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Case Report

Temporal evaluation of the Beni Haroun dam's (Algeria) raw water quality, through a literature review

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ABSTRACT

Several authors have carried out physic-chemical analyses of the raw water from the Beni Haroun dam since it was exploited, and others continue to do so. The aim of this work is to present a temporal synthesis (2003-2018) of the variation in their quality. It depends on several parameters, such as climate, socio-economic development and population growth around its tributaries. The parameters studied are : Temperature, pH, EC, TDS, and in (mg/l) Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, HCO_3^{-}, NO_3^{-}, NO_2^{-}, NH_4^{+} and PO_4^{3-}, as well as organic parameters such as: COD, BOD_5 , dissolved O_2 and certain heavy metals (µg/l): Pb, Cd, Zn, Fe, Cr, Cu and Mn. The results of this collection of publications show that the quality of the raw water from the Beni Haroun dam varies over time, depending on the season and mainly on the water supply resulting from rainfall, which leads to dilution of the various chemical elements. The air temperature modifies the water temperature, which affects the organic composition. The conclusion shared by all the authors is that raw water must undergo prior treatment before being used for drinking or irrigation.

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INTRODUCTION

In Algeria, the growing need for fresh water is outstripping available resources, as a direct consequence of socio-economic and demographic development. The mobilization of surface water in dams therefore remains one of the possible solutions for managers, depending on the prevailing hydroclimatic conditions [1]. However, these surface waters are vulnerable to various pollutions and are often of poor quality. They may contain significant amounts of natural organic matter such as humic substances but also organic compounds from various pollutant discharges or intensive agricultural practices [2]. The importance of the studies of the quality of the water of the dams, lies in the fact of their use in the food of the populations, the animals and in irrigation [1].

The Beni Haroun dam, located on the Wadi El Kebir watershed (WS), is a very important structure in the region of Mila, and in the entire eastern region of Algeria, by the volume of water it is able to store (about one billion m^3), and also by its location which allows it to ensure the need for Drinking Water Supply (DWS) and Irrigation Water (IW) of six neighboring wilayas [3, 4].

Several studies, in the different frameworks (doctorate, magister, master, and license), were interested in the waters dams physic-chemical quality evaluation in Algeria; others

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took particularly as objective to follow and analyze the raw waters quality and the organic parameters of the Beni Haroun dam ; and some used the remote sensing and GIS methods to map this quality [4]. To achieve their objectives, these works have either collected data from the ANRH (National Agency for Hydrous Resources) or the ANBT (National Agency for dams and Transfer), or carried out the sampling and chemical analyses themselves.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY FRAMEWORK

The Beni Haroun dam is located in the Wilaya of Mila, on the Wadi El Kebir, in the Kebir Rhumel watershed (East-Algeria) (Figure 1), it belongs to the sub-humid domain, with an annual precipitation of about 654.80 mm and an interannual mean temperature of 16.43°C, for the series 2003-2013 [5]. Wadi Rhumel feeds it from the West and Wadi Endja from the East.

The catchment area of Kebir Rhumel, with an area of 6595 km^2.

It is naturally bordered by the Constantinois Ouest and Constantinois Centre catchment areas (WS n° 03) to the north, the Hauts Plateaux du Constantinois catchment area (WS n° 07) to the south, the Soummam catchment area (WS n° 15) to the west and the Seybouse Wadi catchment area (WS n° 14) to the east [3, 4, 6].

The Beni Haroun dam is of the rectilinear weight type, in BCR (Roller compacted concrete), with a length of 710 m at the crest, levelled at the 216.3 m coast, a height of 118 m above the foundation. The lake of the reservoir hugs the captured part of Wadi El Kebir and the two valleys of Wadi Rhumel and Wadi Endja, on a surface of 39.29 Km^2, that is to say nearly 4,000 ha. The rainfall-reservoir balance makes it possible to determine a net destocking by evaporation, equivalent to an average annual tranche of 350mm. The reservoir allows to store 963 Hm^3 of water, that is to say a

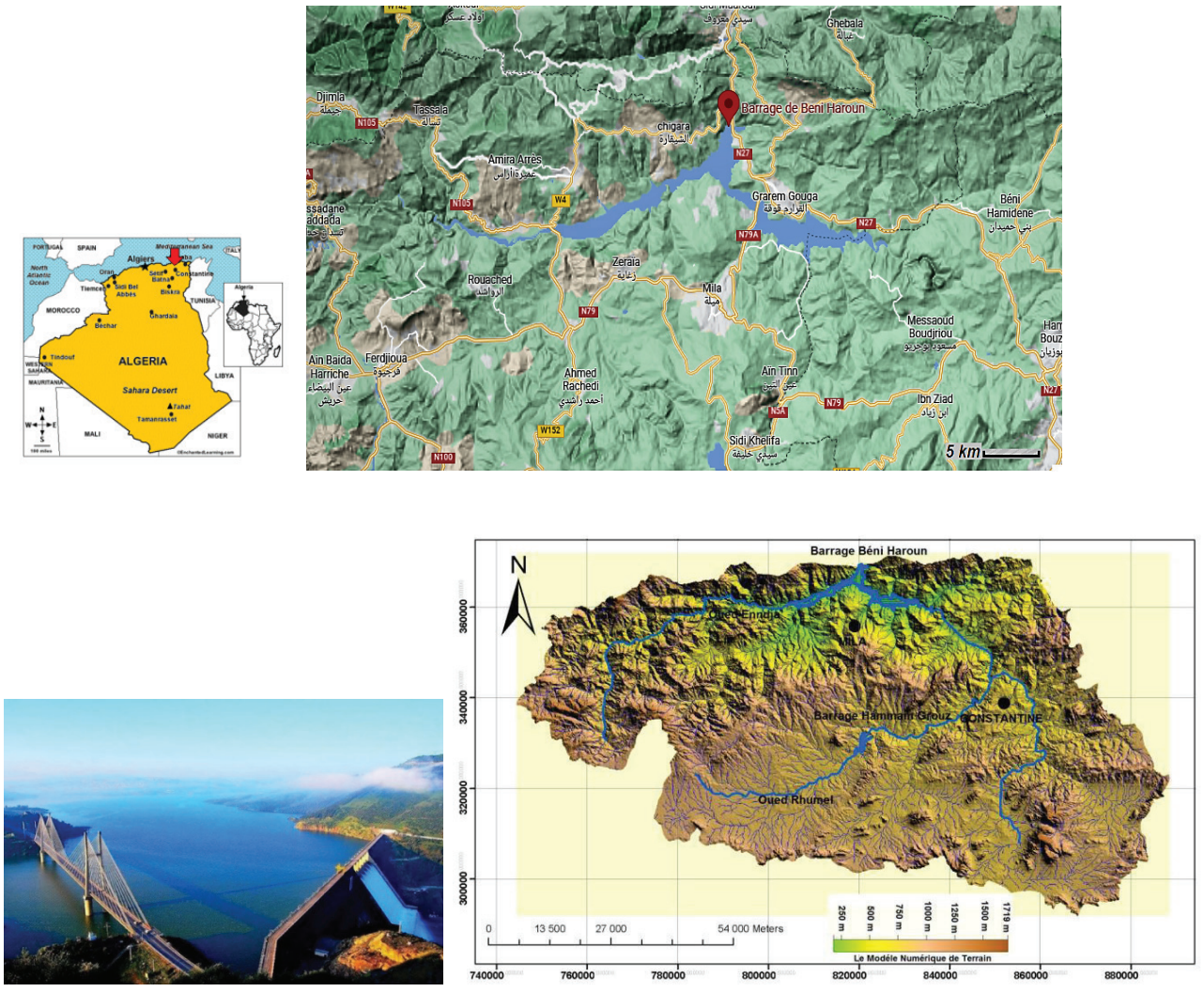

Figure 1. Geographical location (Google map 2023), and view of the Beni Haroun Dam (reservoir).

useful volume of 732 Hm^3, it allows to regulate an annual contribution of 435 Hm^3, with a reserve of 1 billion m^3 of water reached on February 12th, 2012; it is put in exploitation in 2003. It provides a drinking water supply to 4 million inhabitants, spread over six Wilayas, which are: Mila, Jijel, Constantine, Oum El Bouaghi, Batna, Khenchela, and four irrigated areas with a total area of about 40,000 ha. It is manage by the ANBT [1, 3, 4, 6, 7].

METHODS AND DATA USED

To carry out this study of the quality of the raw water of the Beni Haroun dam, through time, we have collected studies of doctorate, master, magister and licenses, which have treated the subject, over a period of 16 years, from 2003 to 2018. Each one has its own objective, there are those who study the evolution of the temporal variation of the quality of the raw water of the dam [8-22]. There are those who make the assessment in order to search for indicators of pollution in the water, in the fauna and flora that form the ecosystems populating the site [6, 23] by the determination of heavy metals and the analysis of sediments of the dam [24-27] and there are those who apply statistical methods [15, 22] or even mapping and GIS methods [4] to show the spatial variability of certain physical elements. There are also studies of the quality of Wadi El Kebir before the realization of the dam of Beni Haroun from 1983 to 2003 (Figure 2) [6, 16].

The physic-chemical elements followed in this work are: Temperature, pH, electrical conductivity (EC), dry residue (DR), suspended matter (SM), Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, HCO_3, SO_4^{2-}, NO_3^-, NO_2^-, NH_4^+ and PO_4^{3-} in (mg/l), as well as organic parameters such as: COD, BOD_5, dissolved O_2 and some heavy metals (µg/l): Pb, Cd, Zn, Fe, Cr, Cu and Mn.

RESULTS AND DISCUSSIONS

The monitoring of dam water quality is very important, in order to protect against anthropic pollution, which can reach the ecosystems present in these waters, that is why the National Agency of Hydraulic Resources (ANRH) has installed a network of control and physico-chemical measurements of waters along all the wadis feeding the dams on the whole Algerian territory; as well as the establishment of a scale of classification going from good to very bad, based on the values of the various physico-chemical parameters present in this water (Table 1). On the Kebir Rhumel watershed, there are four control stations; we have the station 100315 at Hammam Grouz Dam on Wadi El Athmania. The three stations: 100403 at Ain Smara, 100624 at El Menia and station 100601 at Grarem Gouga upstream of the Beni Haroun Dam, are on the Rhumel Wadi.

The ABH (River Basin Agency) and the ANRH (National Water Resources Agency) established in 2009 a classification grid for surface water quality (Table 1) [2, 6], it is based on the values of different chemical elements present in these

Table 1. Water quality grid for dams adopted by the ABH and ANRH in 2009 [2].

	Unit	Class 1 Good	Class 2 Average	Class 3 Mediocre	Class 4 Very bad
pH		6.5 - 8.5	6.5-8.5	8.5-9	>9 and <65
(Dry Residue) DR	mg	300-1000	1000- 1200	1200-1600	>1600
TDS	mg/l	0-30	30-75	75-100	>100
Ca^{2+}	mg/l	40-100	100-200	200-300	>300
Mg^{2+}	mg/l	<30	30-100	100 -150	>150
Na^+	mg/l	10-100	100-200	200-500	>500
Cl^-	mg/l	10- 150	150-300	300-500	>500
SO_4^{2-}	mg/l	50-200	200-300	300-400	>400
Dissolved oxygen (DO)	%	90-100	50-90	30-50	< 30
BOD_5	mg/l O_2	<5	5-10	10-15	>15
COD	mg/l O_2	<20	20 -40	40-50	>50
OM (organic matter)	mg/l	<5	5-10	10-15	>15
PO_4^{3-}	mg/l	≤ 0.01	0.01 -0.1	0.1-3	>3
NH_4^+	mg/l	≤ 0.01	0.01 -0.1	0.1-3	>3
NO_2^-	mg/l	≤ 0.01	0.01 -0.1	0.1-3	>3
NO_3^-	mg/l	≤ 10	10-20	20-40	>40
Fe^{2+}	mg/l	0-0.5	0.5-1	1-2	>2
Mn^{2+}	mg/l	0-0.1	0.1 -0.3	0.3-1	>1

Table 2. Comparison with the descriptive statistics of the raw water of Beni Haroun Dam (2003-2018)

	Mean	Min	Max	Class
pH	7,78	7,27	8,45	**1-2**
TDS	96	25	27,3	**1**
Ca^{2+}	113,69	65,61	195,74	**1-2**
Mg^{2+}	68,99	44,18	145,61	**2-3**
Na^{+}	93,56	30,61	123,41	**1-2**
Cl^{-}	177,63	30,88	334,57	**1-2-3**
SO_4^{2-}	232,86	162,50	347,33	**1-2-3**
BOD_5	6,36	3,00	9,70	**1-2**
COD	64,34	44,50	97,65	**3**
PO_4^{3-}	1,04	0,05	2,64	**2-3**
NH_4^{+}	1,69	0,13	4,72	**3-4**
NO_2^{-}	1,38	0,17	2,64	**3**
NO_3^{-}	11,35	0,55	24,37	**1-2-3**
Mn^{2+}	0,17	0,14	0,22	**2**

waters. We compared the results of statistics (Min, Max and Average) of raw water of Beni Haroun dam, for the period of 2003-2018, with those of the grid. We notice that they present a good to average quality for the following elements: pH, TDS, Ca^{2+}, Mn and Na^{+}, mediocre for Cl^{-}, SO_4^{2-}, PO_4^{3-}, NO_3^{-} and NO_2^{-}, poor for NO_2^{-}, COD and very poor for NH_4, which exceeds 3 mg/l . In general, it can be considered to be of average quality.

The establishment of graphs, on a logarithmic scale, of raw water from the site of the Beni Haroun dam on Wadi El Kebir, before its construction, over the period 1984 - 2002 (Figure 2.a and Table 3), where we have collected the descriptive statistics (Min, Max and Avrg), allows us to note that these waters have a poor quality to very poor, while on Figure 2.b, all the elements show some stability through time, except for a few particularities:

- NH_4^{-}, shows a decreasing peak from 1986 (2.25 mg/l) to 1987 (0.1 mg/l), followed by an increase in 1988 (1.55 mg/l).
- A decrease in TDS, from 1.47 mg/l (1984) to 0.0245 (1990).
- NO_2^{-}, shows a double increasing slope from 0.16 mg/l (1996) to 2.15 mg/l (2000), and from 0.3mg/l (1998) to 1.87 mg/l (2002).
- The rest of the elements have kept a certain temporal stability in their concentrations.

Figure 3 shows the descriptive statistics of the chemical elements of the raw water of Beni Haroun Dam between 2003 and 2018, or we notice that:

- NO_3^{-}, NO_2^{-}, NH_4^{+}, PO_4^{3-}, BOD_5 and O_2 have low values compared to the other elements.
- Cl^{-}, SO_4^{2-} and HCO_3^{-} have high concentration values.
- Ca^{2+}, Mg and Na have relatively average values.

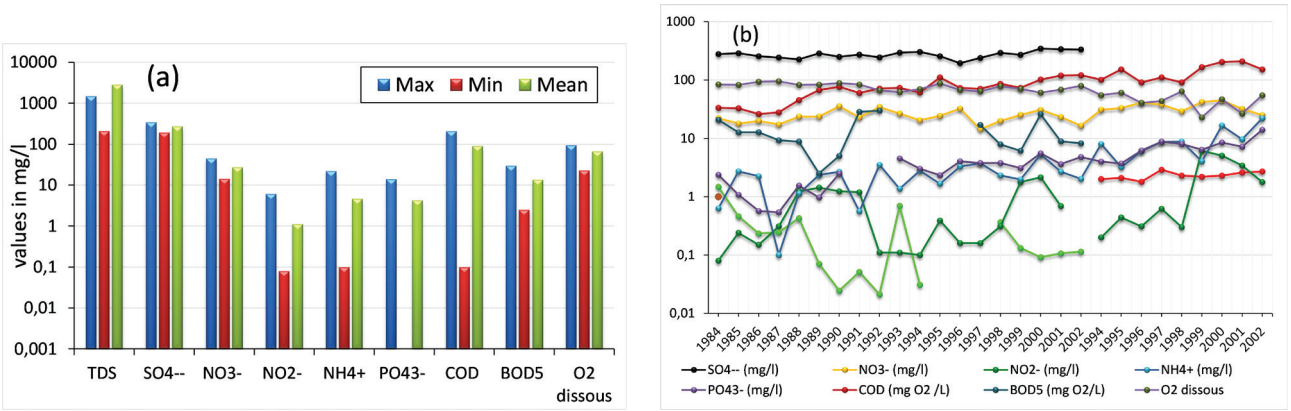

Figure 2. a and b, Water quality of Wadi el Kebir before the construction of the Beni Haroun Dam, before 2003.

Table 3. Descriptive statistics of raw water from Beni Haroun Dam (1984-2002)

	Turbidity NTU	EC (mS/cm)	TDS (mg/l)	SO_4^{2-} (mg/l)	NO_3- (mg/l)	NO_2- (mg/l)	NH_4+ (mg/l)
Max	92,00	2,90	1475	346,10	45,00	6,09	22,00
Min	4,39	1,80	212	194,29	14,33	0,08	0,10
Mean	20,26	2,32	2844	274,44	27,39	1,11	4,64

	PO_4^{3-} (mg/l)	COD (mg O_2 /L)	BOD_5 (mg O_2 /L)	O_2 dissolved (mg O_2 /L)
Max	14,00	209,00	29,83	95,29
Min	0,001	0,10	0,001	22,89
Mean	4,25	91,05	12,75	67,24

- Pb and Fe stand out, with maximum values exceeding 150 mg/l.
- Mn is always low with a maximum of 0.22mg/l.
- Cd, Zn, Cr and Cu, their maximums do not exceed 44 mg/l.

Figure 4a shows the evolution over time, from 2003 to 2018, of the quality of raw water of Beni Haroun dam, heavy metals, or we notice that:

- Almost all the elements have a certain stability of concentration, with the exception of SO_4^{2-} and Cl^-.
- Fe decreases, sharply, between 2003 and 2004, and continues its descent until 2017, then it increases in 2018 (97 µg/l).
- The element Pb increases in 2011 (186.72 µg/l), decreases in 2014 (83.82 µg/l) and returns to a stability around 100 µg/l, from 2015 to 2018.

In **Figure 4b**, we observe the temporal evaluation of major and minor elements, where we notice that:

- Almost all the elements show some stability over time, except for the SO_4^{2-}.
- SO_4^{2-} begins a descent from 2004 (347.33 mg/l) to 2018 (226.26 mg/l).
- In 2013, all elements show a remarkable decrease, except for HCO_3 which increases with a value of about 65 mg/l.
- The element Cl^- increases from 30.88 mg/l (2013) to 334.57mg/l (2016) and declines, relatively, in 2017 (198.50 mg/l).

A ***PCA (Principal Component Analysis)*** is establish for the variables (chemical elements) and the elements (years of realization of the analyses), in order to see the different existing correlations, or we observe:

- The formation of three groups on the two representations in Figure 5 a and b.
- K^+ and HCO_3 form the first group, for the variable and 2013, for the elements, indicating the increase in their concentration in that year.
- Organic nitrogen compounds (pollution indicators) and elements of anthropic origin, which increased in 2003, mainly form the second group.

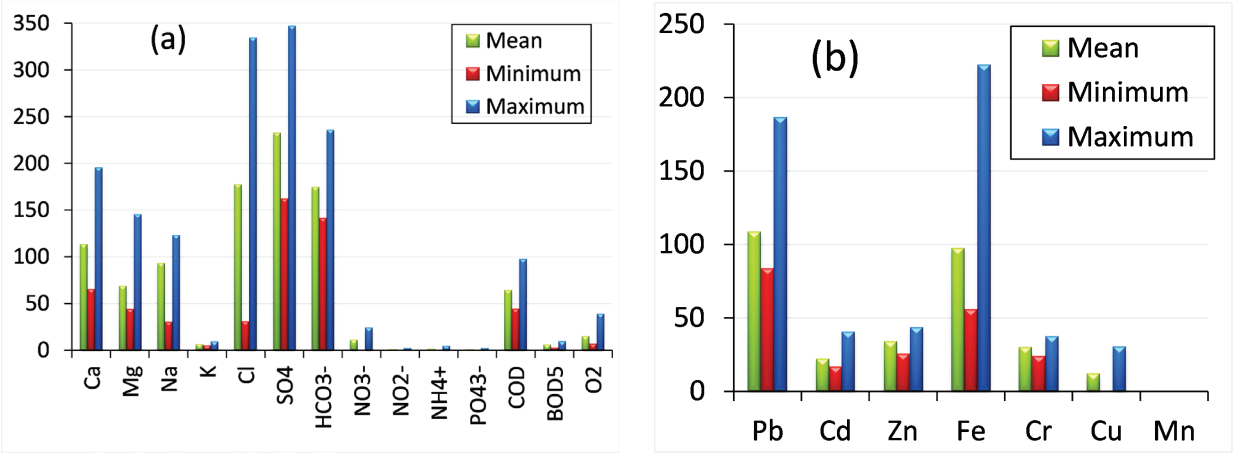

Figure 3. Descriptive statistics of chemical elements in the raw water of Beni Haroun Dam (1984-2002).

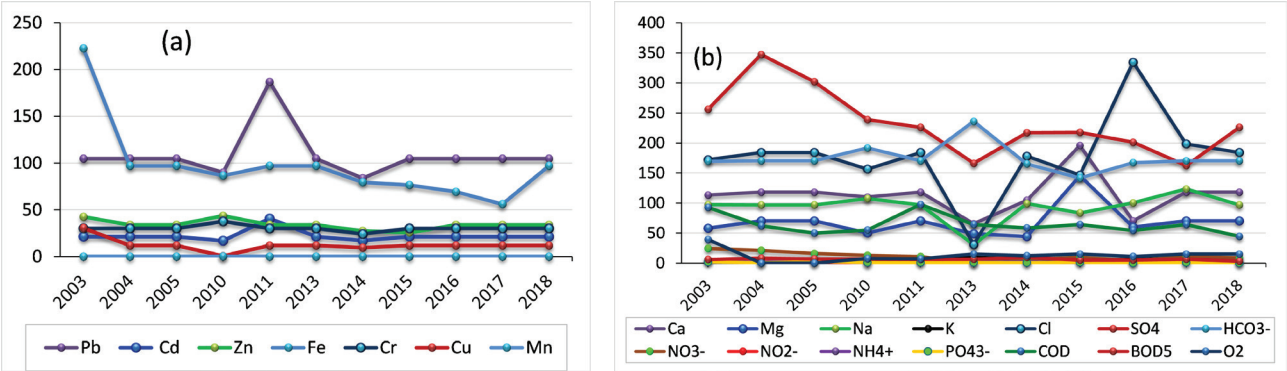

Figure 4. Water quality of Beni Haroun Dam, average, min and max from 2003 to 2018.

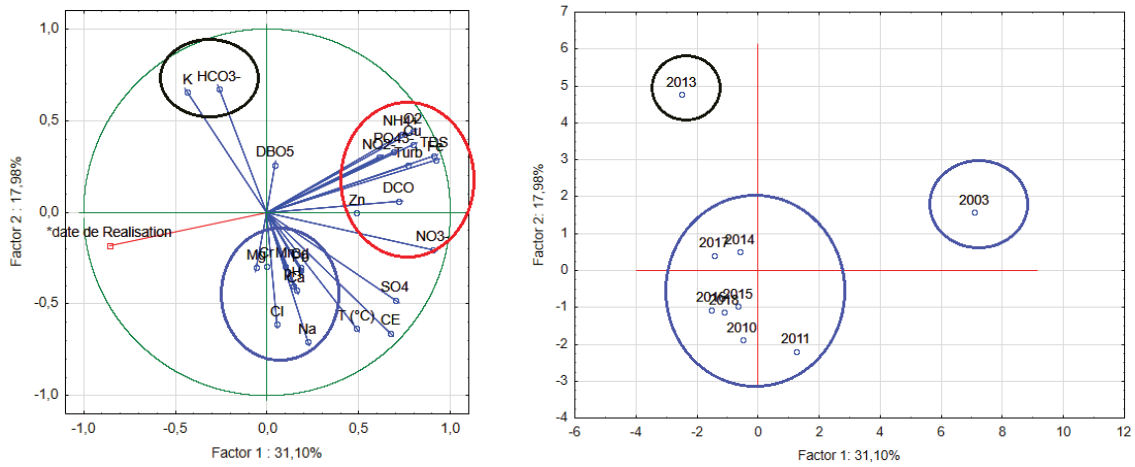

Figure 5. PCA plot (a: variables, b: elements) of raw water from Beni Haroun Dam (2003-2018).

- The third group is composed of elements of geological origin, and which keep their concentrations relatively stable during the rest of the years, represented in the center of the graph of the elements.
- The variable 'date of realization' does not influence the quality nor the quantity of chemical elements.

DISCUSSIONS

For this section, we have collected the main interpretations issued, according to the goals pursued, which are listed and attributed to their authors; we start with the work done before the construction of the dam: Kerdoud (2006) and Maarouf (2012). The others carried out after the impoundment of the dam, in 2003, are present in chronological order of their year of completion.

The analysis and monitoring of the pollution parameters of the Kebir Rhumel basin for a period of twenty years (1984 - 2005), allows us to advance that some analysis parameters are related to the natural structure of water such as pH, conductivity, turbidity, chloride ions, sulfate ions, etc.. In addition, others concerning undesirable substances such as the content of nitrates (NO_3^-), phosphates (PO_4^{3-}), which are the main factors responsible for the proliferation of algae and the acceleration of the eutrophication phenomenon. The pollution indicator parameters such as COD, BOD_5 , dissolved O_2 and saturated O_2, present worrying concentrations especially in the summer season **(realization years of the study: 1984-2005)** [16].

The watercourses that flow into the future site of Beni Haroun are characterize by poor water quality. A generalized contamination of the watershed by organic matter, nitrogenous matter and phosphorus matter is the consequence of a strong urban concentration. The high values of these parameters have a tendency to increase from upstream to downstream as the number of urban groups increases. The waters having undergone treatment, which remains low and leave some values exceeding the standards of discharge required **(realization years of the study: 1994-2003)** [6].

The temporal evolution of the content of the physico-chemical elements according to the volume of water in

the dam shows that the majority of the elements evolve in an inverse way to the volume of the dam; this can be explain by a phenomenon of dilution and concentration.

The pollution elements, notably COD, BOD_5 and the COD/BOD_5 ratio show that the raw water of the dam presents a high proportion of non-degradable organic matter linked to anthropic action. These waters cannot be used for drinking water without prior treatment, and they are generally of good chemical quality (**years of study: 2003-2013, annual monitoring)** [28].

Wadi El Kebir and its tributaries (Wadi Boumerzoug, Smendou, Ktone, Enndja, Kébir, Rafraf, Metlili ...) are subject to very important demographic, industrial and agricultural pressures; this fact obliges us to control the level of a possible contamination of waters and sediments.

The analyzed parameters, revealed cases of disturbances and alterations that were translated by a pH with alkaline tendency (not exceeding 8.5) and a generally high EC, reflecting an excessive mineralization, an increase in the rate of dissolved oxygen, that reflects an advanced process of self-purification, important rates of dry residue and major mineral elements, whose contents of cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) and anions (Cl^-, SO_4^{2-}), show a significant salinity **(realization years of the study: 2010, monthly monitoring)** [26].

The quality of the raw water from the Beni Haroun dam shows that it has a high hardness and mineralization with low levels of phosphates, nitrate and organic matter. Chlorides and hardness, present stable contents in time. The evolution of the different parameters during the study period shows the effects of biological incorporation, evaporation and sedimentation. This quality is good in winter and depends on seasons, it is. While the excessive hardness remains characteristic of the waters of the dam **(realization years of the study: 2010, monthly values)** [10].

The results obtained show that the waters of the dam have a high hardness and mineralization with low levels of phosphates, nitrate and organic matter. Chlorides and hardness, present stable contents in time and space. The quality of the raw water of the dam depends on the season. They are of good quality in winter **(the study years: 2010, monthly monitoring**) [29].

Secondary metabolites of pesticides in sediments, which is certainly due in part to the particular climatic conditions that preceded the sampling stage. These conditions are very favorable to the degradation of pesticides either by the biotic or abiotic mode. The organic load estimated by measuring the BOD_5 and COD shows that the concentrations of COD are high and suggest the presence of organic macro pollution upstream of the dam **(realization years of the study: 2011)** [27].

The water and sediments have a rather degraded quality with a certain homogeneity in their compositions. It is certain that the dam is influenced by discharges from urban sites in the Wilayas of Constantine and Mila **(year of the study: 2011)** [24].

For irrigation, the raw water from the Beni Haroun dam is of good quality and presents no risk to crops. The Cl^-, Na^+ and K^+ ions are mainly of external origin and can come from the saliferous formations of the Triassic or marl and clay formations. Na^+ and K^+ are derive from the alteration of silicate minerals. On the other hand, the element Cl^- can have a meteoric origin, i.e. from the leaching of the lithological formations by the rainfall **(realization years of the study: 2012-2013)** [13].

The results of the physico-chemical analyses from 2005 to 2014 show that a large percentage of the contents related to agricultural, industrial and domestic pollution is notable, which indicates that the raw water of the dam's reservoir cannot be used for human consumption without prior treatment. Synthesis of the physico-chemical parameters. The year 2005 allowed classifying this water between average and bad. While in the year 2014, it was of good to average quality. The surface water is practically not drinkable without prior treatment, due to the presence of various substances of natural or anthropic origin **(years of study: 2005-2014)** [2].

Measurements carried out in situ, show that the raw water of the dam has an alkaline tendency, with an average temperature around 18 °C and electrical conductivity (EC >1000 µS/cm). According to the assessment grid of the general water quality in 2014 is qualified as good quality (class 2) **(realization years of the study: 2014**) [17].

The main objective of the study is to evaluate the level of organic pollution in the raw water of Beni Haroun dam, and to compare their evolution over time during 6 months. A generally high EC, but not exceeding the standards, reflecting an excessive mineralization; an increase in the dissolved oxygen rate that reflects an advanced process of self-purification; nitrogenous matter contents (ammoniums, nitrite and nitrates) reflecting a good quality water probably due to the fact that the wastewater of the important agglomerations are treated in the treatment plants **(realization years of the study: 2013-2014)** [30].

Nutrients, whose content in nitrogen compounds (nitrate, nitrite and ammonium) exceed the standards, so according to the standards of ANRH, the waters of Wadi Rhumel are of poor quality. On the other hand, the water of Wadi Endja is of good quality **(year of the study: 2014)** [31].

Currently, the use of water from the Beni Haroun dam for irrigation purposes is practiced without any evaluation of the quality of this water by the farmers. A periodic control is recommend. The results of samples taken between September and March have shown an alarming increase in concentrations parameters. We also note, an additional contribution of chemical substances by runoff and in the rainy period **(realization years of the study: 2014-2015**) [12].

The quality control of the raw water and sediments of the Beni Haroun dam have allowed the identification of a pollution by PAHs (Polycyclic Aromatic Hydrocarbons)

and pesticides. It was also found that fish are quite significantly contaminated by persistent organic pollutants. The organic load estimated by measuring the BOD_5 and COD, shows that the concentrations of COD are high, which suggest the presence of macro organic pollution by non-biodegradable organic pollutants, and an accumulation of organic matter upstream of the dam **(realization years of the study: 2015)** [23].

It appeared that the quality was globally average, characteristic of a surface water with its variability and the importance of certain physicochemical parameters. The values indicate that the waters studied have a pH close to neutrality, a high mineralization and an acceptable hardness. For the elements considered undesirable or toxic (copper, iron, manganese and bromine) present low levels. Although the mineral and organic pollutions do not seem excessive, it is obvious that the water intended for consumption requires various physicochemical treatments in order to provide a water in conformity with the standards of potability **(realization years of the study: 2014-2015**) [18].

Water temperature variations depend on seasonal variations. The most alkaline values (pH) are attribute to the summer season. This alkalinity favors the productivity of phytoplankton. TSS contents in the raw water of the Beni Haroun dam are very variable both in time and in space; they depend on the nature of the land crossed, the season, the rainfall and the discharges. Apart from the periods of flooding, the TSS content does not present any anomaly. The highest values of Nitrate are attribute to the spring and summer seasons of the two years (2015-2016) with the exception of peaks appearing during the rainy season. The enrichment of water in nitrates during the rainy periods suggests that these ions come from the leaching of soils by runoff, inputs of waste of plant and animal origin rich in nitrogenous organic compounds and inputs of urban origin. The Beni-Haroun dam, give it a normal quality meeting the quality of fresh surface water intended for the production of drinking water. The nitrites also characterize the environments with active eutrophication. These non-negligible values are essentially the consequence of domestic discharges, fecal matter from grazing herds and phosphate fertilizers used in agriculture on the land surrounding the dam. The presence of sulfates is primarily relate to the geological nature of the bedrock and terrain in the area. The highest levels are recorded during the summer season, which may be the consequence of the phenomenon of evaporation that will tend to concentrate the salts **(years of study: 2015-2016**) [14].

The monitoring of the evolution of the physic -chemical quality of the raw water of Beni Haroun Dam, over a period of seven months (from September 2015 until March 2016), sampled monthly have shown that it is characterized by: a temperature below 25 °C which is seasonal, influenced by air temperature. A weakly alkaline pH between 7.4 to 7.9; an average of 1204.29 µs/cm for the electrical conductivity which is quite high, translating an excessive mineralization, important rates of dry residue and TSS revealing an organic pollution marked by strong organic and mineral loads. The evolution of the dissolved oxygen rate reflects an advanced self-purification process and generally well oxygenate waters. A BOD_5, a high COD, ammonium contents, nitrogen contents of nitrates, nitrites translating a water of good quality. Without forgetting a possible continuous arrival of some pollutants in the dam **(realization years of the study: 2015-2016)** [9].

The quality of the raw water of the Beni Haroun dam reveals relatively low concentrations for most chemical elements, except for chlorides, which have quite high levels, which are relate to the strong evaporation in the dam lake. A variation of major elements is observe from one tributary to another, this variation is due to the geological nature of the land crossed by the water, given the geological diversity of the basin. The analyses show that the most important pollutant load (organic) comes from the wadis Mila and Rhumel; this is due to the wastewater discharges of the agglomerations of Mila and Constantine. The study of the characteristic ratios shows a predominance of chlorides compared to sodium, which explains a second origin of chlorides, probably anthropic. Calcium comes from the evaporitic formation. A carbonate origin for calcium, and evaporitic for sodium, as well as sulfates. We also note the good quality of the water of the dam during the period of high water, without forgetting the existence of organic pollutants at the level of two tributaries feeding the dam **(realization years of the study: 2016**) [19].

The interpretation of the physic-chemical analyses show that: The pH of the waters is close to neutrality with a slight alkaline character; the conductivity and hardness are higher; the organic load is high in all the waters tested. However, the proportion of humic substances remains appreciable, indicating the natural origin of these organic materials; The Beni Haroun dam is considered to be the most polluted dam among the eleven dams studied, since it is characterized by poor physic-chemical quality both organic and mineral **(realization years of the study: 2017**) [21].

The raw water from the Beni Haroun dam that feeds the plant was of average quality overall, with some parameters having high levels. While some parameters seemed to be largely corrected by the treatment in the plant, other parameters such as organic matter, ammonia or bromides seemed less well influenced by the treatment of water in the plant **(realization years of the study: 2017)** [20].

The quality of the Beni Haroun dam varies between good, average and polluted for most of the measured parameters **(years of the study: 2018)** [11].

Nutrient levels are high in the raw water of the Beni Haroun dam. Nitrites and ammonium evolve in parallel with each other and the volume of water in the dam in the months of December, January and March, and inversely during the other months **(years of the study: 2017-2018**) [22].

CONCLUSIONS

After consulting the various works of evaluation and control of the quality of raw water of Beni Haroun dam, carried out by different authors over different periods (2003-2018). We note that the studies do not take into account all the parameters, and that there are always a few missing elements. We have gathered a set of conclusions, where we can see that each of the authors has issued a conclusion specific to the objective and the period of realization of his study, from which we can extract some deductions that converge in the same direction:

- Water quality is a function of the seasons, and is influence by climatic parameters such as air temperature (which modifies water temperature) and precipitation (water inputs help dilute concentrations).
- Some chemical elements (cations Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}, and anions Cl^{-} , $SO4^{2-}$) are of geological origin.
- Others (Pb, Cd, Zn, Fe, Cr, Cu, Mn) are of anthropogenic origin.
- The raw water from the dam cannot be use directly for consumption and irrigation without undergoing adequate prior treatment.
- The quality of these waters is likely to be degrade by the proliferation of urban sites in the path of the tributaries feeding the dam.
- Organic nitrogen compounds vary with seasonal water inputs.
- Finally, they all formulated the perspective of establishing and maintaining a system of continuous monitoring and periodic control of the water quality of the dam.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY

The data used to support the findings of this study are included within the article.

AUTHOR'S CONTRIBUTIONS

All authors are contributed equally to bring out this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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