Quality Characterization

The results show that pH of lake water is very alkaline with a value of 9.15. Its salinity is very high with EC of 56.24 dS/m. The water of the lake reveals a high concentration of lake water with Nitrate (NO_3^{-}) and phosphorus (PO_4) which are of 128 mg/L and 1031 mg/L, respectively. For the groundwater, the results of the EC and pH are summarized in the Table 1. We notice that the pH of groundwater range from 7 to 19 (S** 1) and to 9.12 (S** 4). Generally, the groundwater is slightly alkaline. The EC of these groundwater vary from 1.22 dS/m (S** 2) to 9.66 dS/m (S** 6). According to Ayers and Westcot [4], the Salinity of the groundwater is classified as follows: High salinity **C3** (S** 2 et 3) and very high salinity **C4** (S** 1, 5, 6 et 6).

The results show that the calcium content varies from 29.85 mg/l (S**2) to 162.7 mg/l (S**1). On the other hand, the chloride content ranges from 1065 mg/l (s**3) to 3550 mg/l (s**7). Finally, the Nitrate and Phosphorus content in the groundwater show that nitrates vary from 2.217 mg/L (S**4) to 11.78 mg/L (**S **5) while the phosphorus content is lower and varies from 0.4 mg/l (S** 6) to 1.108 mg/l (S** 4).

3.2 Spatio-Temporal Variation of Soil Salinity

Salinity profile allows us to distinguish 3 trend of salinity changes with depth along the toposequence N-S. In general, the shapes of the salinity profile are: shape A (Ascendant) maximum of salinity in the surface, Shape C (descendent) whereby the maximum of salinity is in the depth, and shape B (maximum of salinity in the middle of soil profile). The overall trend in salinity profile dynamics between the two period show two patterns of evolution which are represented by the soil profile 1 and 6 (Table 2).

The Table 2 shows that the salinity profile 1 (2016) is of shape B with a maximum of salinity 7.85 dS/m at the middle of the soil profile (20–40 cm). On the other hand, the salinity profile 1 (2017) is of shape A with a maximum of salinity at the soil surface (0–20 cm) and (2.38 dS/m). However, for the salinity profile 6, the results show that the salinity profile (2016) corresponds to shape C (descending) with a maximum of EC (9,447 dS/m) at the depth (40–60 cm). On the other hand, the salinity profile (2017) is of shape A (Ascending) with a maximum of salinity at the soil surface (0–20 cm) (0.729 dS/m).

4 Discussion

The groundwater nearby the wetland is very high in soluble salts, alkaline, and calcium content. The obtained results in this study are similar to those found by Demdoum et al. [5] in the same saline wetland. There is a danger of eutrophisation of the lake because of high concentration of nitrate and phosphorus. It is due to sewage and fertilizer's contamination of the lake from the city of Eulma and from the agricultural land uphill as well.

Soil salinity dynamics associated with time factor reveal a different trend despite the fact that the sampling has been done in the end of the humid season where there should be a maximum leaching of the salt. Other factor can explain this dynamic, namely, by land cover, micro-relief, water and clay content [3, 6].

5 Conclusion

This work as it is carried out on the soil salinity dynamic and water quality in an inland saline wetland (Bazer-Sakra) allowed us to show that the salinity of groundwater and eutrophisation of saline lake can be detrimental to biodiversity and agriculture in its neighborhood. Irrigated crops in this region may increase the risk of salinization if specific practices (leaching and drainage) are not adopted.

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