Genetics And Biodiversity Journal
Journal homepage: https://journals.univ-tlemcen.dz/GABJ/index.php/GABJ
ISSN: 2588-185X
OPEN ACCESS

Original Research Paper

Bio-Evaluation of Groundwater Quality in the Souk Naamane and Ain M'lila region (Oum El Bouaghi, High Plain of Eastern Algeria

SATOUR Abdellatif [1], ALLAOUA Noua [2,3], HAFID Hinda[2,3]

[1]Department of Ecology. University 8 Mai 1945. Guelma. Algeria
[2]Laboratoire de recherche : Ressources Naturelles et Aménagement des Milieux sensibles (RNAMS) Université de Larbi Ben M'hidi d'Oum El Bouaghi
[3]Department of Natural Sciences, University of Oum El Bouaghi, Algeria.

Corresponding Author: Satour Abdellatif, Department of Ecology. University 8 Mai 1945. Guelma. Algeria; **Email**: satour.abdellatif@gmail.com

Article history: Received: 16 December 2021; Revised: 28 August 2021; Accepted: 23 January 2022

Abstract
The present study was carried out to assess the quality of groundwater in the western region of Oum El Bouaghi district, (commune of Souk Naamane and commune of Ain M'lila).A total of nine wells and two water springs were tested in the two communes for eight months, from October 2017 to May 2018.The fauna was sampled using two methods: the net phreatobiological and the baited trap method. Some Physico-chemical properties of the wells were measured during each campaign. A total of1237 individuals belonging to 47 families were recorded during the sampling. From a physical-chemical point of view, the principal component analysis (PCA) indicates that the water is highly mineralized (with high electrical conductivity),this might be explained by the dissolution of the limestone, saline, and gypsum rocks of the terrains covering the study area, in addition, anthropogenic action would be added to natural action. The results revealed that parameters such as pH, Ammoniumions, Sulphates and electrical conductivity were within the accepted standards. Nevertheless, relatively important fluctuations in Hardness,alkalinity and Chlorides were recorded.

Keywords
Groundwater, Physico-chemical properties, Aquatic fauna, Wells, Springs, Souk Naamane, Ain M'lila.

الملخص
أجريت هذه الدراسة بهدف تقييم جودة المياه الجوفية في المنطقة الغربية من أم البواقي (بلدية سوق نعمان وبلدية عين مليلة). تم أخذ عينات من 9 آبار ومنبعين في البلديتين على مدى ثمانية أشهر من أكتوبر 2017 إلى مايو 2018. تم أخذ عينات من الحيوانات باستخدام طريقتين، شبكة فخياطوبيولوجي وطريقة القارورة الفخ. تم قياس بعض المتغيرات الفيزيوكيميائية لمياه الآبار خلال كل حملة. تم تسجيل 1237 فردًا ينتمون إلى 47 عائلة أثناء المعاينة. من وجهة النظر الفيزيوكيميائية، يشير تحليل المكونات الرئيسية إلى أن المياه شديدة التمعدن (مع توصيل كهربائي عالي)، ويمكن تفسير ذلك من خلال انحلال الصخور الكلسية والمالحة والجبسية للأرض التي تغطي منطقة الدراسة علاوة على ذلك، فإن الفعل البشري سوف يضاف إلى الفعل الطبيعي.

الكلمات المفتاحية
المياه الجوفية، العوامل الفيزيوكيميائية، الحيوانات المائية، الآبار، الينابيع، سوق نعمان، عين مليلة.

Introduction

Groundwater is a hidden, discreet, and poorly known resource. As an essential component of the hydrological cycle, thiswater constitutes the world's largest freshwater reservoir containing 95% of the world's fresh water (Morris et al., 2003). They are considered an indispensable source of water supply and are generally a complement to the easily accessible surface water. They provide a stable habitat for a rich and diverse biocenosis adapted to these environments. They play an important role in the sustainability of many terrestrial ecosystems, and a crucial role in human life and socio-economic development (Liu et al., 2020).In recent years, ecological research on the underground aquatic fauna and in particular on the water table at the wells represents one of the aspects of applied phreatobiology known as the appropriate method of updating (Cvetkov, 1968). In Algeria, the underground fauna was being explored since the beginning of the 20thcentury, thanks to the studies of some species led by Racovitza (1912). Indeed, until some years ago, investigations onthe ecology of Algerian groundwater were rare and partial, including the work of Gurney, 1908;Monod, 1924;Nourrisson, 1956;Delmare Deboutteville, 1960;Pesce et Tete, 1978;Pesce et al., 1981 and Lakhdari, 2014.

In recent years, underground fauna has been the subject of systematic studies aimed at inventorying the stygoby species of the alluvial water table of Wadi Tafna (Chebika, 2003; Belaidi, 2004; Benouada, 2005; Mahi, 2007; Haicha, 2013; Belaidi et al, 2011 and Allaoua N et al, 2015).

This study aims to complete the work already carried out in this field, focusing on the west part ofOum El Bouaghi, by accessible routes such as wells and springs to contribute to the establishment of anexhaustive list of stygoby species in Algeria and to assess the physicochemical quality of these habitats.

Materials and Methods

Description of Study Area

The study area belongs to the High Plains of Eastern Algeria, which is a region composed of mountains, valleys and plateaus between the Mediterranean Sea and the Sahara Desert, where the landscape is dominated by steppe vegetation, and the basin is characterized by a semi-arid climate with a cold winter. Our choice focused on two different regions located west of OumelBouaghi city, Souk Naaman (230 km²) with geographical range 35° 53′ 45″ N, 6° 23′ 22″ E and Ain Mlila (236 km2) geographical range 36° 1′ 60″ N, 6° 34′ 60″ E (Figure. 1).

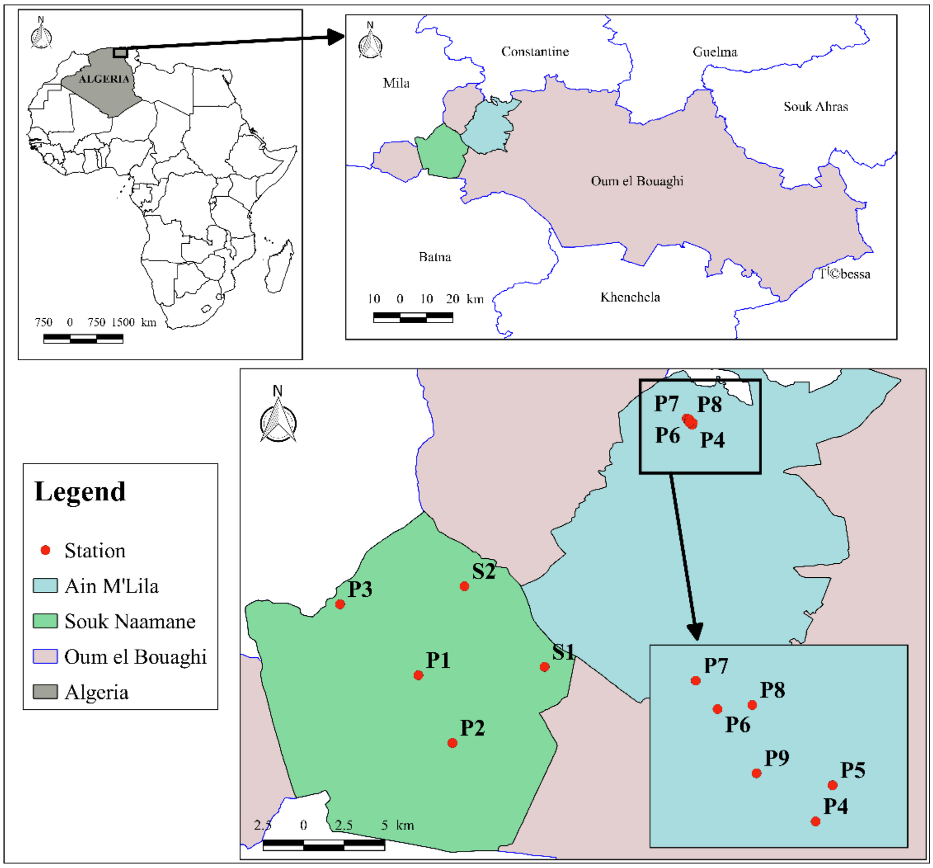

Figure 1. Geographic location of the study area and location of sampled stations.

Physico-chemical Analysis

Nine wells and two springswere prosecuted during the academic year (2017 to 2018) to assess water quality and ecosystem diversity of invertebrates.Five of them are located in Souk Naamane and six in Ain Mlila.Temperature, pH, conductivity, and salinity were measured in the field using a multi-parameter WTW (Multiline P3 pH/LF SET).Water intended for chemical analysis was filtered beforehand, then placed in 1.5 L polyethylene bottles and stored at a temperature of 4°C, then transported to the laboratory. The chemical analyses were carried out in theDepartment of Natural Sciences,University Oum El Bouaghi’s laboratory. The total hardness or hydrotimetric titer (TH) was obtained by the complexometric method by titration with EDTA using the specific-colored indicator (eriochrome black T at 0.5%) and in a buffered medium pH = 10 (Rodier, 2009).Principal component analysis (PCA) was the main multivariate statistical method used in this study to analyze the different physicochemical parameters of the water. The statistical analyses were performed using XLSTAT.

Fauna Sampling

The faunal sampling at the wells was carried out using a phreatobiology net based on the model initially developed byCvetkov (1968) and slightly modified by Boutin (1996). (Boutin and Boulanouar, 1983) recognized the effectiveness of this sampling method for the capture of planktonic and neketonic fauna. The spring fauna was sampled by direct filtration of the water through a 300 µm silk net (Messouli, 1984). Sampleswere preserved in 100% ethanol and then transported to the laboratory, where theysorted carefully under a binocular loupe, and identified at the family level using a key of Tachet et al. (1980) and Tachet et al. (2000).

Results

The Physico-chemical Characteristics of Water

The results of the Physico-chemical analyses of the 11 stations during the study period are shown in Table1. All pollution parameters are within WHO standards, except for Ammonium, which is slightly higher in well P3. The water temperature recorded did not show great variations, with 18 C° in most wells, except P6 (20C°) andS1 (22C°).There is no substantial variance in the pH readings, which remain closer to neutral in all study stations. The electrical conductivity values indicate the high mineralization of groundwater in the study area,which were ranging from 620 µs/cm (S2) to 6480 µs/cm in well (P3). Hardness shows high values and great variations, wherethe maximum value was recorded in well P3 (1048mg/L) and the minimum in P5 (208 mg/L). The recorded alkalinity contents vary between 210mg/L (P7) and 1000mg/L (p3), the high values of which are probably due to the circulation of these waters in the aquifer reservoir of calcairo-dolomitic nature.

The average value of Sulphates in the waters of the study area wasaround250 mg/L, which shows that the waters in question comply with Algerian standards. Chlorides are important inorganic anions with variousconcentrations in natural waters, generally in the form of Sodium (NaCl) and Potassium (KCl) salts. The concentrations of Chloride ions were found to range from 129.3mg/L (S2) to 680.3mg/L (P3).Nitrates can be issuedfrom the decomposition of plant or animal matter, fertilizers used in agriculture, manure, domestic and industrial wastewater, precipitation, or geological formations containing soluble nitrogen compounds. Nitrate levels show that most tested groundwater contained low levels, except for well P3 (75.24 mg/L). The ammonium content varies between 0.1mg/L (P8) and 35.2mg/L (P3). The amount of Orthophosphate is found to be less than 1 mg/L.

A Principal Component Analysis (PCA) was carried out to establish a relationship between the different physicochemical parameters. The correlation matrix between 11 physicochemical parameters studied (Table 2) shows significant positive associations between most parameters.

DOI: *10.46325/gabj.v6i2.186*

Table 1. Main physicochemical characteristics of the water from the nine studied wells and two sources.

Station	P1	P2	P3	S1	S2	P4	P5	P6	P7	P8	P9
T (c°)	18	18	18	22	18	18	18	20	18	18	18
p H	7	7,5	8	6,5	7	7,5	7,5	7,5	7,5	7	7
CE (µs/cm)	1580	940	6480	1380	620	1680	1300	1650	780	780	840
Sal (mg/L)	790	440	3300	680	300	820	620	800	400	380	410
TAC (mg/L)	420	260	800	246	240	388	244	390	210	260	280
SO4 (mg/L)	243.7	193.83	767	216.24	164.55	267.47	240.48	339.51	152.59	124.25	154.48
NO3 (mg/L)	14	14.61	75.24	10.48	16.81	15.64	21.38	10.35	12.2	24.5	15.3
NH4 (mg/L)	0.198	0.223	35.237	0.201	0.402	0.443	0.12	0.123	0.126	0.1	0.142
Cl (mg/L)	408.19	241.5	680.32	278.33	129.26	581.68	366.01	442.21	204.09	201.77	255.12
PO4 (mg/L)	0.0006	0.0007	0.0013	0.0006	0.0007	0.0007	0.0007	0.0007	0.0006	0.0006	0.0006
DT (mg/L)	590	380	1048	352	252	250	208	226	270	500	302

Table 2. Correlation matrix between the physicochemical variables of the study stations.

	T	p.H	CE	Sal	TAC	SO4	NO3	NH4	Cl	PO4	DT
T	1	-0.5	-0.05	-0.05	-0.04	0.53	-0.22	-0.14	-0.06	-0.17	-0.17
p.H	-0.5	1	0.6	0.59	0.47	-0.5	0.46	0.51	0.62	0.69	0.34
CE	-0.05	0.6	1	1	0.94	-0.24	0.38	0.92	0.77	0.95	0.85
Sal	-0.05	0.59	1	1	0.94	-0.25	0.38	0.92	0.76	0.95	0.86
TAC	-0.04	0.47	0.94	0.94	1	-0.33	0.33	0.97	0.56	0.95	0.85
SO4	0.53	-0.5	-0.24	-0.25	-0.33	1	0.12	-0.41	-0.12	-0.34	-0.2
NO3	-0.22	0.46	0.38	0.38	0.33	0.12	1	0.29	0.39	0.45	0.12
NH4	-0.14	0.51	0.92	0.92	0.97	-0.41	0.29	1	0.56	0.91	0.89
Cl	-0.06	0.62	0.77	0.76	0.56	-0.12	0.39	0.56	1	0.67	0.48
PO4	-0.17	0.69	0.95	0.95	0.95	-0.34	0.45	0.91	0.67	1	0.78
DT	-0.17	0.34	0.85	0.86	0.85	-0.2	0.12	0.89	0.48	0.78	1

Factor 1 (Figure 2) expresses 75.9 % of the variance of the data and shows high and positive correlations of electrical conductivity as well as major elements (such as sulfates,chlorides and hardness), polluting elements (ammonium, nitrate and orthophosphate) and negatively correlated with temperature.

The Factor 2 expresses 10.81% of the variance of the data, showing a good positive correlation with the temperature and a negative correlation with the pH. The analysis of the circle performed by the two factors F1 and F2 shows a correlation between all the chemical elements constituting the mineralization of the waters as well as the pollution elements. These interpretations allow us to consider factor 1 as the mineralization factor related to the dissolution of geological formations and the pollution factors.

The hierarchy of stations based on the physical-chemical descriptors of water allows distinguishing three different groups:

Group1: it included the well P3, which is a well without a cover, therefore not protected from various wind contributions. It presents water of poor to bad quality. It is, as indicated above, richer in organic pollution indicator ions, ammonium ions whose contents often exceed the standards set by the WHO.

Group 2: This group includes a set of five wells: P1, P4, P6, P7, P8, and twosprings, whose water presents excessive mineralization and an important hardness as well. They are often richer in organic pollution indicator ions, with contents sometimes exceeding the standards set by the WHO.

Group 3: involves three wells, P2, P5, P9, all unprotected, from wind contributions but located quite far from inhabited areas. The water in these wells has lower organic or mineral pollution indices than that from the well P3, whose water is highly mineralized. It is, as indicated above, richer in pollution indicator ions (ammonium ions) exceeding WHO standards, therefore, presenting a serious potential risk to the local population's health.

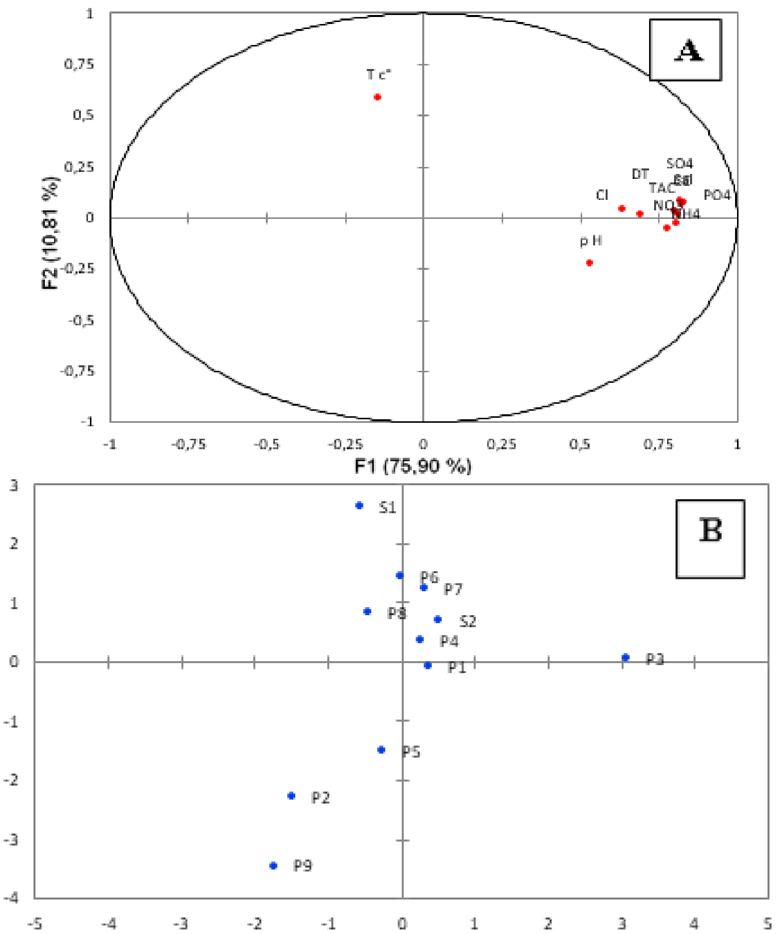

Figure 2. Graphical approach of PCA of physico-chemical parameters in water according to the F1xF2 design. A - Factorial map of the variables. B - Factorial map of the stations.

Faunal Diversity

Analysis of the fauna harvested in the studied sites revealed the presence of 1237 individuals belonging to four phyla: Arthropods, Molluscs, Plathelminths and Annelids. Insects are the most abundant with 880 individuals (71.14%) followed by gastropods, 147 individuals (11.88%), crustaceans 106 individuals (8.57%) and Plathelminthswith 96individuals (7.76%), Hydracariensand Annelids are the least represented, fiveindividuals and three individuals respectively (Figure 3).

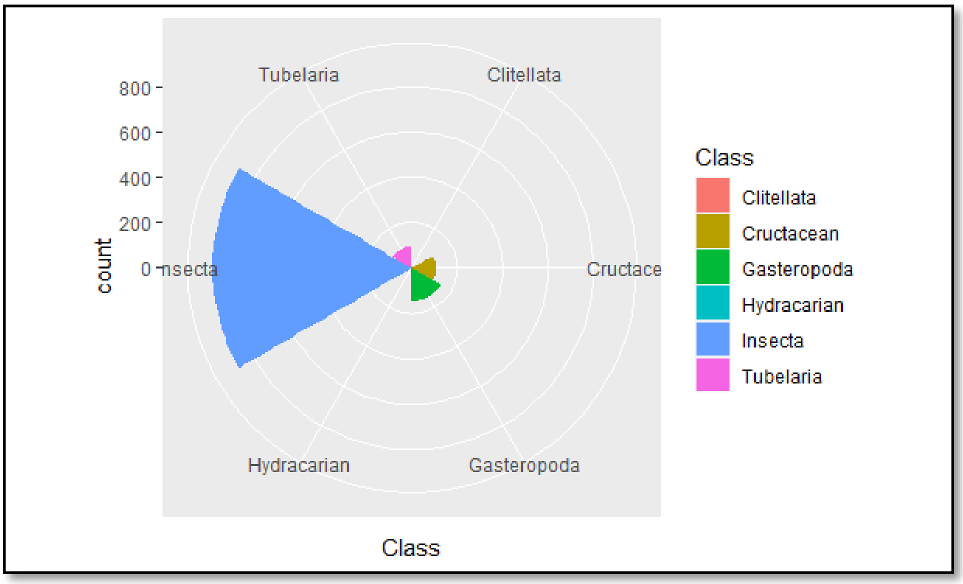

Figure 3. General structure of zoological groups.

The Abundance of Studied Groundwater

❖ *Insects*

The class of insects is the most abundant (71.14%); it include 36 families that belong to seven orders, with Diptera (insects) being the most abundant and important group numerically 47.73 % represented strongly by the Culicidae.

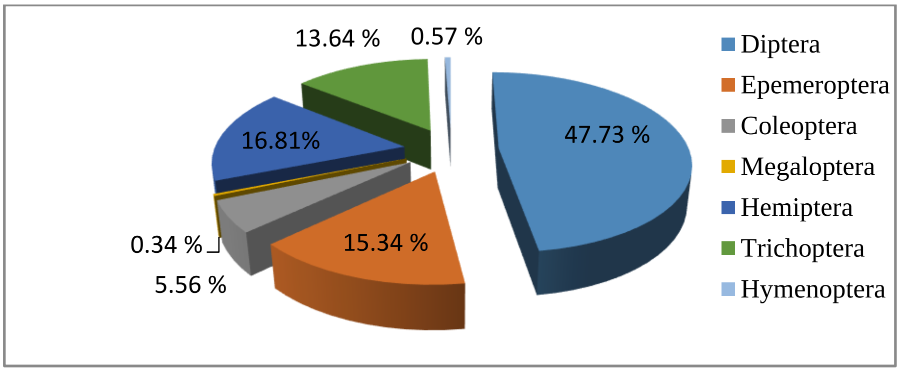

Figure 4. Insects identified during the study.

❖ *Molluscs*

They represent 11.88% of the total number of harvested samples, comprising a single class of gastropods presented by four families; a dominatingHydrobiidae with 50%, Ferrissidae 39.5%, Physidae 1.36% and Planorbidae 0.68% (scarce).

DOI: *10.46325/gabj.v6i2.186*

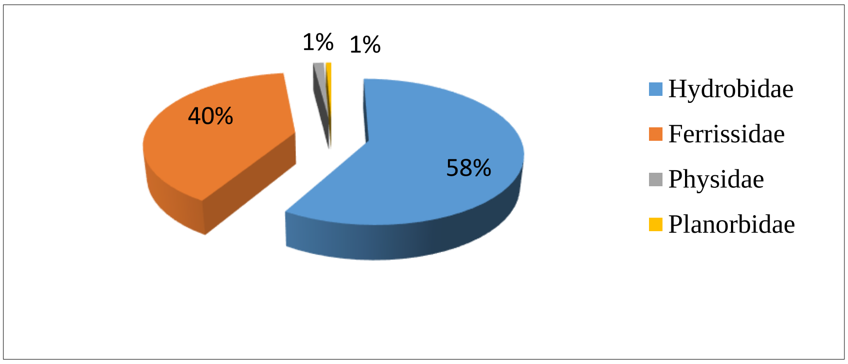

Figure 5. Families of Molluscs collected during the study.

❖ *Crustaceans*

Crustaceans represent 8.569% of the harvested fauna, with dominating Ostracods (98.11%), while Isopods are poorly represented with only 1.89%.

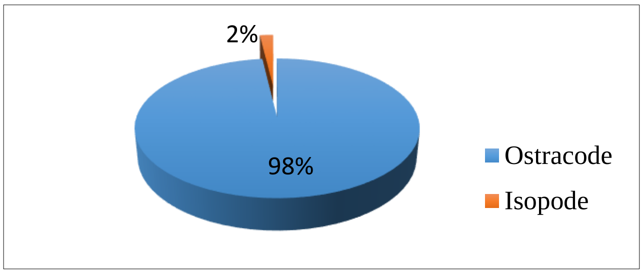

Figure 6. Crustaceans identified during the study.

❖ *Plathelminths and Arachnids* constitute a low and very low abundance respectively.

Discussion

During the study period, the results showed that water is highly mineralized. Allaoua et al. (2015) argued that all these ions come mainly from rocks, limestone, or salt sometimes crossed by water in addition to anthropogenic stressors such as agricultural practices (Bouakkaz et al., 2017). The water temperature showed relatively little variation in wells (18°C-20°C). According to Rodier(2009), groundwater is less sensitive to temperature variations than surface water, and the variation in pH between stations generally does not exceed one pH unit, ranging between 6.5 and8, which indicates the degree of alkalinity of the environment. The conductivity recorded values showed high and significant variations, ranging from 620 µs/cm to 6480 µs/cm, these high values (above 1000 µS/cm) are normal in eastern Algeria (Ramzi et al., 2020). The hardness, exhibits high values with a great variation from 208 mg/Lto 1048mg/L. Rodier et al. (1984) indicated that this parameter is directly related to the quantity of calcium and magnesium in the water and these high values are probably related to the lithological nature of the geological formation of the water table, in particular, to its dolomite composition which is rich in magnesium and calcium. In the study stations, the sulfatewas around 250 mg/L, denoting that the waters in question comply with Algerian standards, throughout, according to Meybeck et al. (1996), the presence of sulphates in "unpolluted" natural waters invokes the presence of gypsum or pyrite.High levels of pollution elements (ammonium, nitrate and orthophosphate) affectspecies sensitive to pollution (Lylia et al., 2020). This is the case of P3, which presents water of poor to bad quality, this well is strongly represented by Diptera 92%, mainly the most resistant to pollution such as Psychodidae, which is considered as indicators of pollution (Mastrantuono, 1985).

Conclusion

Water is a vital natural resource essential to life in all ecosystems. 11 stations located in two regions, Souk Naamane and Ain M'lila, have been the subject of physical-chemical analyses and benthic macro-invertebrate sampling.

The physical-chemical results show that all pollution parameters are within WHO standards except for Ammonium (NH4+-) which is higher in S3 and P8. The strong mineralization recorded in the stations could be explained by the dissolution of the limestone, saline and gypsum rocks of the terrains covering the study area. In addition, anthropogenic action would be added to natural action. Indeed, agricultural practices donot influencethe stations, and this is justified by the total absence of nitrate and ortho-phosphate contamination.

Throughout this work, the study carried out in the 11 selected stations made it possible to harvest 1237 individuals. Despite the low number of individuals, 47 families were identified revealing a large abundance of the epigenetic fauna in the water of the prospected wells.. These results are consistent with previous work. Beetles are the best-represented faunal group (16 families). After that comes the Diptera and the Gasteropods, with eight and four familiesrespectively, the Hydracariens (fourfamilies) and the Trichoptera (three families), the Hymenoptera and the Ephemeroptera have two families, each; however, the Megaloptera, the Triclades and the Citellata only have one.

Acknowledgments

The authors would like to express their gratitude to the anonymous reviewers for their remarks and suggestions on the previous version of our text, as well as to thank Professor GHERRAF Noureddine for his precious help.

References

Allaoua N, 2015 Contribution à l'étude de la qualité biologique et physico-chimique de l'eau des écosystèmesaquatiques et des puits de la régiond'Oum El-Bouaghi (Hautes plaines de l'Estalgérien).p43-44.

Allaoua, N., Hafid, H., Merzoug, D., Ghouraf, N. & Houhamdi, M. (2015). Evaluation of physic-chemical quality of well water in the area of OUM El-Bouaghi (High Plains of Eastern Algeria) characterization and analysis in principal component. *Advances in Environmental Biology,* 9**,** 63-72.

Belaidi, N., Taleb, A., Mahi, A.,&Messana G (2011).Composition and distribution of stygobionts in the Tafna alluvial aquifer (north-western Algeria). SubterraneanBiology, 8: 21- 32. Benouada, 2005.

Belaidi, N., Taleb, A., & Gagneur J., 2004. Composition and dynamics of hyporheic and surface fauna in a semi-arid stream in relation to the management of a polluted reservoir. *Ann. Limnol. Int. J. Lim,* 40 (3): 237-248.

Benaouda B., 2005. Contribution à l'étude du genre *Typhlocirolana*(Isopode, Crustacée) de la moyenneTafna: Ouest algérien. Mém. Ing. Fac. Sc. Univ. Tlemcen : 46p.

Bouakkaz, A., Hadjab, R., Khammar, H.,& Houhamdi, M. (2017). Physico-chemical and biological characterization of wells water quality in Berriche region (North-east Algeria).

Boutin C, Boulanouar M (1983). Methods of catching stygobian fauna: Experimentation of different types of baited traps in the wells of Marrakech. Bull. Fac. (2). Sc. Marrakech: 5-21.

Boutin C (1996). Book review. "H.P. Wagner, 1996 A monographic review of the Thermosbaenacea (Crustacea: Peracarida). A study on thgeir morphology, taxonomy, phylogeny and biogeography". Zool. Vaehandelingen, Leiden, 338pp. 500 Fig." Crustaceana, 69(6): 801-804.

Chebika R., 2003. Contribution à l'étude de la faune de quelques puits de la moyenne Tafna (région de Maghnia). Mém. Ing. Fac. Sc. Tlemcen (Algérie): 65p.

Cvetkov l., 1968. A biological phréato fillet. Bull. Inst. Zool. Mus. Sofia. XXVII: 215-219.

DanielopoldL., Greibler C., Gunatilaka A. et Notenboom J., 2003. Present state and future prospects for groundwater ecosystems. *Environmental Conservation* 3D: 104-130.

Delamare Deboutteville C., 1960. Biologie des eaux souterraines littorales et continentales. *Hermann Ed. Paris*: 740p.

Gurney R., 1908. A new species of Cirolana from a fresh-water spring in the Algerian Sahara. *ZoologischarAnzeiger,* 32: 682-685.

Haicha (2013). Contribution to the knowledge of the stygofauna of Algeria. Study of the fauna of the wells of the alluvial aquifer of Lower Tafna. Magister. Univ. Tlemcen (Algeria).

Lakhdari FT (2014). Contribution to the knowledge of the stygofauna of Algeria: Study of the quality of the water and the aquatic fauna of the wells of the region of Mascara (North-West Algeria). Thesis of Magisterium in Ecology - Univ. Tlemcen (Algeria). 107pp.

Liu, Y., Wang, P., Ruan, H., Wang, T., YU, J., Cheng, Y. & Kulmatov, R. 2020. Sustainable use of groundwater resources in the transboundary aquifers of the five central Asian countries: Challenges and perspectives. *Water,* 12**,** 2101.

Lylia, R., Ramzi, H., Hichem, K., Djemoi, M. & Menouar, S. (2020). Groundwater Quality in Two Semi-Arid Areas of Algeria: Impact of Water Pollution on Biodiversity. *Journal of Bioresource Management,* 7**,** 2.

Mahi., 2007. Contribution à l'étude de la faune stygobie de la région de Tlemcen (Nord-Ouest Algérien). Thèse. Magistère. Univ. Tlemcen (Algérie): 127p.

Mastrantuono, L. (1985). Littoral sand zoobenthos and its relation to organic pollution in Lake Nemi (Central Italy). *Hydrobiological Bulletin,* 19**,** 171-178.

Messouli M (1984). Research stygobian fauna from the sources of the Marrakech region. Memory of DEA, University of Marrakech, 1-35.

Monod TH., 1924. Sur quelques Asellides nouveaux des eaux douces de l'Afrique du Nord. *Bulletin de la Société d'Histoire Naturelle d'Afrique Nord* 15: 327-336.

Morris B. L., Lawrence A. R., Chilton P. J. C., Aadams B., Calow R. C. et Klinck B. A., 2003. Groundwater and its susceptibility to degradation: a global assessment of the problem and options for management. *Early warning and assessment report series, RS. 03-3. United Nations Environmental Programme. Nairobi, Kenya*: 126 p.

Nourrisson M., 1956. Etude morphologique comparative et critique des *Typhlocirolana* (Crustacés isopodes Cirolanides) du Maroc et de l'Algérie. *Bull. Soc. Sci. Nat. Phys. Maroc,* 36 : 103-124.

Pesce G. L. et Tete P., 1978. Microparasellidesd'Algérie (Crustacea:Isopoda). *Rev. Zool. Afr*., 92 (4): 992-1001.

Pesce GL, Tete P, De simone M (1981). Fauna research in groundwater fractions of the Maghreb (Tunisia, Algeria, and Morocco) and Egypt. Natur. Soc. Ital. Sc. Nat. Civ. Museum Stor. Nat. And Acquario civ. Milan, 72, (1-2): 63-98.

Racovitza E. G., 1912. Cirolanides (première série). Biospeologica 27. *Archives de zoologie expérimentale et générale,* 10: 203-329.

Ramzi, H., Hichem, K., Lylia, R., Djemoi, M. & Menouar, S. 2020. Impact of Anthropic Pressure on the Quality and Diversity of Groundwater in the Region of Sighus Oum-El-Bouaghi and El Rahmounia, Algeria. *Journal of Bioresource Management,* 7**,** 7.

Rodier., 2009. Interprétation des résultats analytiques, 9émeédition : 1187p.

Rodier, J., 1984. L'analyse de l'eau, eaux naturelles, eaux résiduaires et eau de mer. 7èmeédition, Dunod, pp : 1365.

Tachet .H., Bournaud M., Richouxp et Usseglio-Polatera, 2000.Invertébrés des eaux douces : systématique, biologie, écologie .Ed CNRS Paris : 588p.