# *CONTRIBUTION TO THE CHARACTERIZATION OF GROUNDWATER QUALITY IN THE WATERSHED OF WEST KEBIR (SKIKDA)*

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## ABSTRACT

The strong industrialization, accelerated urban concentration and the modernization of agriculture in the watershed Kebir West have led to a considerable increase in demand for water, therefore a high degree of pollution
This river has been the subject of several previous studies, because of the importance of its watershed, whose this study aimed to determine the overall water quality of the river and its main tributaries, and assess the spatial and temporal variability in dry and wet weather of the various parameters. It appears from this study that the surface waters of the Kebir West watershed are highly mineralized particularly those in the downstream part of the basin, affected by a high degree of pollution by organic matter (NO3, PO4, NH4 ...), these concentrations have promoted advanced eutrophication.

**Keywords:** West Kebir, watershed, mineralization, resources, alteration.

## 1. INTRODUCTION

the Centre Constantinois Coastal (Skikda) have several major rivers and have a quite dense network of more than 4200 km, which in some perennial flow, flowing from different mountain ranges and open into the Mediterranean. These rivers and associated watersheds (Kebir West Safsaf and Guebli) occupy an important place in the ecosystem of the region. In addition to their essential role in irrigated agriculture, these rivers determine the richness and diversity of the flora and fauna of the region. The chemical quality of water in the area is known by the nitrate and chloride concentrations. ANRH [1]. Currently, water quality is subject to heavy pollution exerted by population growth and industrial activity and uncontrolled discharges of urban and industrial wastewater, the quality is impaired including excessive use of agrochemicals.

## 2. METHODOLOGY OF WORK

The Kebir West Part of the Central Constantinois Coastal ABH [2] is one of the three watersheds located in Skikda North East, between the watershed Safsaf in the West and that of Seybouse in the East with 80% of the area (administrative divisions) are part of the so-called wilaya and the remaining 20% are connected to the wilaya of Annaba in the West and Guelma in the South, the watershed of the river Safsaf is its eastern limit (Figure: 1a).
The studied basin is in the eastern part of the Tell Atlas, line meeting igneous and metamorphic formations of the Precambrian. The upper part is limited to the south by the mountains of Constantine or dominant formations are Jurassic limestone and marl and Cretaceous limestone and marl and Eocene calcareous marl. We find the same formations in the northwestern part of the mixed with igneous and metamorphic rocks basin. The coastal area is part of the metamorphic massif Edough, Marre, A [3] consists of crystalline schist and Numidian sandstone limited to the north by the eruptive Cap Iron chain (Annaba). The plain Kebir (Azzaba) formed by siltation intense coastal depressions characterized by a relatively gentle slope towards the sea and the presence of wetlands in the downstream part. (Figure: 1b).

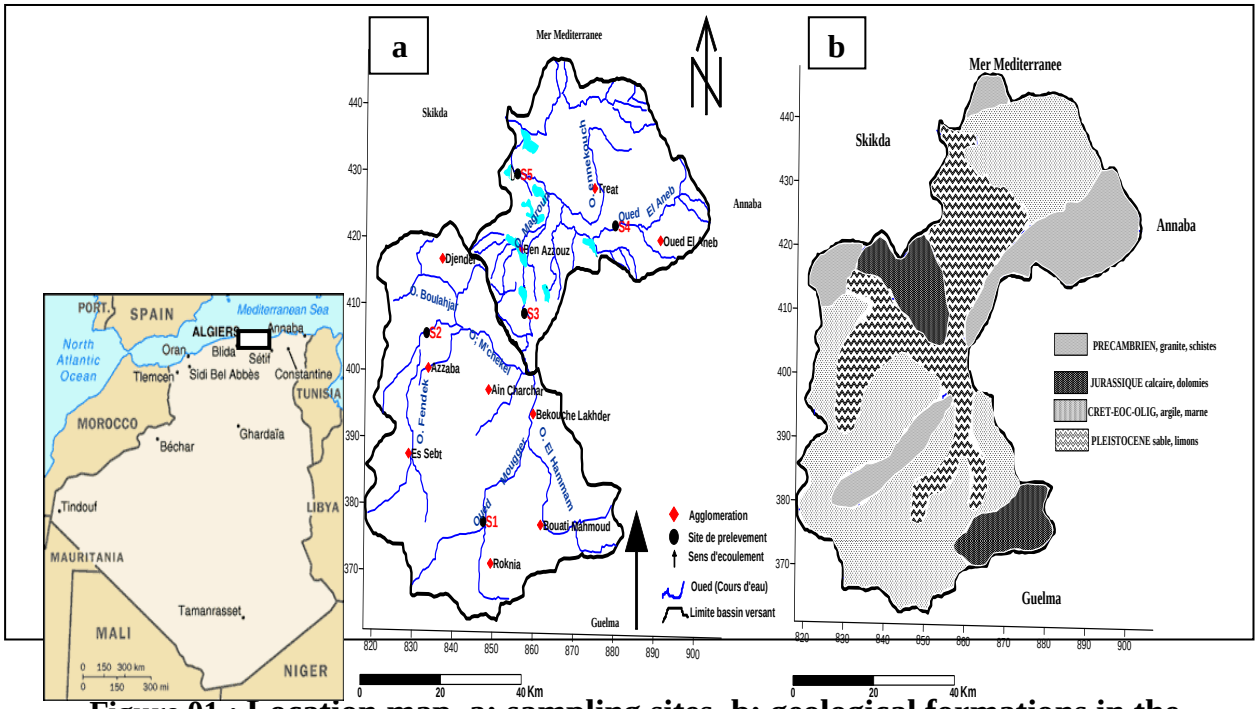


**Figure 01 : Location map, a: sampling sites, b: geological formations in the catchment area of Kebir West river**

### 2.1 Hydrology

The watershed has a total area of nearly 1619 km2, with a humid climate zone influenced by the Mediterranean Sea and the mountains of Edough North and South Mountains Boutellis, large alluvial plains and important ground water, the length of

the main stream (West Kebir) is estimated at 43 km, the estuary is located in the Mediterranean, 20 km east of Skikda, and flow annual average of 282 million m3/year BENRABAH et al, [4]. The watershed has been a water development through the construction of a large dam (Zit Emba) and many small dams that have reduced flows to the sea mobilize a significant volume of water. BENRABAH, S et al,[5]. The main source of the river that maintains its flow throughout the year in the northern slope of Mount Boutellis North Guelma. Several additional tributaries (Mougger, Mchekel, Fendek El Aneb and El Enekouche) enrich the flow of the water main, which together form a dense river network (Figure: 1a).

## 2.2. Climatology

This watershed is among the wettest Northeast Algerian, characterized by heavy rainfall can reach 1200 mm \ year variations in temperature and relatively low average evaporation (50% of average rainfall). TESCO, V [6], these favorable climatic conditions have allowed large volumes of groundwater and the surface accumulation medium. Despite this, these reserves are subject to intense exploitation, to meet the needs of increasingly increased irrigation, industry and domestic use of the population MEBARKI, A, [7]. (Table: 01).

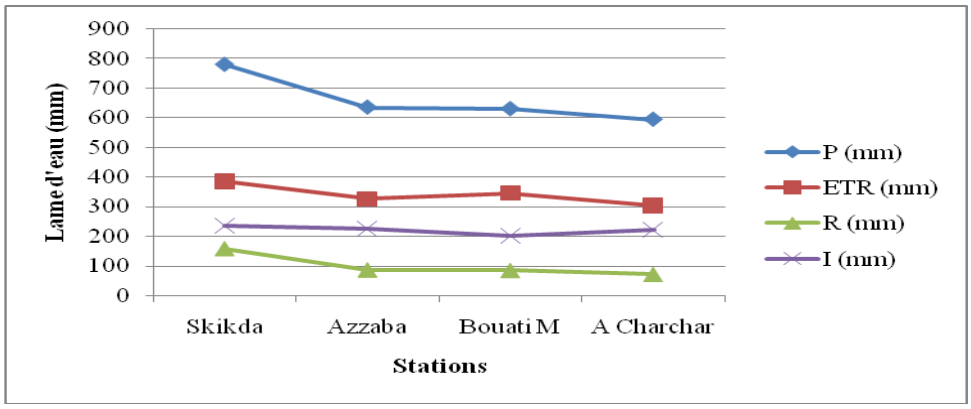


**Figure : 02 Changes in climatic parameters (precipitation, ETR, R, I for the period 1999/2010).**

According to the case study TITI BENRABAH S et al [8], it is estimated that a total annual rainfall of 630 mm intake the water cycle of the entire watershed Kebir West decomposes at a average runoff of 80 mm (12%) An infiltration of 200 mm (33%), evaporation of 300 mm (52%). (Figure 02).

**Table 01 Summary of the elements of water balance calculated for the four rainfall stations covering the field of study**

| Stations | Pr | ETR | ETR(%) | R | R(%) | I | I(%) |
|---|---|---|---|---|---|---|---|
| **Azzaba (Ouest)** | 635,4 | 325,45 | 51,22 | 85,51 | 13,46 | 224,44 | 35,32 |
| **Bouati M (Est)** | 630,17 | 345,20 | 54,78 | 83,41 | 13,24 | 201,56 | 31,98 |
| **A Charchar (aval)** | 594,46 | 302,13 | 50,82 | 70,02 | 11,78 | 222,31 | 37,40 |

This distribution reflects in itself a great imbalance to the detriment of runoff (12%) or there has been a runoff less than the underground infiltration in this region is higher compared to surface runoff, increasing significantly the ability to recharge aquifers, favored by the predominance of permeable ground in the region. Despite the low rate of runoff, construction of hydraulic structures is important for the mobilization of a greater amount of runoff. (Heathcote, I, W, [9].

## 2.3. Hydrogeology

Geological formations studied by VILLA. JM [10] are home to two types of aquifers revealed by the section is made in the alluvial plain of West Kebir, north-south orientation (Fig 03).

Surface-patches: formed from a mixture of sand, gravel and pebbles locates in a semi-permeable waterproof is the most important layer, its thickness varies from 5 m to the north and can go up to 20 meters in the south (Figure 03), its lateral extension is observed on both sides of the river Kebir West exceeding 10 kilometers, the total operating rate in the West Kebir Valley is about 362 l / s or the permeability coefficient is 10-3 m / s and the transmissivity ranging from 3.10-4 to 10-2 m2 / s, the storage coefficient is assessed to 5.10-3.
Low-deep: sand formed whose thickness varies from 10 to 20 meters sloping to the south. The substratum is formed usually by the Pliocene marls of varying thickness, the most permeable zones of the alluvial groundwater are at the mouth of Kebir West river and its tributaries due to the size of the ground with a transmissivity of 2.10-3 m2 / s and storage coefficient up to 3.10-4.

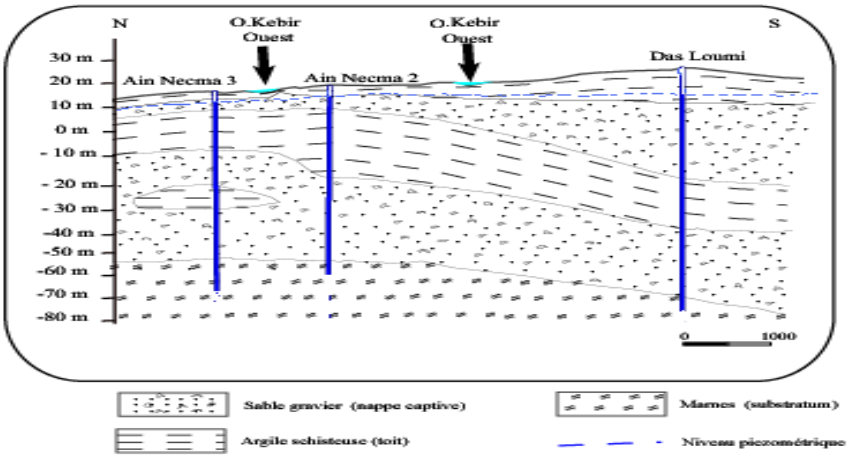


**Figure: 03 Hydrogeological section in the field of study (Skikda)**

# 3. RESULTS AND INTERPRETATION

## 3.1. Quantitative characterization .

The watershed Kebir West has relatively abundant water resources for an annual contribution by the river of 282 million m3, the volume mobilized by the dam and boreholes are respectively 43.4 and 27 million m3, 39 million m3 for a total of 70 , 79 Mm3 which should easily cover the needs of a population of 194,390 inhabitants.
This is oriented resource mobilized for irrigation, with 7.56 million m3 and drinking water with 13.47 million m3 and industries with a little more than 2 million m3. (Table 02). For a volume of 43.4 million m3 for regulation, evaporation and leakage in the networks are valued at nearly 11 million m3 of the 57 holes drilled in the webs of the Oued Kebir West mobilize a volume of 27.39 million m3.

**Table : 02 Various water sources in the catchment of Kebir West river**

| **Les sources d'eau** | **Volume mobilisé ($Mm^3$/an)** | **Volume exploité ($Mm^3$/an)** |
|---|---|---|
| **Forages et puits** | 27.39 | 6.75 |
| Barrage (ZitEmba) | 43.4 | 16,30 |
| Total | 70,79 | 23,05 |

Overall, at the watershed of Kebir West river, half of the water needs for all uses and all water needs are met from groundwater deep groundwater locally exploited.

## 3.2. Qualitative characterization

The analysis of anions and cations in water revealed the existence of two dominant facies magnesium bicarbonate and calcium bicarbonate, which have a direct link with the geological formations traversed (carbonate rocks such as limestone and Cretaceous dolomites). A very high salinity downstream is recognized during the period of this study, and, higher concentrations of nitrate is observed in the center of the study plot is an agricultural plain (plain Azzaba) party during the year 2008/2009 with values that exceed the WHO standard. . (Figure 04).

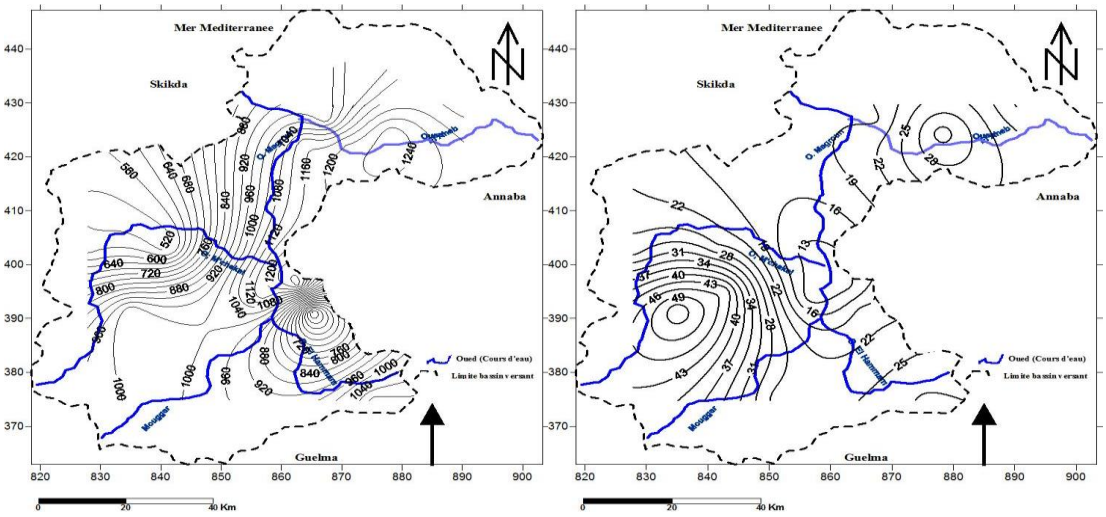


**Figure 04 Map of nitrate concentrations (mg / l) in the field of study**

### Genesis of the mineralization and saturation state of surface waters:

The chemical composition of the water used to evaluate the steady state with reference to the minerals in the rock. The degree of water saturation can be estimated by calculating the saturation index, which becomes zero when the solution is in equilibrium with a solid phase (water and mineral). A positive saturation index indicates a super saturation of the solution (water can precipitate the mineral) and a negative index indicates under saturation with respect to minerals (water can dissolve the mineral).

**Table 03 Saturation index of the water catchment area of Kebir West River**

| | Gypse | Anhydrite | Halite | Calcite | Dolomite | Aragonite |
|---|---|---|---|---|---|---|
| **S1** | 0,79 | 0,55 | -4,13 | 2 | 3,28 | 1,86 |
| **S2** | 0,93 | 0,72 | -4,14 | 1,94 | 3,11 | 1,79 |
| **S3** | 0,87 | 0,66 | -4,58 | 1,74 | 2,78 | 1,6 |
| **S4** | 0,69 | 0,47 | -4,37 | 1,98 | 3,38 | 1,84 |
| **S5** | 0,68 | 0,47 | -4,31 | 1,79 | 2,98 | 1,65 |

Concentrations of various major components, (Ca 2 +, Mg 2 +, Na +, K +) and (HCO3-, Cl-, SO42-, NO3), surface waters of the various tributaries of the Kebir West river shows that waters region are slightly supersaturated with evaporite elements such as anhydrite (CaSO4) and gypsum (CaSO4: 2H2O) with indices respectively saturations ranging from 0.47 to 0.72 and 0.68 0.79. This saturation is almost regular in the waters of the five sampling sites. This water is likely to precipitate the mineral gypsum or anhydrite and actually lower concentrations of Ca and SO4 in water (90 and 200 mg / l respectively).

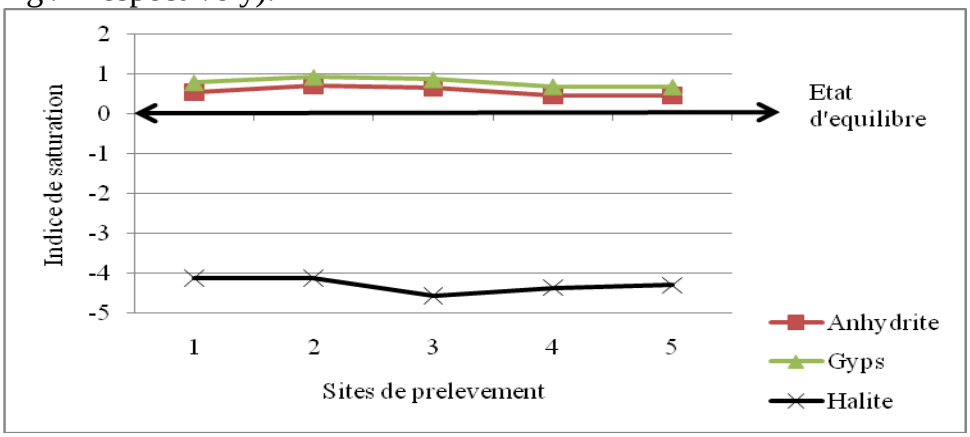


**Figure 05 State of saturation of various evaporite elements in surface water catchment of Kebir West river**

A saturation is apparent in (Figure 05) with respect to the element Halite (NaCl), with negative values of the saturation index ranging from -4.58 to -4.13. Whose most under saturated waters by this element are those of site S3 (Magroun river). In this case, water can dissolve the mineral Halite where higher concentrations of Na and Cl in water with maximum values respectively of 150 and 50 mg / l.

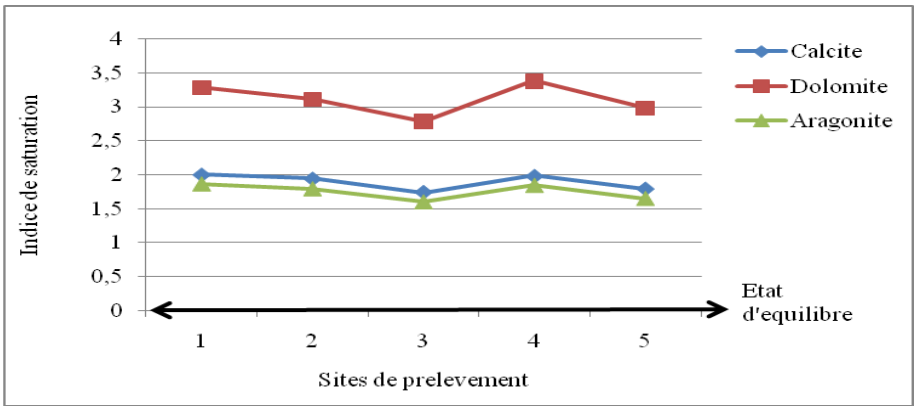


**Figure 06 State of saturation of different carbonate elements in water catchment area of Kebir West River.**

The saturation state of carbonate elements in surface water catchment of Kebir West river is positive indicating super saturation from a saturation index of 1.5 to 2 aragonite (CaCO3) and calcite (CaCO3). The water can precipitate these minerals resulting in lower concentrations of calcium in the water. (Figure 06).

Dolomite (CaMg (CO3) 2 displays a higher super saturation up to a saturation index of 3.5 in the sampling sites S1 (Mougger river south of the watershed) and S4 ( El Aneb river North West watershed.) in these regions, dolomite may be precipitated in this case, the concentrations of calcium and magnesium are falling in water

This approach highlighted genesis of the mineralization and saturation state of surface water catchment of Kebir West river, revealing the important role of nature that caused the high salinity of surface water and underground ones.

## 5. CONCLUSIONS

The recipients are under increasing pressure from anthropogenic activities. Different releases all these areas will contribute to a greater or lesser degree, this pollution, whether it is industrial waste unconnected, runoff, diffuse contamination, spillage networks or stormwater discharges.

In this context, a comprehensive assessment of the origins of the pollution of the river kebir West during periods of dry weather and wet weather could be established in this study. The results showed the presence of a significant difference between the different sampling sites and between periods of rain and dry periods. However, the influence of sampling time seems to play a significant role in the transport and mobilization of pollutants. The origins of pollution vary according to the type of land use. Discharges from urban waste water, industrial and leaching can be considered as the main sources of pollution of the river. In the short term, and in view of the great variability of levels we believe it is essential to make very tight monitoring of streams in order to take into account seasonal variations and variations during floods, because for some metals situations from one year to another can be quite different.

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