Poll Res. 39 (4) : 830-838 (2020)

ISSN 0257–8050

ASSESSMENT OF THE PHYSICO CHEMICAL AND BIOLOGICAL QUALITY OF THE OURIKA CATCHMENT

YASSINE SCHAHRAKANE[1], HANANE IDALI[2], NAAIMA BENJELOUN[1], ABDELATIFE KHATABI[3], WAHBI ABDERRAZIK[1] AND OUADIA TAZI[1]

[1]*Immunology and Biodiversity Laboratory, Faculty of Sciences Ain Chock Casablanca, Morocco*
[2] *Health and Environment Laboratory, Faculty of Sciences Ain Chock Casablanca, Morocco,*
[3] *National Forest Engineering School, Rabat, Morocco*

(Received 4 February, 2020; Accepted 13 May, 2020)

ABSTRACT

The present work has for object the study of the physico-chemical parameters including some heavy metals (Lead, Cadmium and Zinc) as well as the benthic component, at the level of the Ourika River, to determine the state of pollution of the area and its impact on public health. Sampling was carried out in seven areas of the basin for the biological and heavy metals study and at eleven zones for the physico-chemical study. The choice of these areas is mainly related to accessibility and socio-economic activities near each zone. The physicochemical study showed, values exceeding the norms with a maximum of 619.8 ìS.cm^{-1} for conductivity, 1.108 mg.L^{-1} for orthophosphate, 1.985 mg.L^{-1} for ammoniacal nitrogen , 0.99 mg.kg^{-1} for cadmium, 104.75 mg.kg^{-1} for Zinc (substrate samples) and 0.08 mg.kg^{-1} for Lead (water samples). The biological study, meanwhile, revealed an average water quality for the indexes Global Normalized Biological and the Ephemeroptere Plecoptere trichoptere index and a low quality (polluted) for the riparian band quality index. Following these results, good monitoring and management of these resources is necessary to preserve its biodiversity and the health of its local population.

KEY WORDS : Biodiversity, Heavy metals, Macro-invertebrates, Ourika catchment area, Physico-chemical parameters, Pollution.

INTRODUCTION

The Ourika Valley, located 35 km from Marrakech is one of the most famous tourist sites in Morocco and is known mainly for its agricultural, tourism and livestock activities (Saidi, 2012).

Various human activities along the banks of the river Ourika (coffee, restaurant, hotels or agriculture that is practiced throughout the watershed), making this river a popular place for visitors. However, it suffers heavy damage, some of which are visible to the naked eye, and others decimated in the various components of nature.

To evaluate the changes and disturbances in the study area, we used some biological water quality indices such as the IBGN, EPT, RQI, IQH (Habitat Quality Index) on the one hand, on the other hand to the composition and structure indices (taxonomic wealth, Shannon-Wiener diversity index and Piélou's fairness index).

Benthic macrofauna, an essential link in the food chain of aquatic ecosystems, is considered a very good biological indicator of pollution (Diomandé, 2005). These living organisms are sensitive to changes in their environment (changes in pH, temperature, mineral compounds and organic matter) and are therefore likely to react to these changes and may serve as indicators of existing disturbance (pollution) (Rodier, 2009).

As for heavy metals, they are naturally present in the rocks, however the different human activities contribute to increase their quantities because of their multiple uses. Although they are present in trace amounts in the environment, they can become toxic at certain doses because of their cumulative effects.

The objective of this work is to be a contribution to the evaluation and characterization of the water of the Ourika region, through:

(i) The study of the composition (taxonomy, richness and abundance of species) and the structure (diversity, dominant species) of the benthic population.

(ii) The impact of fluctuations in hydrological conditions on the seasonal spatial variability of the benthic community.

(iii) The interactions of benthic populations with the hydrological compartment.

MATERIALS AND METHODS

Sampling

The collection of water for the physicochemical analysis was carried out at eleven stations, on a frequency of twice per season noted (C1 / C1 '- C2 / C2' - C3 / C3 'and C4 / C4') during 2017, for both groundwater and surface water.

Groundwater samples, noted (S1, S2, S3 and S4), were made at the douars: Amelougui, Aghbalou and Timalizene. While the surface water samples noted (O1, O2, O3, O4, O5, O6, O7), have seen interest all along the Ourika River (more specifically: Setti Fadma, Imi N'tadart, Tazitount, Oualmas and Aghbalou) (Figure 1).

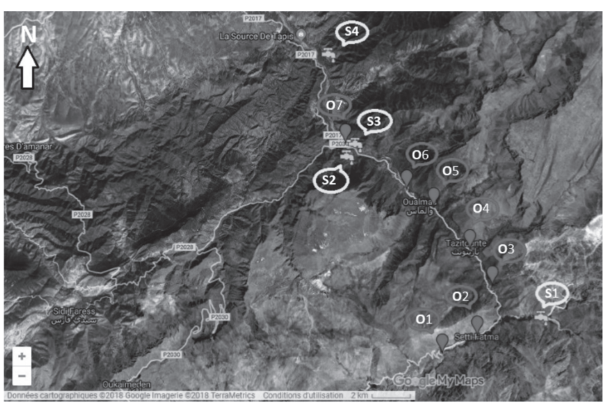

Fig. 1. Ground and surface water sampling points

In order to follow the spatio-temporal evolution of the benthic settlements, 8 samples of substrate are made per station, along the River at the level of the zones (O1, O2 ... O7), once per season during the years 2016- 2017 (Figure 1).

In the field, the macroinvertebrates harvested are fixed immediately with 10% formalin. Once transmitted to the laboratory, they are sorted under a binocular loupe and identified using an identification key (Tachet, 2010).

The analysis of heavy metals involved both surface water and substrate samples at O1, O2 ... O7 during 2017 (Fig. 1).

The water and substrate samples (crushed and sieved) are first mineralized with oxygenated water and nitric acid, then adjusted to 50 mL with distilled water and stored until analysis with spectrometry. Atomic Absorption (Bendada, 2011).

The methods used for the different physicochemical analyzes, are those described by (Rodier, 2009).

RESULTS

Following the various results obtained, the parameters Temperature, Hydrogen potential, Biochemical oxygen demand, Nitrate, Nitrite, Oxidability, Chloride, Hardness, Suspended matter and Sulphate, presented results that do not exceed the standards (Marchal, 2011; Decree n°2003/464 2003; Minestery of sustainable development 2013; Official journal 2009), so they will not be taken into account in the result part. We limited ourselves to the parameters that showed critical values namely: Electrical Conductivity, Dissolved Oxygen, Orthophosphate and Ammoniacal Nitrogen.

Electrical conductivity

The guide value set by the decree n° 2003/464 (2003) is 200 $\mu S.cm^{-1}$.

For surface waters, all zones do not exceed the norms, while for spring waters the limit value has been exceeded in zones S2 and S3 to reach a maximum of 619.8 $\mu S.cm^{-1}$ in spring (Figure 2).

Dissolved oxygen

According to the standards described in (Ministry of Sustainable Development, 2013). For the protection of aquatic life the dissolved oxygen concentrations should not be less than 5 - 6 $mg.L^{-1}$ for temperatures between 10 and 25 °C.

According to our results, some areas recorded values lower than 5 $mg.L^{-1}$, namely: S3 in Fall and Winter and S2, S3, O1, O2, O6 in Spring (Figure 3).

Orthophosphate

According to the standard (Metrohm process analytics 2005), the acceptable limit for orthophosphate is 0.05 $mg.L^{-1}$.

All areas showed values exceeding limits with a maximum of 1.108 $mg.L^{-1}$, except for S4 and O3 in

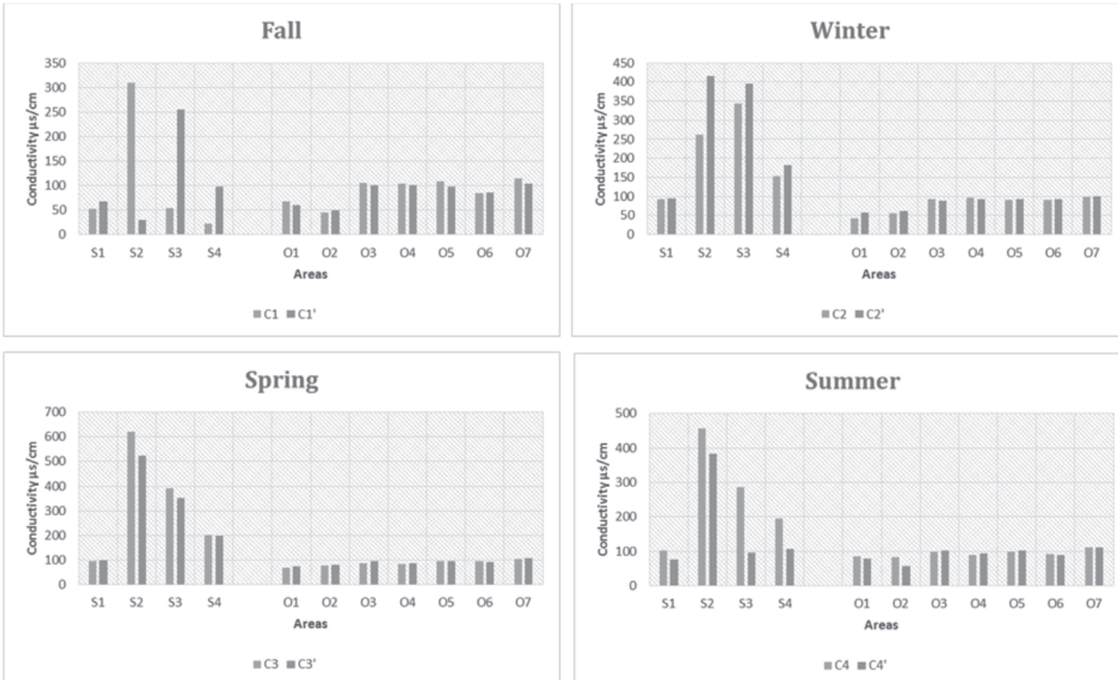

Fig. 2. Change in the electrical conductivity of groundwater and surface water in 2017

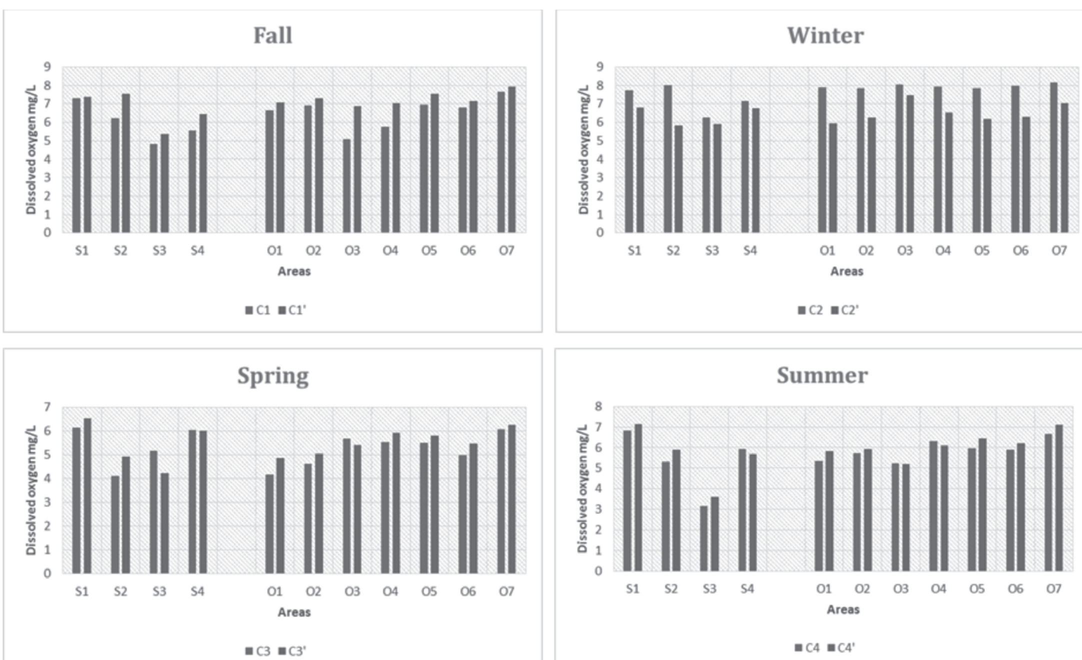

Fig. 3. Variation of dissolved oxygen levels in groundwater and surface water in 2017

Fall and Summer (Figure 4).

Ammonia nitrogen

Compared with the maximum concentration of 1.5 $mg.L^{-1}$, described in (Ministry of Sustainable Development, 2013).

The only values that exceed this limit are recorded at zone O1 in Spring and O5 in Summer (Figure 5).

Heavy metals

The concentration of Cd in the seven sites (Figure 6), shows a maximum value of 0.991 $mg.kg^{-1}$ recorded at site O1 and O7, and a minimum value of 0.00 mg.kg^{-1} recorded at site O3.

For lead (Figure 6), concentrations range from 0.00 to 0.57 mg.kg^{-1}. These minimum and maximum values are recorded respectively at site O6, O7 and site O4.

The zinc concentration results (Figure 6) show a maximum value of 104.75 mg.kg^{-1} in the O7 site, and a minimum value of 11.58 mg.kg^{-1} recorded at the O2 site.

The results of the zinc concentration (Figure 7) show a maximum value of 1.732 mg.kg^{-1} in the O4 site, and a minimum value of 0.522 mg.kg^{-1} recorded at the O6 site. The concentrations do not exceed the standards described.

The concentration of Cd in the seven sites (Figure 7), shows a zero value and absence of this element in all areas.

For lead (Figure 7), the concentrations range from

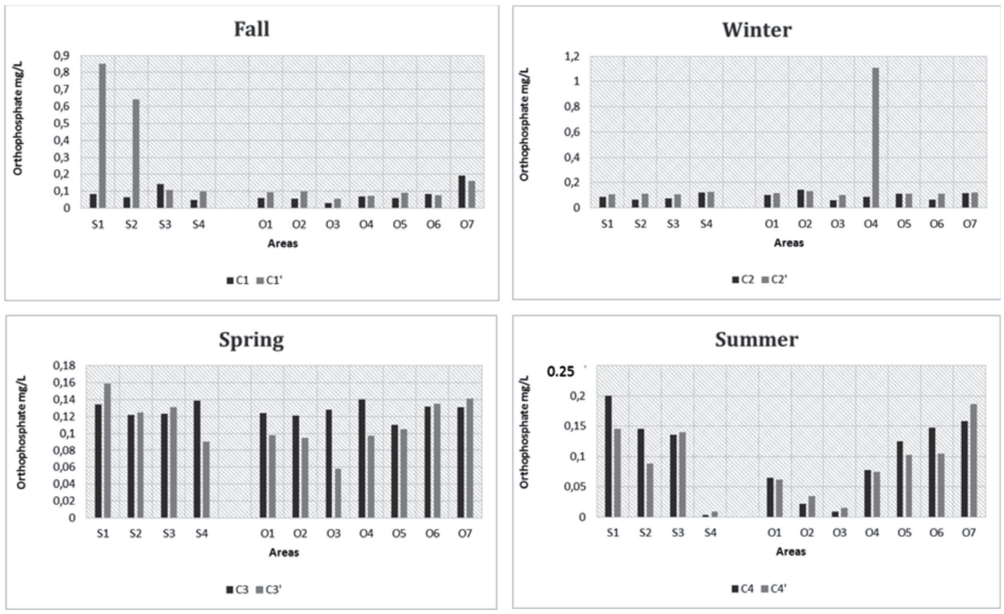

Fig. 4. Variation of orthophosphate content in groundwater and surface water in 2017

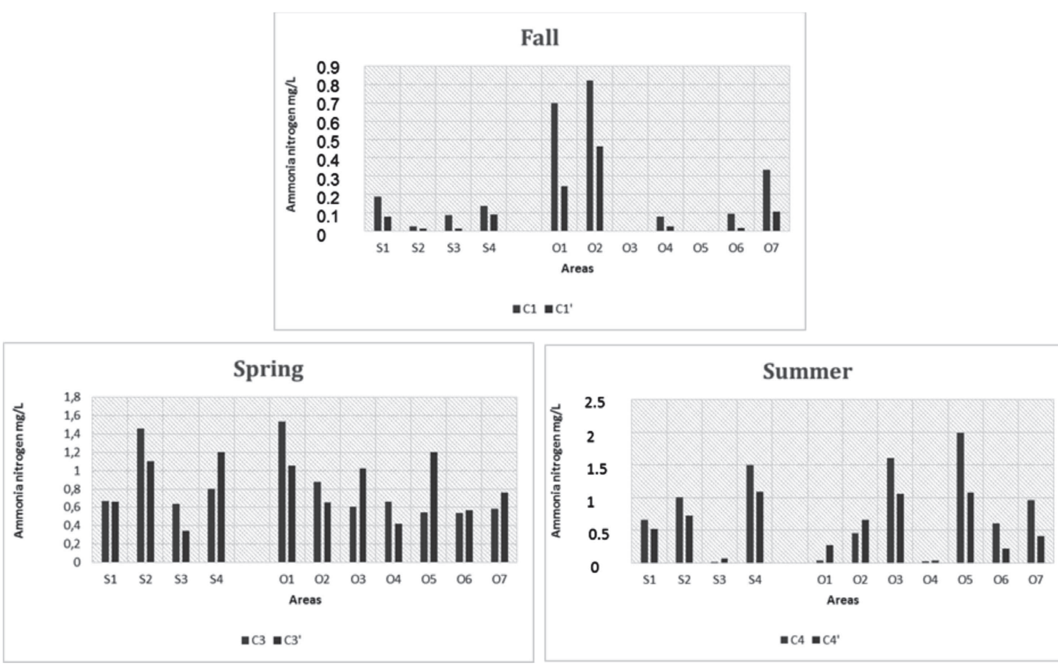

Fig. 5. Change in ammonia nitrogen content in groundwater and surface water in 2017

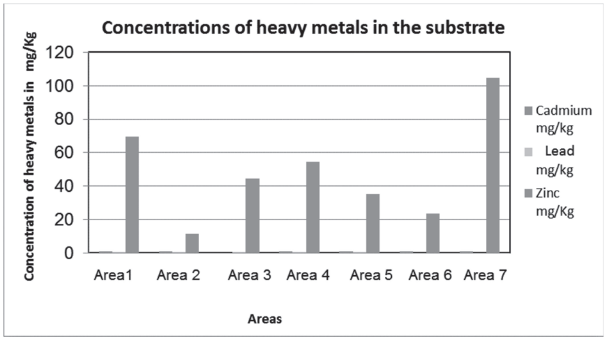

Fig. 6. Lead, cadmium and zinc content in mg/kg in substrate samples collected in 2017

0.00 mg.kg^{-1} recorded in the O1, O3, O4 and O5 sites as the minimum value and 0.08 mg.kg^{-1} as the maximum value recorded at the O7 site. The concentrations are slightly above the norms in zones O6 and O7.

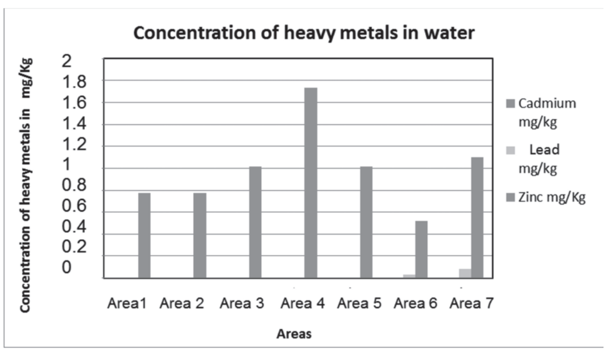

Fig. 7. Lead, cadmium and zinc content in mg/kg in water samples taken in 2017

Biological parameters

In order to evaluate the impact of human activities on these ecosystems, various indices were used:

Global Biological Normalized Index (IBGN)

In 2016, the Ourika region is generally characterized by medium-quality water during the four seasons and in most areas, with the exception of the O5 zone, which deteriorated in Winter and Summer by revealing poor quality water. As well as the zones O1 and O2 which showed them a good quality water in Summer (Figure 8).

In 2017 The Ourika region recorded deterioration in water quality during the Fall from medium to poor in all areas (Figure 8).

During Winter and Spring, water quality improved on average in most areas except for O6 in Winter and O2 in Spring. However, all areas showed moderate water quality during the summer (Figure 8).

Ephemeroptera, Plecoptera, Trichoptera (EPT) index

A decrease in this index is generally due to an increase in disturbances (Huet, 2016).

In 2016, the lowest values of this index were recorded in zones O6 and O7 in winter and at the level of O5 in spring (Figure 9).

While in 2017 the lowest values were recorded at the level of the zone O6 in autumn and winter and at the level of O7 in summer (Figure 9).

Habitat Quality Index (HQI)

The HQI makes it possible to determine the ability of a river to support aquatic life (Moisan, 2013).

According to our results, all zones are characterized by a suboptimal IQH class and are therefore able to support aquatic life (Table 1).

Quality index of the riparian strip (RQI)

The RQI is used to assess the ecological condition of a riparian environment (Saint-jacques, 1998).

According to our results, the study area is generally characterized by a very weak to weak riparian band except for the right bank O7 zone which is considered average (Figure 10).

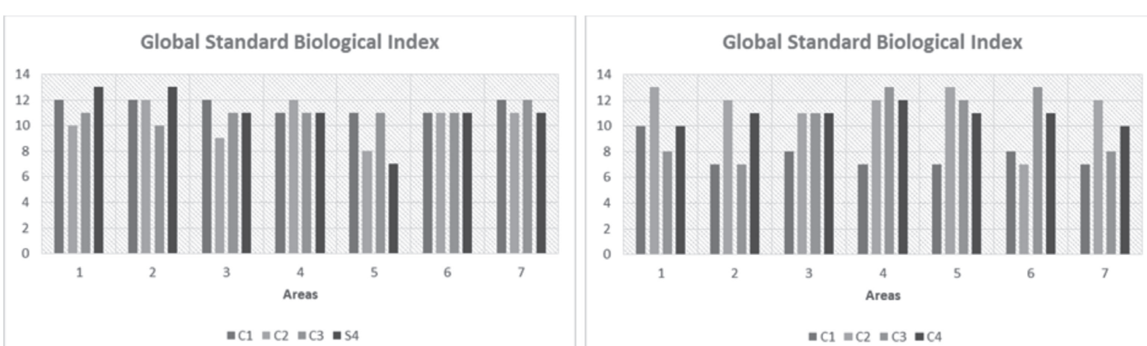

Fig. 8. Results of the standardized global biological index, during the four seasons of the years 2016 and 2017

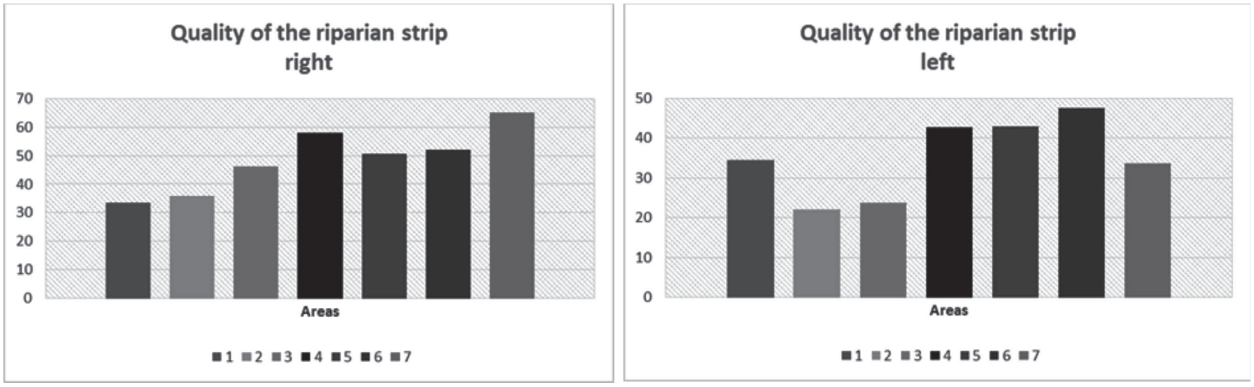

Fig. 9. Results of the Ephemeroptera, Plecoptera, Trichoptera index during the four seasons of the years 2016 and 2017

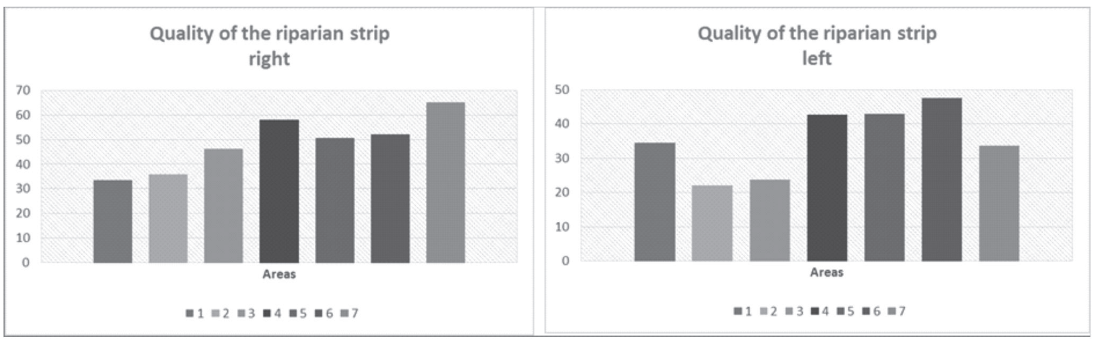

Fig. 10. Results of the riparian strip index right and left

Table 1. Results of the Habitat Quality Index according to the Guide for Biological Monitoring based on Quebec Freshwater Benthic Macro-Invertebrates

IQH out of a total of 200	O1	O2	O3	O4	O5	O6	O7
	Suboptimal 142 = 71%	Suboptimal 133 = 66.5%	Suboptimal 131 = 65.6 %	Suboptimal 100 = 50 %	Suboptimal 110 = 55 %	Suboptimal 110= 55 %	Suboptimal 104 = 52%

Shannon-Wiener index (H ')

It makes it possible to express diversity by taking into account the number of species and the abundance of individuals within each of these species (Grall, 2006).

The Shannon-Wiener index showed low values between (0 and 1.5) at all zones, hence the presence of a less diversified stand with dominant species and therefore qualifies our water as highly polluted as in 2016 or 2017 (Figure 11).

Index of Piélou (J ')

The equitability index makes it possible to measure

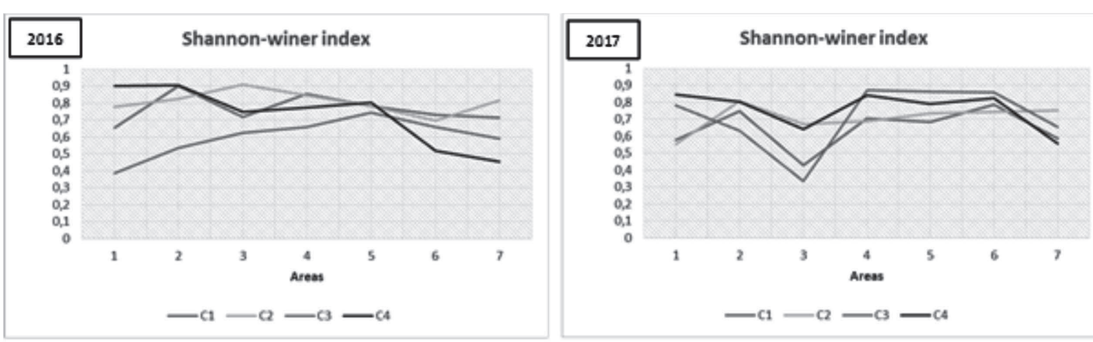

Fig. 11. Results of the Shannon-Wiener index according to the four seasons of the years 2016 and 2017

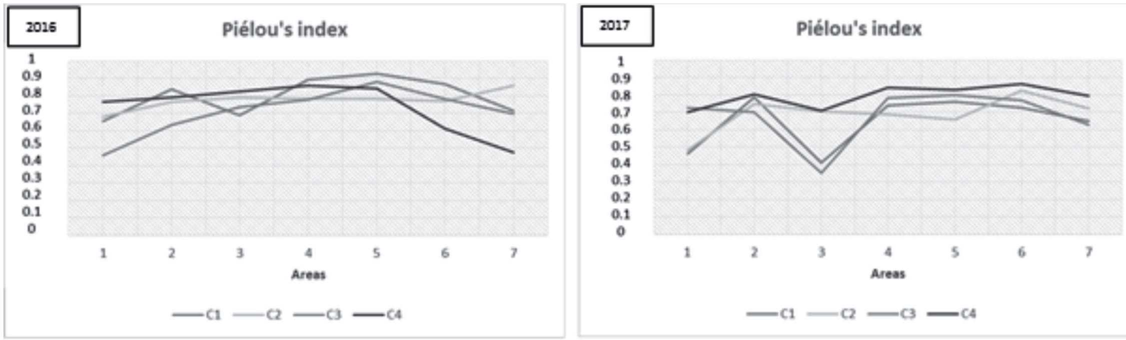

Fig. 12. Results of Piélou's equitability index according to the four seasons of the years 2016 and 2017

the distribution of individuals within species, regardless of species richness (Grall, 2006).

The Piélou index shows values close to 1 for the majority of the zones, which results in an equidistribution of individuals in the species for the two years 2016 and 2017 (Figure 12).

Taxonomic wealth

The year 2017 was slightly less diversified than the year 2016 with the disappearance of five families (*Hydrophylidae, Chaoboridae, Psychodidae, Ephydrirae* and *Ephemerellidae*), however it has experienced a greater number of individuals on all the taxa (5902 individual in 2017 compared to 5032 individual in 2016).

But generally for the two years, the order of the *Ephemeroptera* was the most represented with a total of 3606 individuals in 2017 and 3069 individuals in 2016.

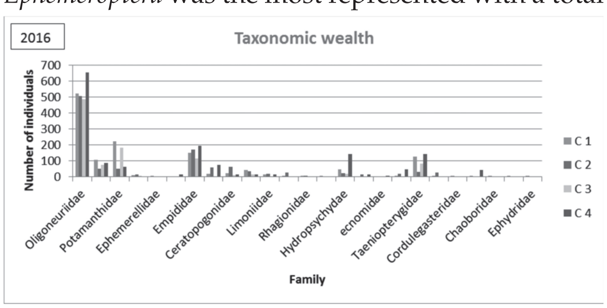

Fig. 13. Graphic representation of all the taxa identified during the year 2016

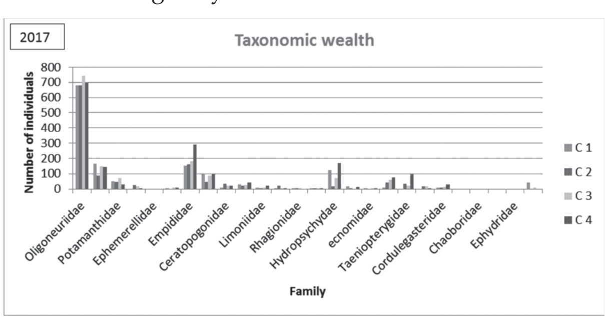

Fig. 14. Graphical representation of all the taxa identified during the year 2017

DISCUSSION

The set of biological indices defines a medium quality water with a suboptimal habitat able to support aquatic life, hence the presence of a fairly large biodiversity despite the dominance of certain species, which explains the low indices of Shannon-Wiener and piélou in 2016 and 2017 (Karrouch, 2009).

When the 2 indices have low values, then the studied medium is said to be homogeneous and specialized. On the contrary, when these values are high, the environment is relatively diversified (Huet, 2016).

The region is characterized by a rather large taxonomic richness, with the dominance of some families, namely *Taeniopterygidae* belonging to group 9 indicator taxa, followed by the families *Heptageniidae* and *Potamantidae* belonging to group 5, *Hydropsychydae* belonging to group 3 (Rodier, 2009).

The physicochemical parameters showed for all the substandard results except for the conductivity, the dissolved oxygen, the orthophosphate and the ammoniacal nitrogen.

The increase in conductivity is the mineralization of water salts and the increase in the concentration of ions, not to mention that the conductivity is strongly related to temperature. An increase in temperature results in an increase in conductivity (Ouhmidou, 2014). Compared to the results obtained in 2016 (Schahrakane, 2018), we note that many more areas are characterized by a conductivity exceeding the norm of 200 $\mu S.cm^{-1}$. (Decree n°2003/464 2003).

For dissolved oxygen, levels below the norm of 5-6 $mg.L^{-1}$ have been found for 2016 in S1, O1 and

2017 in S2, S3, O1, O2 and O6. The decrease in oxygen is generally due to the oxidation of chemical compounds released by human activities, or when consumption (bacterial, plant and animal respiration) becomes greater than production (Photosynthesis, Agitation of water under the effect of wind and currents) (Loire Estuary Cell of Measurements and Balance sheets, 2002).

High concentrations of ammonia nitrogen are accompanied by an increase in orthophosphate especially in 2017, where all areas have shown values above the standard of 0.05 $mg.L^{-1}$ (Metrohm process analytics 2005) This is due to the fact that these two elements are the major responsible for the enrichment of the environment (reservoirs and lake water) in an excessive way (eutrophication phenomenon) which can cause a real degradation and become irreversible.

The determination of heavy metals in the substrate was done to get a general idea of the sources of origin of these elements. The concentrations obtained in the substrate are higher for lead in all zones except the O3 zone and for zinc in the O7 zone compared with the global average Cd 0.35 $mg.kg^{-1}$; Pb 35 $mg.kg^{-1}$; Zn 90 $mg.kg^{-1}$ (Senou 2014) the rest of the zones show non-disturbing values.

The important contribution in Zinc is the result of its use in agriculture, as a trace element supply, mainly in cultivation zones (Senou, 2014). But must not exceed in water intended for human consumption according to the European standards the dose of 3 $mg.kg^{-1}$ in Zn (Official Journal, 2009).

The Cadmium load according to the European standards must not exceed the dose of 0.005 $mg.kg^{-1}$ in water (Official Journal 2009), and which can have an atmospheric, agricultural or urban origin, the leaching of the fertilized soil can also constitute a source of cadmium supply in the substrate by sedimentation (Senou, 2014), but the absence of this element can be explained by its dilution in the water which prevails during the current.

As far as lead is concerned, the contents could be due to the vehicle exhaust gases as well as the discharge of wastewater and domestic discharges (Senou, 2014) and must not exceed the dose of 0.01 $mg.kg^{-1}$ in water (Official Journal, 2009).

The results obtained show a significant variation between the zones as well as between the metals themselves and this is due to the fact that lead and cadmium are elements which do not represent a great importance, on the other hand zinc is used everywhere.

The physicochemical and biological studies showed a complementarity of the results obtained during the two years (average water quality), with an increase of the perturbations in 2017 (Increase of the conductivity, the orthophosphate, the ammoniacal nitrogen and decrease dissolved oxygen and taxonomic diversity).

Benthic macroinvertebrates are strongly affected by changes in their habitat, the presence of organic matter, and the quality and diversity of the watercourse bottom, which depends on the ecological functionality of riparian strips and morphology. Streams. It will therefore be lower in anthropised streams. These benthic species are also sensitive to excess nutrients, which is often accompanied by a decrease in the level of dissolved oxygen in the water, which can lead to eutrophication of the aquatic environment and subsequently to the creation of anoxic zones (Benoit-chabot, 2014).

Some macro invertebrates can also be used as bio-indicators because of their high sensitivity to heavy metals. The abundance and distribution of these species is due to the pollen-sensitive factor such as chironomid larvae that disappear in contaminated media as opposed to larvae of oligochaetes that increase in sediments contaminated with cadmium, zinc and chrome (Benoit-chabot, 2014).

ACKNOWLEDGMENTS

The authors appreciate the technical assistance of Department of Biology and Laboratory of Immunology and Biodiversity

REFERENCES

Bendada, K. and Boulakradeche, M.W. 2011. Optimization of atomic absorption spectroscopy (SAAF and SAAET) assay conditions: Application to the determination of pollution and bioaccumulation of heavy metals, University of Science and Technology Houari Boumediene (U.S.T.H.B). *Republic Algerian Democratic and Popular.* 3 : 7-9.

Benoit-Chabot, V. 2014. Selection factors for Bio-indicators of the quality of aquatic ecosystems: development of a decision support tool. University Center for Environmental and Sustainable Development Training, pp. 12 (13) : 48.

Decree n° 2003/464 2003. Bearing classification of surface water and regulation of discharges of liquid effluents. 6 pp.

Diomandé, D. and Gourène, G. 2005. First data on the benthic macrofauna the fluvio-lacustrine hydrosystem of Bia (Ivory Coast). *Sci. Nat.* 2 : 167-176.

Grall, J. and Coïc, N. 2006. Synthesis of methods for assessing the quality of benthos in coastal environments, European University Institute of the Sea - University of Western Brittany Laboratory of Marine Environmental Sciences, p17.

Huet, C. 2016. Benthic Macro-Invertebrate Monitoring in the Vale NC Business Area-Annual Report. Lotic media. 24-25 pp.

Karrouch, L. and Chahlaoui, A. 2009. Bioassessment of the Water Quality of Boufekrane Ouad (Meknes, Morocco). 2009, 15 pp.

Loire Estuary Cell of measurements and balance sheets. the oxygen of water. Notebook No. 1 indicators, the dynamics of life, water support life. 2002, 1 pp.

Marchal, F. and Rabier, P. 2011. Assessment of measurement uncertainty of the hydrotimetric title of drinking water. 105 : 720.

Metrohm process Analytics. 09-2004 Analysis of orthophosphate and total phosphorus in line according to DIN EN ISO 6878 [NF EN ISO 6878 April 2005]. 2005.

Ministry of Sustainable Development, Wildlife and Parks Environment, Quality criteria for surface water. 3rd edition, Quebec, State of the Environment Monitoring Branch, ISBN 978-2-550-68533-3 (PDF), 2013, 510 pp. and 16 annex.

Moisan, J. and Pelletier, L. 2013. Biological monitoring guide based on Quebec freshwater benthic macroinvertebrates, shallow coarse-bedded streams. 23-46 pp

Official Journal. Council Directive 98/83 / EC of 3 November 1998 on the quality of water intended for human consumption (JO L 330 of 5.12.1998, p. 32). 2009, 16 : 18 pp.

Ouhmidou, M., Chahlaoui, A., Kharroubi, A. and Chahboune, M. 2014. Study of the physico-chemical and bacteriological quality of the waters of the Hassan Addakhil dam at Errachidia (Maroc), pp. 1666

Rodier, J., Legube, B. and Merlet, N. 2009. *Water Analysis.* 9th edition, Dunod, Paris, France, 1579 pp.

Saidi, M.E.M., Boukrim, S., Fniguire, F. and Ramromi, A. 2012. The superficial flows on the high Atlas of Marrakech case extreme flows. *Larhyss Journal.* 10 : 75-90.

Saint-Jacques, N. and Richard, Y. 1998. Development of a riparian zone quality index: application to the Chaudière River and related to the biotic integrity of the aquatic environment. 6.6 pp.

Schahrakane, Y., Tazi, O., Idali, H., Benjeloun, N., Chakri, N., Abderrazik, W. and Khatabi, A. 2018. Physicochemical and microbiological study of the Ourika watershed hydrographic network (Marrakech-Morocco region). *AES Bioflux.* 10(3) : 168-186.

Senou, I. 2014. Phytoextraction of cadmium, copper, lead and zinc by five plant species (Vetiveria nigritana (Benth.), *Oxytenanthera abyssinica* (A. Rich.) Munro, Barleria repens (Ness), *Cymbopogon citratus* (DC.) Stapf and *Lantana camara* Linn, grown on tropical and vertiginous ferruginous soils, 2014, Burkina Faso, pp. 94

Tachet, H., Richoux, P., Bournaud, M. and Usseglio-Polatera, P. 2010. *Systematic Freshwater Invertebrates, Biology, Ecology,* CNRS Edition, 2010, 175-553.