International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 18, No. 3, p. 205-213, 2021

INNSPUB

RESEARCH PAPER OPEN ACCESS

Winter saline accumulation in the a Bare Aridosols: the example of the bowl of ouargla (northern sahara Algeria)

Abdelhak Idder[1*], Imed-Eddine Nezli[2], Tahar Idder[1], Salim Azib[3]

[1]*Laboratoire de Recherche en Phœniciculture, Université Kasdi Merbah Ouargla, 30000 Ouargla, Algeria*

[2]*Laboratoire de Géologie de Sahara, Université Kasdi Merbah Ouargla, 30000 Ouargla, Algeria*

[3]*Laboratoire des Bioressources Sahariennes: Préservation et Valorisation, Université Kasdi Merbah Ouargla, 30000 Ouargla, Algeria*

Key words: Salinity, Arid soil, Sahara, Ouargla.

http://dx.doi.org/10.12692/ijb/18.3.205-213 Article published on March 30, 2021

Abstract

The soil landscape of the Ouargla basin is dominated mainly by halomorphy and hydromorphy. These phenomena are the consequence of the high salinity in the region. It was a question of identifying the ionic repartition and the formation of salts from the concentrations found in the soil solution under the influence of the winter climate presenting an evaporating power visible on the surface added to an excessively salty groundwater at the base (C5S3). This bare soil was analyzed through six profiles dug according to the direction of groundwater flow. The granulometric nature of this soil is sandy-limonous, hence the low expression of exchange phenomena. Based on the saline profile of the horizons examined in winter, it is observed that all dosed ions undergo a disproportionate ascent from the bottom to the top of the profile. It is observed that the horizontal movement of salinity follows the direction of the phreatic stream. The concentrations of the ions indicate an imbalance among the cations in favour of the Ca^{+2} and the anions in favor of so_4^{-2}chlorine. This configuration is confirmed by the majority presence of the white salt materialized by the formed salts, namely The NaCl and Na_2SO_4. In addition, results indicate that the different salts identified mass primarily in large quantities on the surface, thus giving it the degraded saline character type A. The majority chlorine and sodium in the soil solution offer sodium chroride chemical facies. Faced with the concentrations observed, this type of soil is not suitable for any crop.

* **Corresponding Author:** Abdelhak Idder ✉ Haki.idder@gmail.com

Introduction

The bare soil, used for millennia, however, remains a natural formation little known to humans. The exploration of this surface layer of the globe, support of plant and animal life, an interface between rocks and atmosphere, has only just begun. (Ruellan and Dosso, 1993). The bare soil of the Ouargla basin has been designated among many others, spread over arid areas, the example to be considered in this study given its adequacy under the title.

The town of Ouargla is located about 800 km southeast of Algiers at the bottom of a vast depression without an outlet (Fig. 1). The salty groundwater is often on the ground. This city is surrounded by large areas of chotts and sebkhas. Ouargla's water resources belong to three aquifers: the Continental Intercalaire and the Terminal Complex, two fossil aquifers, and the quaternary groundwater. The latter, which is very salty, is not exploited (Nezli, 2009; Castany, 1982; Nesson, 1978). Ouargla is located in an area belonging to the Saharan bioclimatic stage in mild winter. Its climate is characterized by aridity clearly expressed by a De Martonne Aridity Index (Im) of 1.2 and a near-permanent drought (De Martonne, 1926). The pedological landscape of the Ouargla oasis is characterized mainly by its halomorphy and hydromorphia (Idder, 1998).

The large bare areas spread over most of Algeria, especially in the Sahara, deserve to be characterized from the point of view of soils and salinization. In human memory, the bare soil, the object of this study, has never experienced anthropogenic actions either by cultivation or irrigation; the moisture of this environment is dependent on a shallow aquifer, fuelled mainly by urban and agricultural water surpluses, and the region's characteristic very low rainfall, not exceeding 40 mm/year, while annual evaporation is in the order of 2000 mm/year (Rouvillois-Brigol, 1975).

The first step is to characterize the physical and chemical quality of the groundwater, and then the salts will be recorded from the ion concentrations measured in the soil. Particular attention will be given to neutral series salts that have a high potential for toxicity to soil material (Hullin, 1983).

Material and methods

The work was carried out on a bare ground sequence of about 32 km length in a soil having the characteristics mentioned in table 2. Profiles dug and analyzed in winter are mentioned in figure 2. This is profile 3 in profile 8. Profiles 1 and 2 (Fig. 2) are not affected by this study. Distances between profiles are shown in Table 1. The encrypted distance is read between two points that follow each other.

These profiles have a maximum depth of 1 m, the limit of which coincides with the groundwater level and are characterized by distinct horizons (H) chosen according to soil salt (Fig. 10) (Halitim, 1985; Ruellan and Dosso, 1993). In determining the chemical quality of the groundwater, a piezometer was installed near each profile from which the water samples to be analyzed were collected. For the determination of the salts that form in the soil profiles, the theorecal chemical method of Bazilevich and Pankova (1968), confirmed by Droubi *et al.,* (1976) and Idder *et al.*, (2012). Based on the combination of anionic and cationic concentrations, at 25°C, in the soil solution and on the order of solubility of the salts, was used for the qualitative and quantitative determination of the different salts present in the profiles studied. The ion concentrations were determined by spectrophotometry DR2000 (hash). Electrical conductivity and pH were measured by conductimetry meter and pH meter (Hanna) (Water extract on land/water: 1/5 (1 g of soil for 5 ml of distilled water), at 25°C).

The conditions under which the experiments were carried out are: Uncultivated soil; Soil sample collection and description period: January 2010; Topography: flat shape with a low slope; Weather: Sunny; Appearance of the soil surface: saline crusting (blisters); Land use: bare soil on 100% of its area, Non-existent drainage.

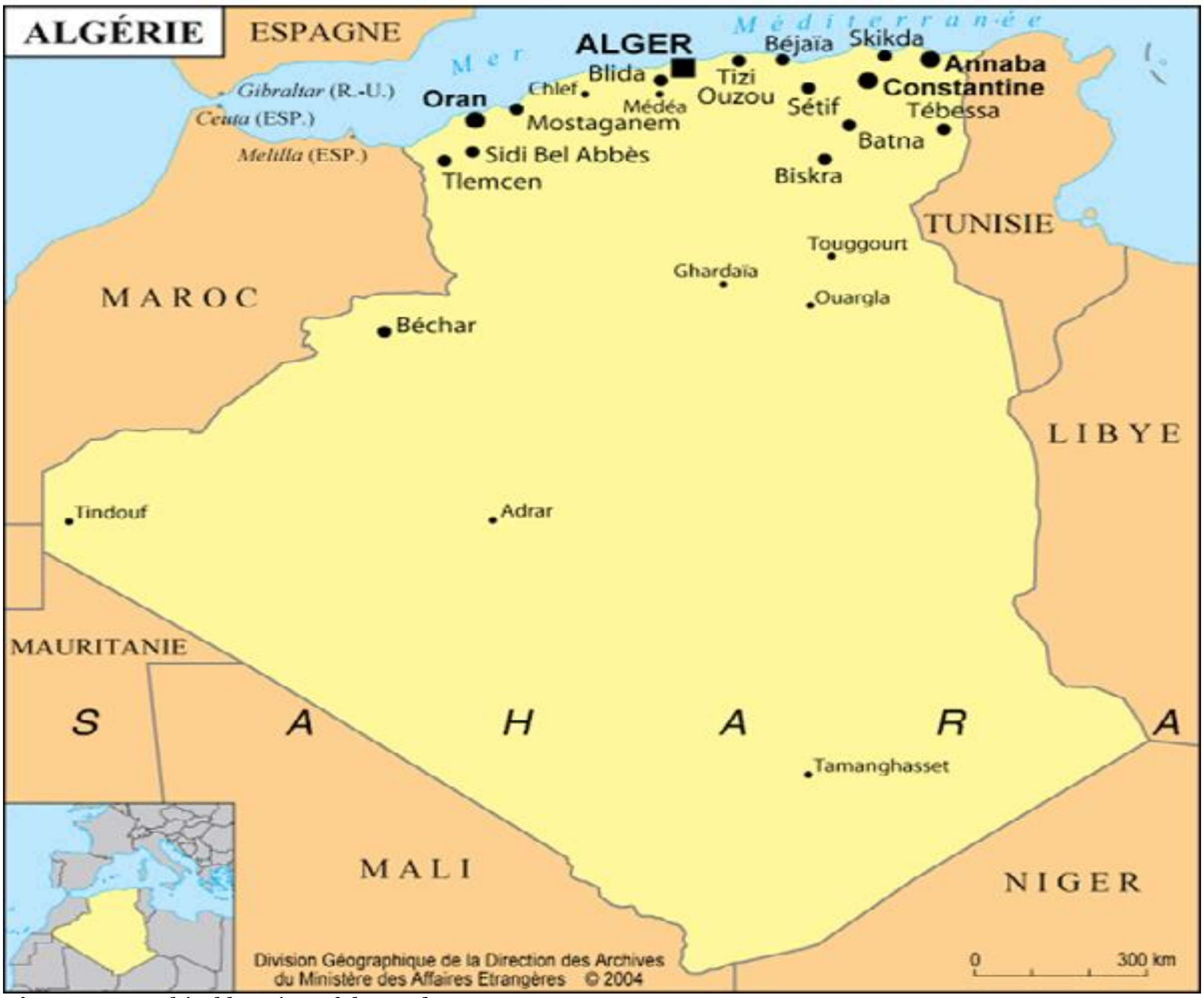

Fig. 1. Geographical location of the study area.

Results and discussion

Ionic and saline distribution in the profiles

Based on morphological characterization and ion distribution in the six profiles examined in winter, it is to be concluded that salinity is ascending from the lowest horizons to the upper horizons (Fig. 3 to 8). This degraded type A character according to Servant (1978) is attested by the values of the electrical conductivity (Fig.3 to 8).

Table 1. Profile of geographic characteristics.

Sector	Profiles	UTM contact information		Distance between points in (m)
		X	Y	
Ex ITAS	Profile 3	716681.78 m E	3536463.24 m N	162
Mekhadema	Profile 4	716681.66 m E	3538896.94 m N	248
Bour El Aicha	Profile 5	717059.12 m E	3555843.17 m N	7898
South N'goussa	Profile 6	719524.30 m E	3546088.99 m N	10208
North N'goussa	Profile 7	717479.36 m E	3560667.78 m N	5175
Sebkhet Sefioun	Profile 8	721007.29 m E	3568684.84 m N	8820

The exception is for profile 8 or ion concentrations are more or less egalitarian. This may be because this profile is located not far from the main drain collecting excess water (Fig. 8). This rise of ions by capillarity is favored on the one hand by the silt on sand rexture (Massoumi, 1968) as is the case for our soil and on the other hand by the solubility of ionic compounds (Gaucher and Burdin, 1974). The upward movement of these ions explains the majority occupation of cations and anions by surface horizons from the salt-causing groundwater and the deficit of rainfall recorded in the region. It should also be mentioned that for the majority of the profiles studied the order of dominance Among the cations: Na^+ > Ca^{++} > Mg^{++} > K^+ and among the anions: Cl^- > SO_4^{--} > HCO_3^- (Fig. 3 to 8). This order of dominance of the ions imposes the sodium chlorinated chemical facies. The primacy and uniqueness of the sodium-chlorinated facies are probably justified by the low evaporation, unfavorable for the other facies.

Table 2. Features of the soil studied.

Characteristics	Observations
Morphological	• Surface crusting • Visible salt crystals • Unretectable organic matter
Physical	• Sablo-limonous texture • Low total limestone • Significant gypsum rate • Low apparent density
Physicochemical	• pH: Neutral saline pathway • Cationic exchange capacity: low to very low • Electrical conductivity: excessively high
Biological	• Insignificant representation

Table 3. pH and CE evolution in the different horizons.

Sectors	Profils	Horizons	Soil CE (dS/m)	Soil pH	Water CE (dS/m)
Ex ITAS	P3	P3H1	16.25	7.38	19.5
		P3H2	11.47	7.64	
		P3H3	06.32	7.46	
Mkhadema	P4	P4H1	14.36	7.53	23.76
		P4H2	10.01	7.38	
		P4H3	05.16	7.46	
Bour El Aicha	P5	P5H1	19.54	7.54	25.9
		P5H2	13.16	7.38	
		P5H3	10.79	7.15	
N'Goussa South	P6	P6H1	19.89	7.53	26.18
		P6H2	16.23	7.59	
		P6H3	13.79	8.00	
N'Goussa north	P7	P7H1	13.92	7.38	38.98
		P7H2	10.63	7.66	
		P7H3	09.68	7.35	
		P7H4	10.98	7.45	
Sebkhet Sefioune	P8	P8H1	21.91	7.58	41.65
		P8H2	19.40	7.38	
		P8H3	20.01	7.25	
		P8H4	20.91	6.53	
		P8H5	21.53	7.32	
		P8H6	22.06	7.33	

This primacy is stipulated by the parameter of the mobility of the cations cited by Simonneau and Aubert (1963), Gaucher et Burdin (1974) and Duchauffour (1977). Finally, it is important to note that soil thickness, such as salinity, increases horizontally on the surface of upstream 16.5 dS/m downstream 22 dS/m south northward (table 3).

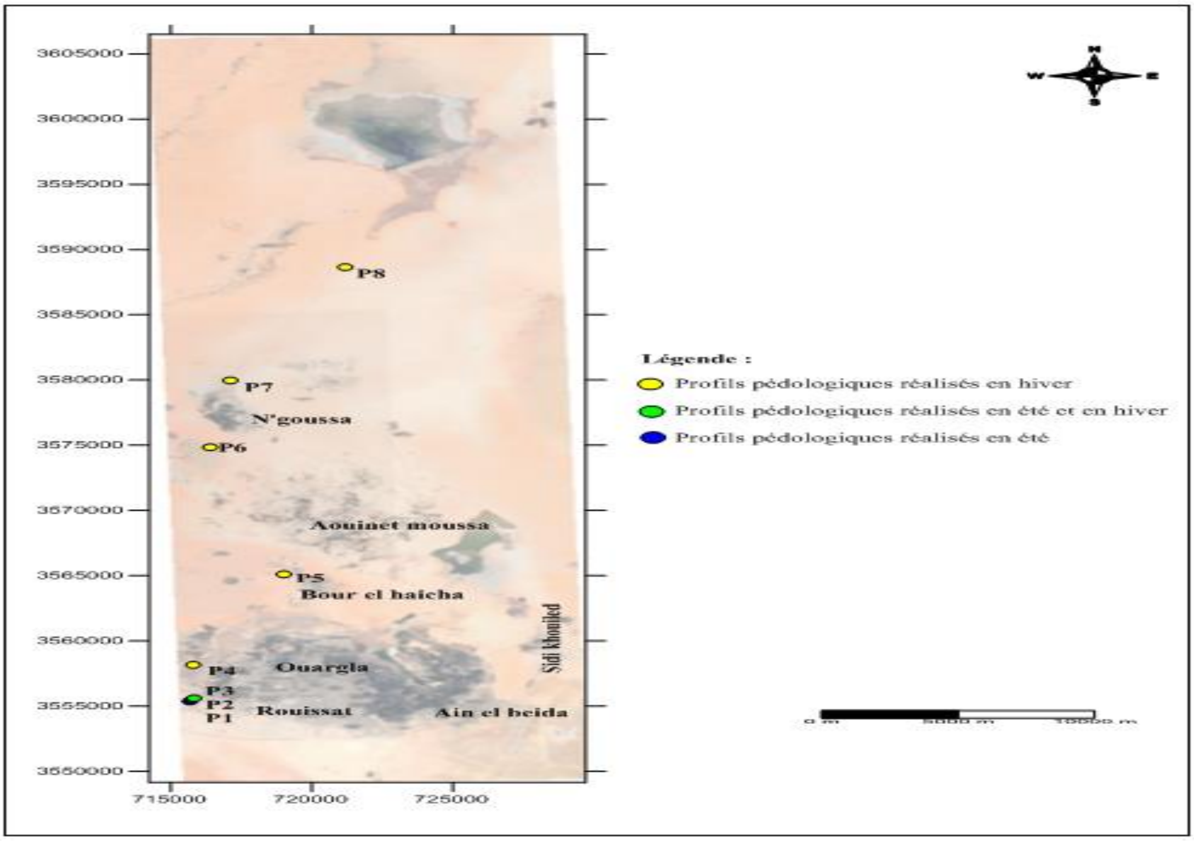

Fig. 2. Study protocol.

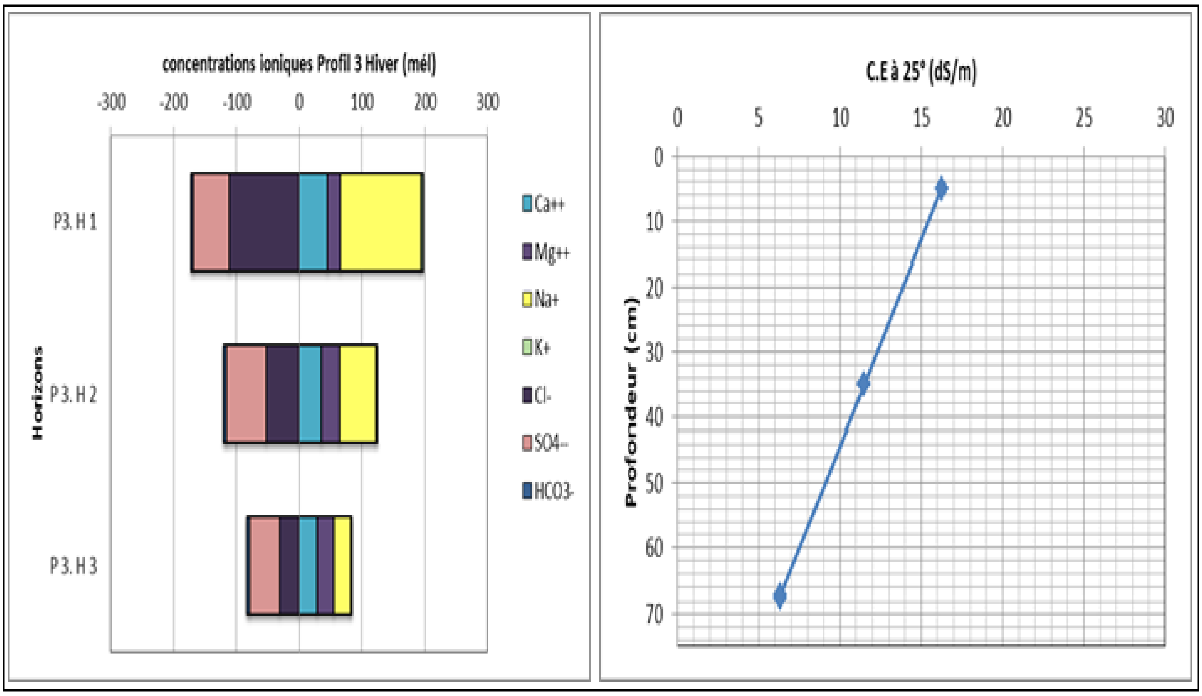

Fig. 3. Ionic and saline profile 3.

Groundwater salinity

The waters of the groundwater are characterized by a very high salinity of sodium-chlorinated type. The increase in salinity follows the direction of the water flow from the groundwater. A relatively charged area is located north of the bowl with an electrical conductivity equal to 41.81dS/m (profile 8) versus 19.5 dS/m in the south corresponding to profile 3 (table 3). This results confirm those of IDDER *et al* (2016).

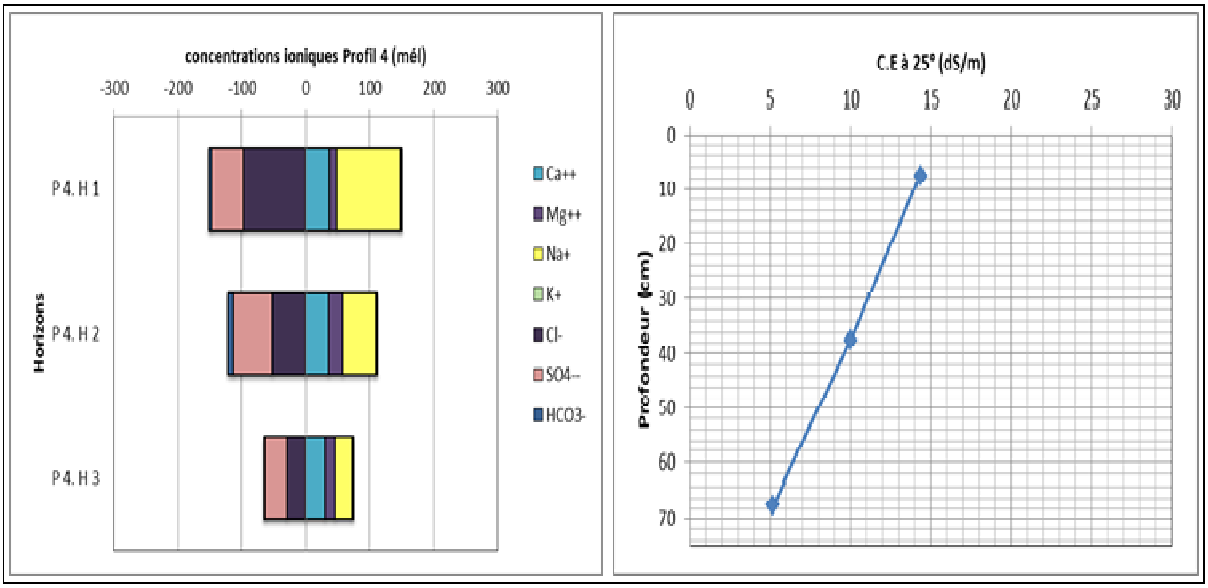

Fig. 4. Ionic and saline profile 4.

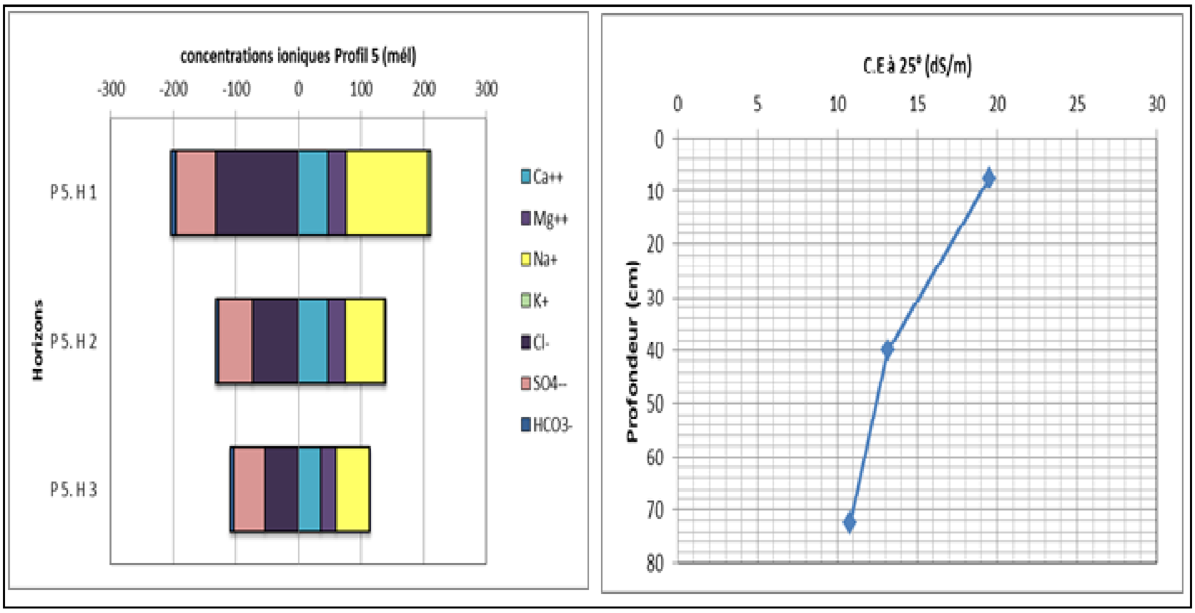

Fig. 5. Ionic and saline profile 5.

General saline formation of the study site

This study on the formation of salts by the theoretical method of Bazilevich and Pankova (1968) concerns only the three important levels of accumulation. These levels include the sum of the salts for the six profiles: upper, intermediate and deep (Fig. 9). It is noted that the rising flood of the NaCl prevailed over the other salts in the three levels of the profile (Fig. 9). Totaling a cumulative concentration equal to 1186, 667 and 556 me/l respectively corresponding to the 52.41, 39.19 and 36.43% percentages according to the above order.

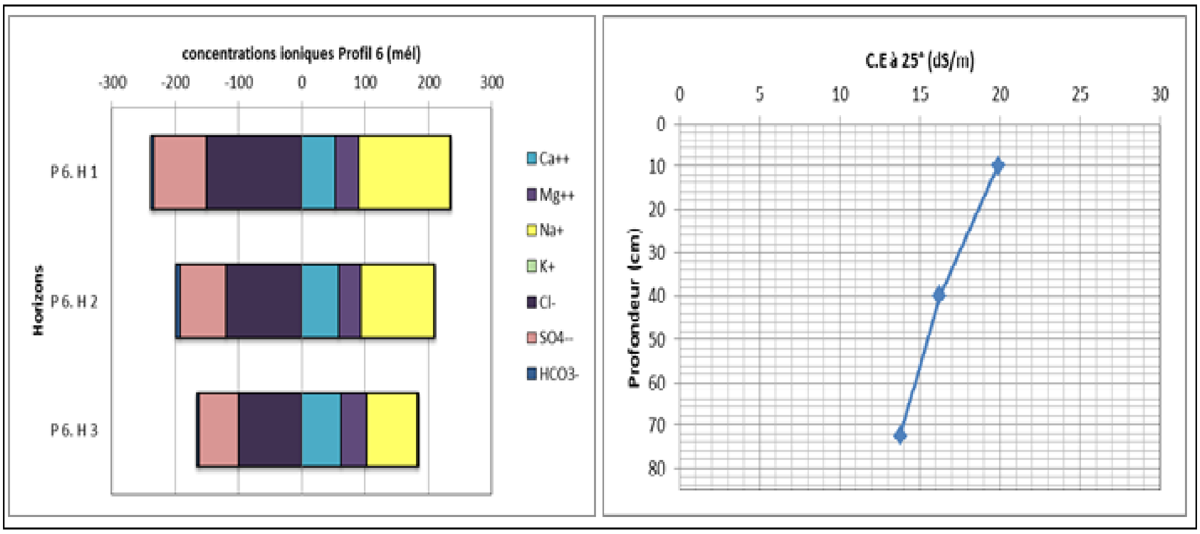

Fig. 6. Ionic and saline profile 6.

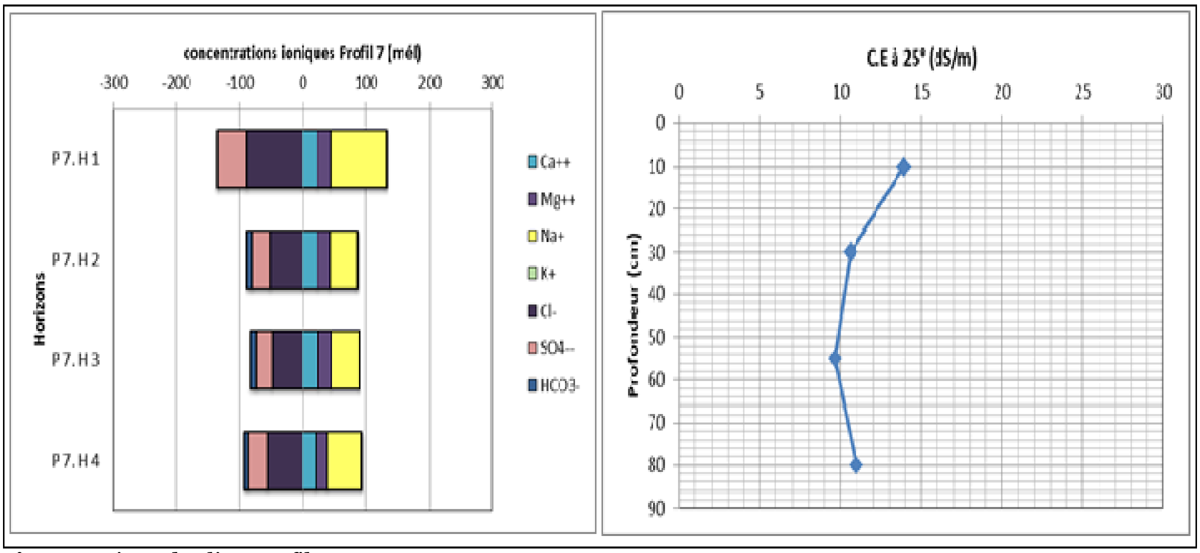

Fig. 7. Ionic and saline profile 7.

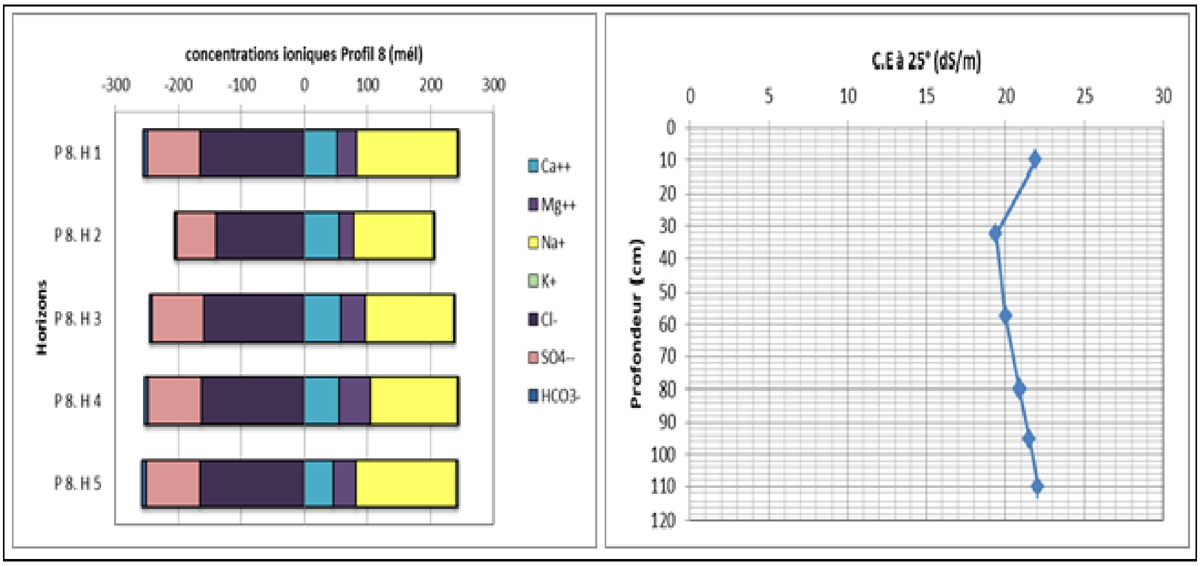

Fig. 8. Ionic and saline profile 8.

This over-energy is confirmed by pH values close to neutrality between 7 and 8 (Table 3). The secondary presence is attributed to $CaSO_4$ with concentrations indicated on histograms. The results concerning mainly NaCl agree well with other previous work carried out in the region (Daddi Bouhoun, 2010; Idder, 2014).

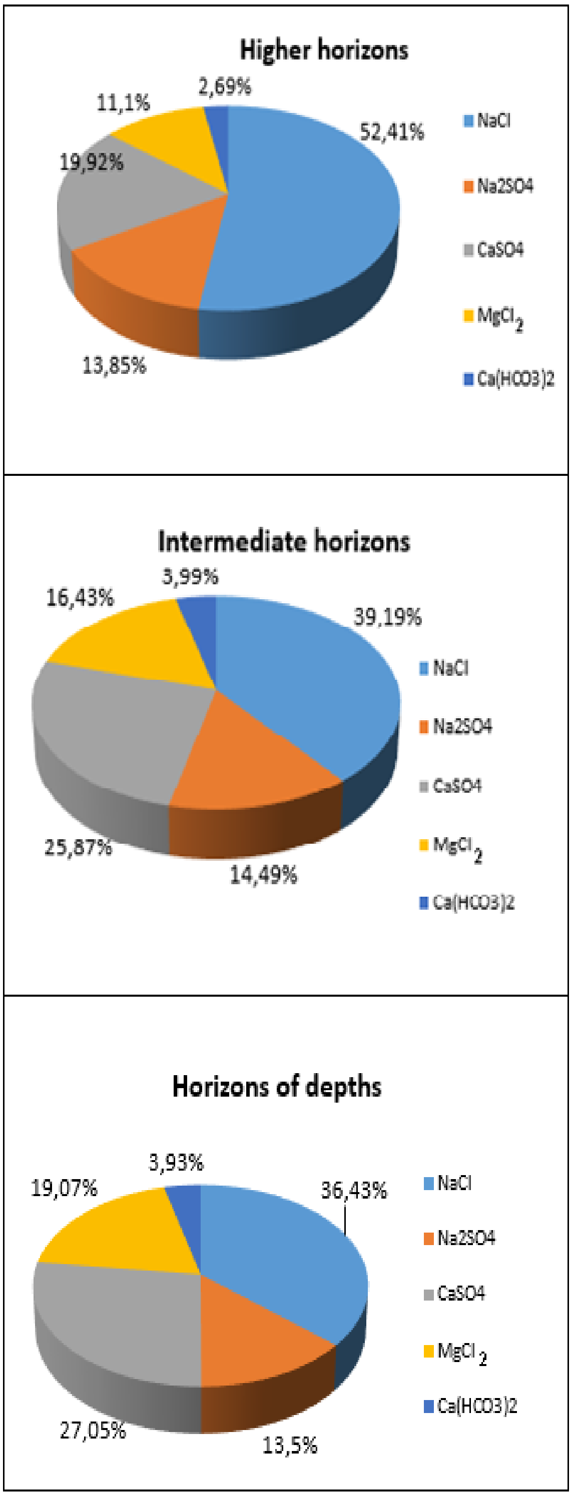

Fig. 9. Distribution and compartmentalization of salts across all profiles.

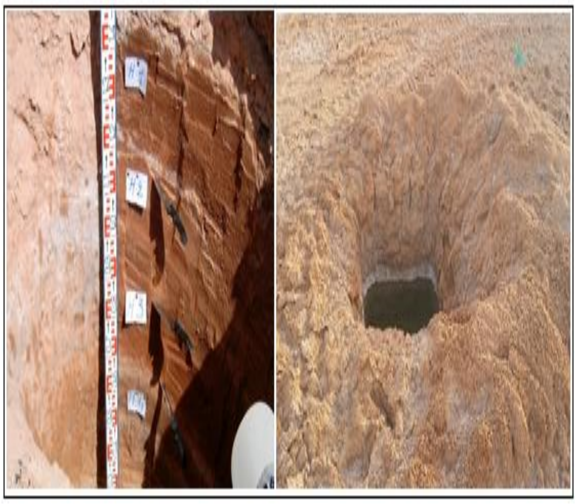

Fig. 10. Study area and profile.

Conclusion

The bare soil of the ouargla dowl subjected to winter conditions and very salty groundwater (C5S3) indicates a sandy-silty texture.The main results show that the soil in question underwent a superficial saline accumulation characterized by type A. Surface ionic abundance for the six winter dosed profiles is materialized by the superiority of calcium-assisted sodium among sulphate cations and chlorides among anions. This case offers sodium chlorinated chemical facies hence the priority formation of NaCl. The salinity evolves from the bottom to the top of the profile and from the south to the north of the topo-sequence in the direction of groundwater.

In view of the high saline concentrations, the bare soils studied are recommended for the production of salts or electrical energy.

References

Bazilevich NI, Pankova EI. 1968. A tentative of classifying soils according to salinization. Pachvavedena **11,** 3-16.

Castany G. 1982. Sedimentary basin of the northern Sahara (Algeria, Tunisia). Continental Intercalaire and Terminal Complex aquifers. *Bulletin du Bureau de Recherches Géologiques et* Minières **2,** 127-147.

Daddi Bouhoun M. 2010. Contribution à l'étude de l'impact de la nappe phréatique et des accumulations gypso-salines sur l'enracinement et la nutrition du palmier dattier dans la cuvette de Ouargla (sud est algerien). Thèse doctorat en science écophysiologie végétale, Université Badji Mokhtar Annaba, 365 p.

Droubi A, Fritz B, Tardy Y. 1976. Balances between minerals and solutions. Computational programs applied to the prediction of soil salt and optimal irrigation backs. Books ORSTOM, pedology series **14(1),** 13-38.

Duchaufour P. 1977. Pédogénèse et classification. Masson, Paris, p 477.

Gaucher G, Burdin S. 1974. Géologie, géomorphologie et hydrogéologie des terrains salés. Presses universitaires de France, p 230.

Halitim A. 1985. Contribution a l'etude des sols des zones arides (hautes plaines steppiques de l'Algerie): morphologie, distribution et role des sels dans la genese et le comportement des sols. Sciences du Vivant. Ecole Nationale Supérieure Agronomique, p 384.

Hullin MR. 1983. Drainage course. Part dedicated to salty soils. Polycopy course, Vol. 3, Institut National d'Aronomie, El-Harrach Algiers 139 p.

Idder A, Nezli I, Idder T. 2012. Compartimentation et accumulation estivale des sels neutres dans les aridisols sableux nus de la cuvette d'Ouargla (Sahara algérien). Lebanese Science Journal **15(1),** 41-50.

Idder A, Nezli IE, Idder T, Cheloufi H, Serraye A. 2016. Intrusion minérale par modélisation géochimique dans les textures sableuses des sols. Le cas du Sahara septentrional algérien. Journal of Materials and Environmental Science **7(10),** 3724-3729.

Idder T, Idder A, Tankari Dan-Badjo A, Benzida A, Merabet S, Negais H, Serraye A. 2014. Les oasis du Sahara algérien, entre excédents hydriques et salinité. Revue des sciences de l'eau **27(2),** 155-164. https://doi.org/10.7202/1025565ar

Idder T. 1998. La dégradation de l'environnement urbain liée aux excédents hydriques au Sahara algérien. Impact des rejets d'origine agricole et urbaine et techniques de remédiation proposées. L'exemple de Ouargla. Thèse de doctorat, université d'Angers, p 284.

Nesson C. 1978. L'évolution des ressources hydrauliques dans les oasis du Bas-Sahara algérien. In: Recherche sur l'Algérie. Ed. CNRS, Paris, 7-100.

Nezli I. 2009. Approche géochimique des processus d'acquisition de la salinité des eaux de la nappe phréatique de la basse vallée de l'oued M'ya (Ouargla). Thèse de doctorat, Université de Biskra, Algérie, p 117.

Rouvillois-Brigol M. 1975. *Le pays de Ouargla (Sahara algérien): variations et organisation d'un espace rural en milieu désertique.* Université de Paris-Sorbonne, p 361.

Ruellan A, Dosso M. 1993. Regards sur le sol. Editions Foucher, Paris, p 192.

Servant I. 1978. Salinity in soil and water: characterization and problems of irrigation drainage. *Bulletin du Bureau de Recherches Géologiques et* Minières **2,** 123-142.

Simonneau P, Aubert G. 1963. L'utilisation des eaux salées au Sahara. Annuaire d'Agronomie Orstom, Section de Pédologie **14(5),** 859-872.