# Physicochemical and organic quality assessment of Mexa dam's waters and its suitability for agricultural use.

Badreddine Saddali[(1)], Rabah Kechiched[(2)], Abderraouf Remita [(3)], and Nabil Bougherira [(4)]

[(1)] *Geology department, Larbi Ben M'hidi University, Oum El Bouaghi*
*saadali.badreddine@univ-oeb.dz*
[(2)] *Earth Science and the Universe department, Kasdi Merbah University, Ouargla*
*rabeh21@yahoo.fr*
[(3)] *Hydrocarbons production department, Kasdi Merbah University, Ouargla*
*remita_raouf@yahoo.fr*
[(4)] *Geology department, Badji Mokhtar University, Annaba*
*nabilbough@gmail.com*

***Abstract*—** The construction of Mexa dam allowed to store the quantities of runoff water inside the Mafragh watershed extended over 2500 km$^2$. The dam is destined to supply drinking water and it is used by the riparian population for irrigation of agricultural land. The waters, that feed the dam, flow from Tunisian territory and constitute a very dense and ramified hydrographic network. The objective of this work is to study the evolution of some physicochemical and organic parameters analyzed during the years 2012 and 2013 to identify the hydrochemical facies and the pollution degree of dam's water using the Stiff and Organic Pollution Index (O.P.I) respectively and the suitability for agricultural utilization using Riverside classification. The results obtained show that the dominant hydrochemical facies is a calcium bicarbonate while the concentrations of major chemical elements are below W.H.O standards. The degree of pollution, according to O.P.I, is low to moderate for the dam waters. The results also showed that water, relative to the Richards classification, are positioned in the box C2/S1 and are considered as good for agricultural use.

*Key-Words— Mexa - pollution degree - Stiff - Richards classification - dam's water*

## I. INTRODUCTION

Water is a must for the existence of human being [2]-[11]-[3] and no other natural resource has much empowering impact on human lives and nature as water [10]-[12]. As a surface resource, river water has been the foundations upon which many civilizations are built. It is responsible for supporting and maintaining various forms of life [4], playing a vital role in both human health and environment safety [5]. The idea of building dams on rivers allows man to mitigate the problem of water supply, provide electricity and control floods. The local circumstances which affect man's requirements for water are determined by climate and the geology of the ground since it is these which result in the frequency and intensity of rainfall and the fate of that precipitation after reaching the ground [1]. The study area is located in the north-east of Algeria, about 07 km east of El Tarf city and about 60 km south-east of Annaba city. It corresponds to geographical coordinates 36°45'15" N latitude, and 08°23'34" E longitude "Fig. I". Mexa is an earth- fill dam of 402 m long with a total capacity estimated at 47 Hm$^3$ / year. To study the climate of the area, we processed the climatic data from El Kala meteorological station for a 39 years observation period lasted from 1971 to 2010. The annual rainfall average is 770.1 mm and the annual temperature average is 18.22 °C. We study the climatic specificity of the study area adopting the De_Martonne aridity index. This index represents the report between the annual precipitations and the annual temperature plus 10 [8]. The De_Martonne aridity index calculated value is 27.29. So, the study area is positioned in a temperate climate. From a geological point of view, the water retention is on grounds dominated

Figure. I. Geographical localization of the study area.

by Numidian sandstones and clays and a Neo-Pleistocene silty alluvia. In the vicinity of the dam, one sees the presence of small dispersive rural agglomeration upstream and who cultivated land and exercised grazing. It is for this reason that we wanted to study the waters of the dam and to estimate its good or bad physicochemical and organic quality and thus to visualize its aptitude for using for agricultural purposes.

## II. METHODS

The physicochemical and organic parameters, given by Hydric Resources National Agency (A.N.R.H), allow to perceive and estimate the quality and the pollution levels of waters. The recommended physicochemical parameters [Calcium ($Ca^{2+}$), Magnesium ($Mg^{2+}$), Sodium ($Na^{+}$), Potassium ($K^{+}$), Chlorides ($Cl^{-}$), Bicarbonates ($HCO_3^{-}$), Sulphates ($SO_4^{2-}$)] and the organic parameters [Biological Oxygen Demand ($BOD_5$), Nitrites ($NO_2^{-}$), Ammonium ($NH_4^{+}$) and Phosphate ($PO_4^{3-}$)] were treated.

On the one hand, we studied the hydrochemical facies of waters according to Stiff representation using software called *diagrams* which treated the major chemical elements during january, april, july and october of years 2012 and 2013.

On the other hand, we have adopted the method of the organic pollution index (O.P.I) for the same periods. The classification of the parameters is mentioned according to five classes of colors corresponding to the pollution degrees “Table. I”. This method consist in distributing the pollutants values in five classes and in determining, from these obtained measurements, the corresponding class number for each parameter in order to make an average “Table. II”.

Table. I. Grid of water pollution degrees.

| | No | Low | Moderate | High | Very high |
|---|---|---|---|---|---|
| Organic Pollution degree | 5 – 4.6 | 4.5 - 4 | 3.9 – 3 | 2.9 - 2 | 1.9 - 1 |

Table. II. Interval of O.P.I parameters classes.

| Parameters Classes | BOD5 (mg-O2/l) | NH4+ (mg-N/l) | NO2- (µg-N/l) | PO43- (µg-N/l) |
|---|---|---|---|---|
| 5 | < 2 | < 0,1 | < 5 | < 15 |
| 4 | 2 - 5 | 0.1 - 0.9 | 6 – 10 | 16 - 75 |
| 3 | 5.1 - 10 | 1 - 2.4 | 11 – 50 | 76 - 250 |
| 2 | 10.1 - 15 | 2.5 - 6 | 51 – 150 | 251 - 900 |
| 1 | > 15 | > 6 | > 150 | > 900 |

To determinate the water quality destiny for irrigation of agricultural land, we use Sodium adsorption ratio (S.A.R). Richards [9] recommend a diagram for the classification of irrigation waters and is based on the electrical conductivity and the sodium-adsorption-ratio. To use the diagram, the electrical conductivity and the concentrations of sodium and calcium plus magnesium are required. Sodium-Adsorption-Ratio (S.A.R) can be determined from the following formula [6]:

$$SAR = Na / [(Ca + Mg) / 2]^{0.5} \qquad (1)$$

The ionic concentrations are expressed in milliequivalents per liter. On the basis of EC values, total concentration of soluble salts was classified in irrigation water into four groups and it is shown in Table III.

Table. III. Classification of waters based on S.A.R [7]

| Water class | Electrical Conductivity (µS/cm) | S.A.R |
|---|---|---|
| Excellent | Up to 250 | Up to 10 |
| Good | 250 - 750 | 10 - 18 |
| Fair/Medium | 750 – 2.250 | 18 - 26 |
| Poor/bad | 2.250 – 5.000 | > 26 |

## III. RESULTS AND DISCUSSION

### *A. Hydrochemical facies*

According to the representation of Stiff “Fig. II”, the water samples have the same patterns in relation with the dominance of one of the cations / anions compared to the others (in milliequivalent per liter). All samples indicate a calcium bicarbonate facies for concentrations not exceeding 3 Meq/ l for the Calcium and 2.2 Meq/l for the Bicarbonates.

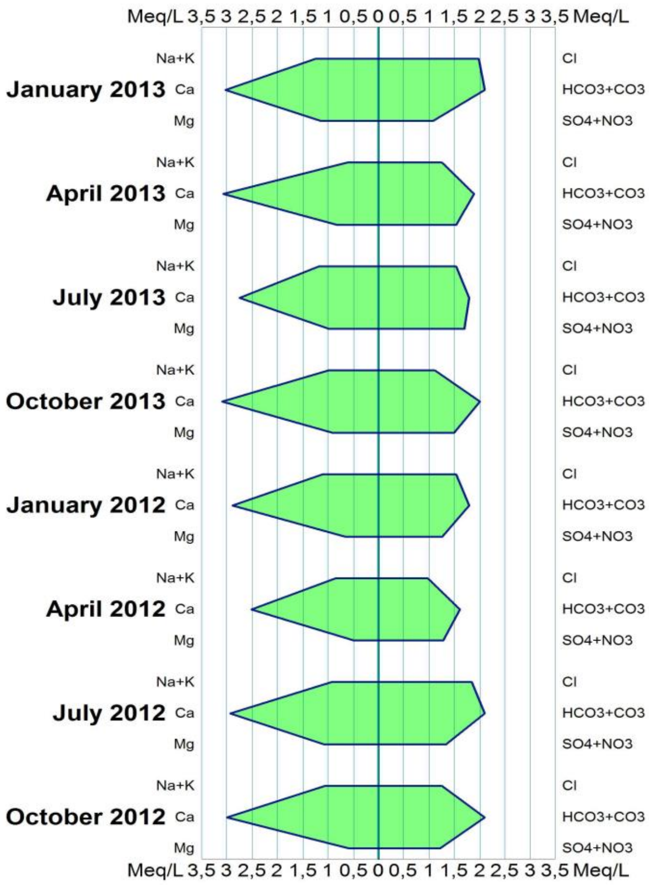


Figure. II Hydrochemical facies according to Stiff diagram.

The presence of carbonate formations formed of limestone (CaCO3) can be at the origin of this hydrochemical facies by the effect of the dissolution and leaching of these outcrop formations.

### *B. Organic pollution index (OPI)*

We calculated the averages for each method “Table. IV” and positioned them compared to the color grid indicated in Table I.

Table. IV. The deduced averages of the O.P.I

| | 2012 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| OPI | October | July | April | January | October | July | April | January |
| | 4 | 4 | 3.75 | 3 | 4.5 | 4.5 | 3.75 | 3.75 |

We see that, for the two mentioned years before, the value is inferior to 4 (but it does not exceed the value 3) in January and April illustrated by the yellow color which indicates that the water presents a moderate pollution degree. But, the value is superior to 4 reaching the value of 4.5 in July and October represented by the green color which indicates that the water presents a low pollution degree. We can say that, in the high water period (January and April), the water brings with it nutrients and organic substances that promote certain physicochemical and biological reactions leading to the degradation of its purity.

### *C. Suitability of waters for irrigation purpose*

Calculated S.A.R values are plotted in the diagram proposed by Richards depending on the conductivity “Fig. III”. The S.A.R values do not exceed 1 and the electrical conductivity values are between 370 and 520 µS/cm. According to Table III, the samples fall into the categories of C2/S1 characterized by a good quality and can be used to irrigate the soils and crops, and present little risk of solidity.

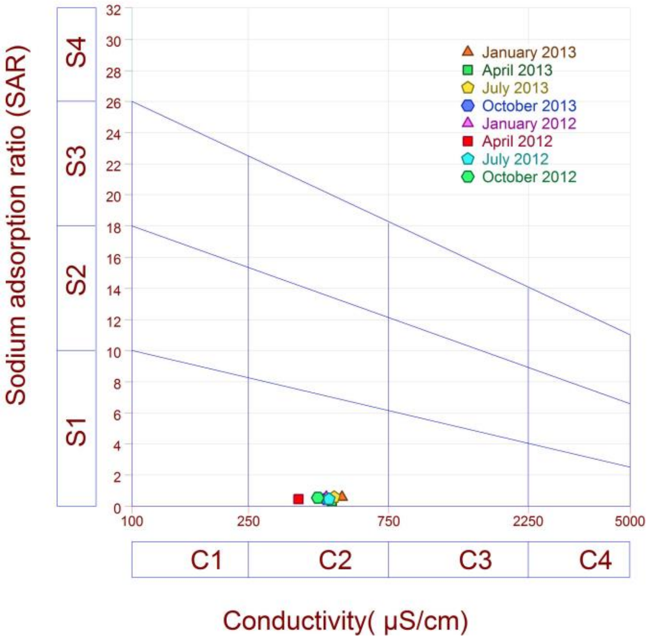


Figure. III. Suitability of water for irrigation according to Richards.

The values increase from the oldest analysis (October 2012) to the most recent analysis (October 2013) this may be due to the increased concentrations of the four parameters (Ca, Mg, Na proportionally to the electrical conductivity).

## IV. CONCLUSIONS

The dam of Mexa can be considered as an important reservoir of surface water for the extent of its hydrographic network. What drives us to study the physicochemical and organic quality of the dam's water is to see people bathe and use the dam water to irrigate agricultural land without treatment and which can cause diseases related to water. We conclude that the waters of the Mexa dam are low mineralized and their concentrations in chemical elements are below W.H.O standards. The dominant hydrochemical facies, according to Stiff's representation, is calcium bicarbonate. The degree of pollution, in determining the organic pollution index, is rather low to moderate. It should be mentioned that phosphate concentrations exceed the required W.H.O standards reaching 0.96 mg / l in January 2013. According to Richards's diagram, the waters are of good quality and can be used to irrigate soils and crops. Finally, to say that the dam water is adequate for daily use requires another essential study which is the bacteriological study.

## ACKNOWLEDGMENT

The authors are sincerely grateful to the functionary of Hydric Resources National Agency (A.N.R.H), for their collaboration, for their help in providing us with the necessary documents for this study. The authors thank principally the organizers of the International Seminar on Hydrogeology and the Environment of Ouargla University for their valuable and constructive suggestions in bringing the extended abstracts to their present shape.

## REFERENCES

[1] Al-Kandari AR. (1992). The importance of water in the ecosystem and marine crisis in the gulf region. GeoJournal., 27, 353–363.

[2] Awais M., Arshad M. Shah S.H.H. and Anwar-ul-Haq M. (2017). Evaluating groundwater quality for irrigated agriculture: spatio-temporal investigations using GIS and geostatistics in Punjab, Pakistan. Arab J Geosci., 10, 510.

[3] Benedini M., Tsakiris G. (2013). Water quality in the context of water resources management. In : Water quality modelling for rivers and streams. Springer, Netherlands., 1–9.

[4] Bhardwaj R., Gupta A. and Garg J.K. (2017). Evaluation of heavy metal contamination using environmetrics and indexing approach for River Yamuna, Delhi stretch, India. Water Sci J., 31, 52–66.

[5] Falah F., Haghizadeh A. (2017). Hydrochemical evaluation of river water quality-a case study: Horroud River. Appl Water Sci., 8, 4725–4733.

[6] Ferchichi H., Farhat B. Ben-Hamouda M.F. and Ben-Mammou A. (2017). Understanding

groundwater chemistry in Mediterranean semi-arid system using multivariate statistics techniques and GIS methods: case of Manouba aquifer (Northeastern Tunisia). Arab J Geosci., 10, 530.

[7] Janardhana Raju N., Shukla U.K. Ram P. (2011). Hydrogeochemistry for the assessment of groundwater quality in Varanasi: a fast-urbanizing center in Uttar Pradesh, India. Environ Monit Assess., 173, 279–300.

[8] Paltineanu Cr., Tanasescu N. Chitu E. and Mihailescu I.F. (2007). Relationships between the De Martonne aridity index and water requirements of some representative crops: A case study from Romania. Int. Agrophysics., 21, 81-93.

[9] Richards L.A. (1954). Diagnosis and improvement of saline and alkali soils, vol 60. US Department of Agricultural Handbook, Washington D.C., 160.

[10] Sultana M.N., Akib S. and Ashraf M.A. (2017). Thermal comfort and runoff water quality performance on green roofs in tropical conditions. Geology, Ecology, and Landscapes., (1) 1, 47–55.

[11] Thapa R., Gupta S. and Kaur H. (2017). Delineation of potential fluoride contamination zones in Birbhum, West Bengal, India, using remote sensing and GIS techniques. Arab J Geosci., 10, 527.

[12] Tiri A., Lahbari N. and Boudoukha A. (2017). Assessment of the quality of water by hierarchical cluster and variance analyses of the Koudiat Medouar Watershed, East Algeria. Appl Water Sci., 8, 4197–4206.