Hydrogeochemical of OuedOuerrha and OuedSra, Taounate (Rif, Morocco)

Ahmed El Bakouri[1*], Safae Tabti[2], Ayoub El Atmani[3], Khadija El Kharrim[4], Mohamed Allouza[5], Abdelhak Bouabdli[6], Jamal Chao[7], Driss Belghyti[8*]

[1,2,3,4,8]Laboratory of Environment and Quality, Team: Waters, Wastewaters, IbnTofail University, Faculty of Sciences, P.O. Box: 133, 14 000, Kenitra, Morocco

[7]Laboratory of Geosciences of Natural Resources, Team: Hydroinformatic, IbnTofail University, Faculty of Sciences, P.O. Box: 133, 14 000, Kenitra, Morocco

[6]Laboratory of Geosciences and Environment, Team: Management and rehabilitation of Ecosystems, IbnTofail University, Faculty of Sciences, P.O. Box: 133, 14 000, Kenitra, Morocco

[5]Department of Geology, IbnTofail University, Faculty of Sciences, P.O. Box: 133, 14 000, Kenitra, Morocco

*Corresponding Author

***Abstract*—*The superficial waters of Taounate district are particularly affected by the pollution problem that threatens their physicochemical quality. The city of Taounate, because of its growing demography, these superficial watercourses are currently threatened by wastewaters discharges. In order to establish a diagnosis of their state of pollution, water samples were taken at two stations on OuedOuerrha and two others on its tributary OuedSra, to make a comparison between these two watercourses.*

The physicochemical characterization of downstream stations, especially in OuedSra, shows high levels in terms of BOD_5 (180 mg/L), COD (288 mg/L), and MES (152 mg/L), with a pH of 8,00 and a decrease in dissolved oxygen levels (4,8 mg/L) due essentially to urban discharges from the city of Taounate.

Otherwise, the influences of liquid discharges would certainly lead to the degradation of the quality of these waters. This situation may be aggravated by climate change, whose consequences could have adverse effects on the potential of water resources, both in terms of quantity and quality.

Keywords*—*Morocco, OuedOuerrha, OuedSra, Taounate, Wastewater.

I. INTRODUCTION

In Morocco, country with semi-arid climate, water resources are quite low.Several surface water have problems with the degradation of their quality. In the Taounateregion, these waters have a fairly high degree of pollution especially at the downstream stations of these watercourses, essentially due to liquid wastewater discharges.

Lack of awareness among the population about the protection of the environment, the rapid growth of agglomerations, as well as the uncontrolled discharges of margins, in these two watercourses, mainly OuedOuerrha or often dumped in sanitation sewers without any treatment, contain free fatty acids and phenolic compounds in high concentrations ranging from 4 to 15 g/L [1]. All this certainly contributes to an imbalance of the aquatic environment and generates polluting elements, may change their physicochemical characteristics.

In this context, the purpose of our study is to determine the hydro-chemical parameters of OuedOuerrha and its tributary Oued Sra. To determine the causes contributing to the degradation of these two watercourses and then measure their degree of pollution.

II. MATERIAL AND METHOD

2.1. Geographical setting

The studied region is located in the central part of the rifaine chain, in northern Morocco, in the Sebou watershed and specifically in the Ouerrha basin (Fig. 1). It is part of TaunateAïnMediouna sector. This region is between the Senhaja-Rheddou massif in the east and the Tabouda-Tafrannt ridge in the west and covers an area of approximately 438 Km², 35 km long, 13 km wide on average.

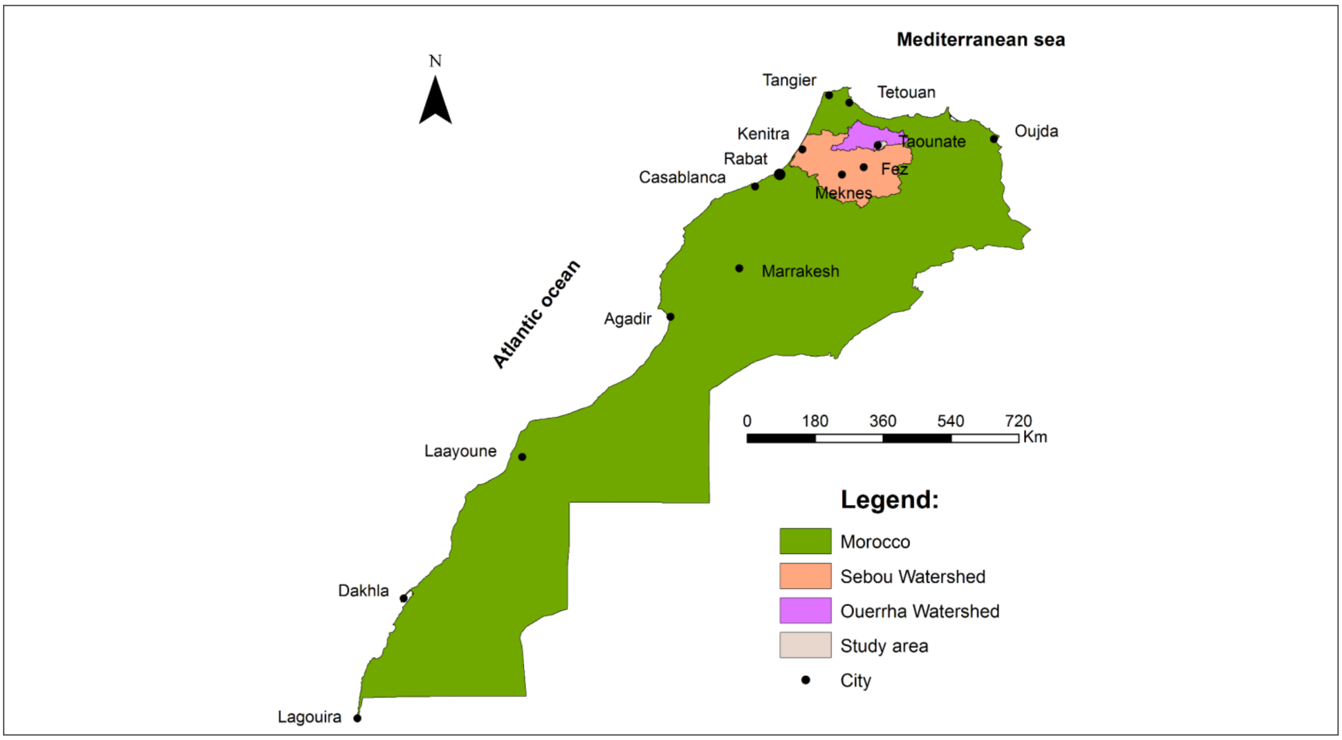


FIG. 1: LOCATION OF THE TAOUNATE STUDY AREA

2.2. Sampling campaigns

Surface water samples were selected from two main streams in the study area (OuedOuerrha and OuedSra).Four stations were prospected, the BeniOulid Bridge, Askar, Khemalcha and Sahel Mrah (Fig. 2 and 3). The various sampling campaigns were carried out during the four seasons of the year, May 2016, August 2016, November 2016 and February 2017.

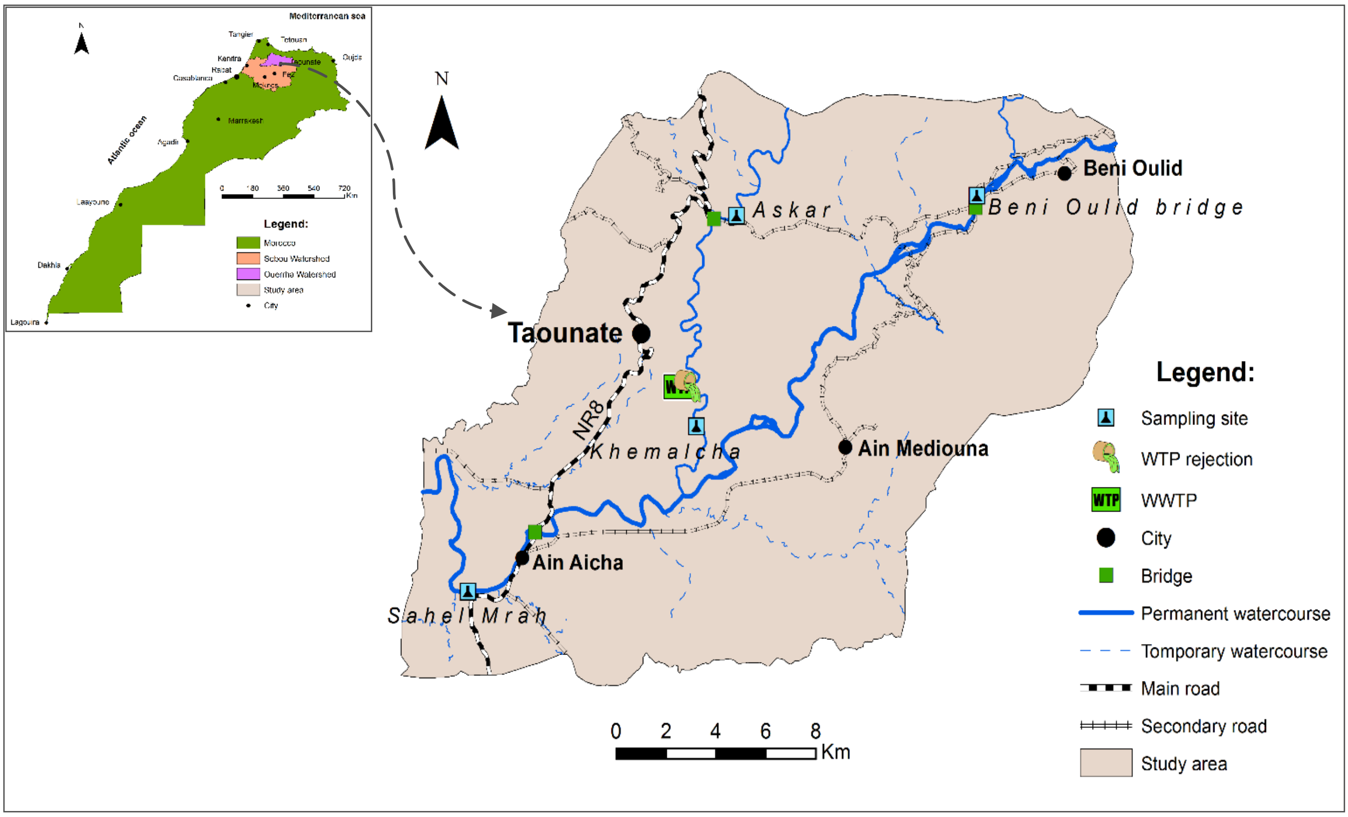


FIG. 2: LOCATION OF SAMPLING SITES.

FIG. 3: SAMPLING SITES, BENIOULID BRIDGE (A), ASKAR (B), KHEMALCHA (C) AND SAHEL MRAH (D)

2.3. Experimental procedure

The physico-chemical study of the waters focused on the determination of fourteen physico-chemical parameters. The temperature was measured "in situ" by an alcohol thermometer; The pH of the analyzed waters is measured using a pH meter Brand ADWA, Model AD1030 with combined electrode; Conductivity by OHAUS Brand Conductivimeter, Starter Model ST3100C-F; the turbidity was determined by a turbidimeter, Brand HACH, Model 2100N; the dosing of the suspended matter is done by filtration on a fiberglass filter; dissolved oxygen is measured by an EutecOximeter; the BOD5 by a BOD-meter Brand OXITOP WTW; COD by a DK6 mineralizer; the Kjeldahl nitrogen content is analyzed by a DK127 distiller; ammonium, nitrates, total phosphorus, orthophosphates and phenol index are carried out by a UV spectrometer, Brand SECOMAM, Model UVILINE 9400.

2.4. Topography

The study areais between the latitudes 34° 25' and 34° 37' North and longitudes 4° 25' and 4° 44' West,between the eastern Rif and the western Rif. The region shows a monotonous relief consisting of a multitude of hills to the south with a very low altitude of 214 m and mountains to the north which can reach 1628 m of altitude (Topographic map 1/50 000).

The lengthening of the reliefs faithfully follows the structural orientation of the Rif which draws an arch whose concavity turned towards the North.

Three sets of structures can be individualized from the analysis of topographic maps (Taounate, Dhar-Souk and Tissa) of 1/50.000:

- The Senhaja massif (Jebel Keil);
- OuedOuerrha Valley;
- The hill system of AinAicha.

Otherwise, we note the difference between the side exposed to the North whose slopes are convex or rectiline and the side exposed to the South have short concave slopes (Fig. 4).

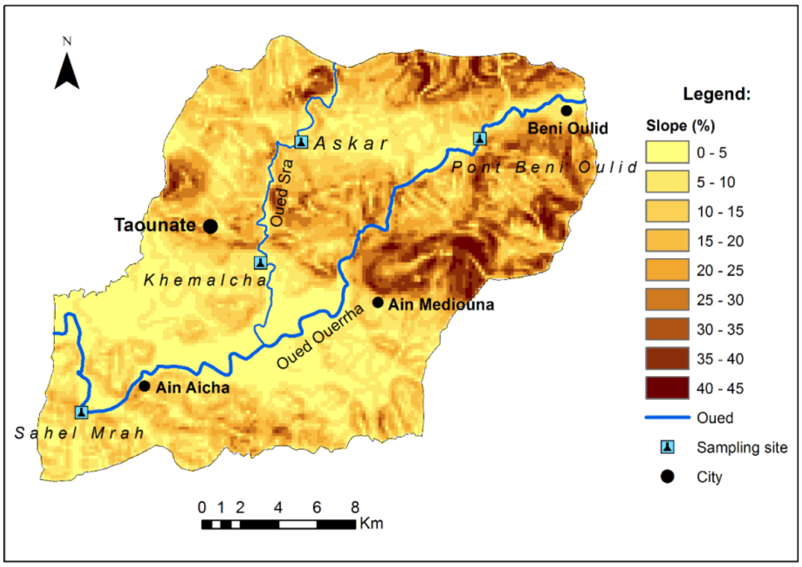


FIG. 4: MAP OF SLOPES AT 1/50.000 OF THE TAOUNATESTUDY AREA.

2.5. Geology

In the Taounate region, the geological formations (Fig. 5) of detail are complex, we have been able to distinguish several geological systems:

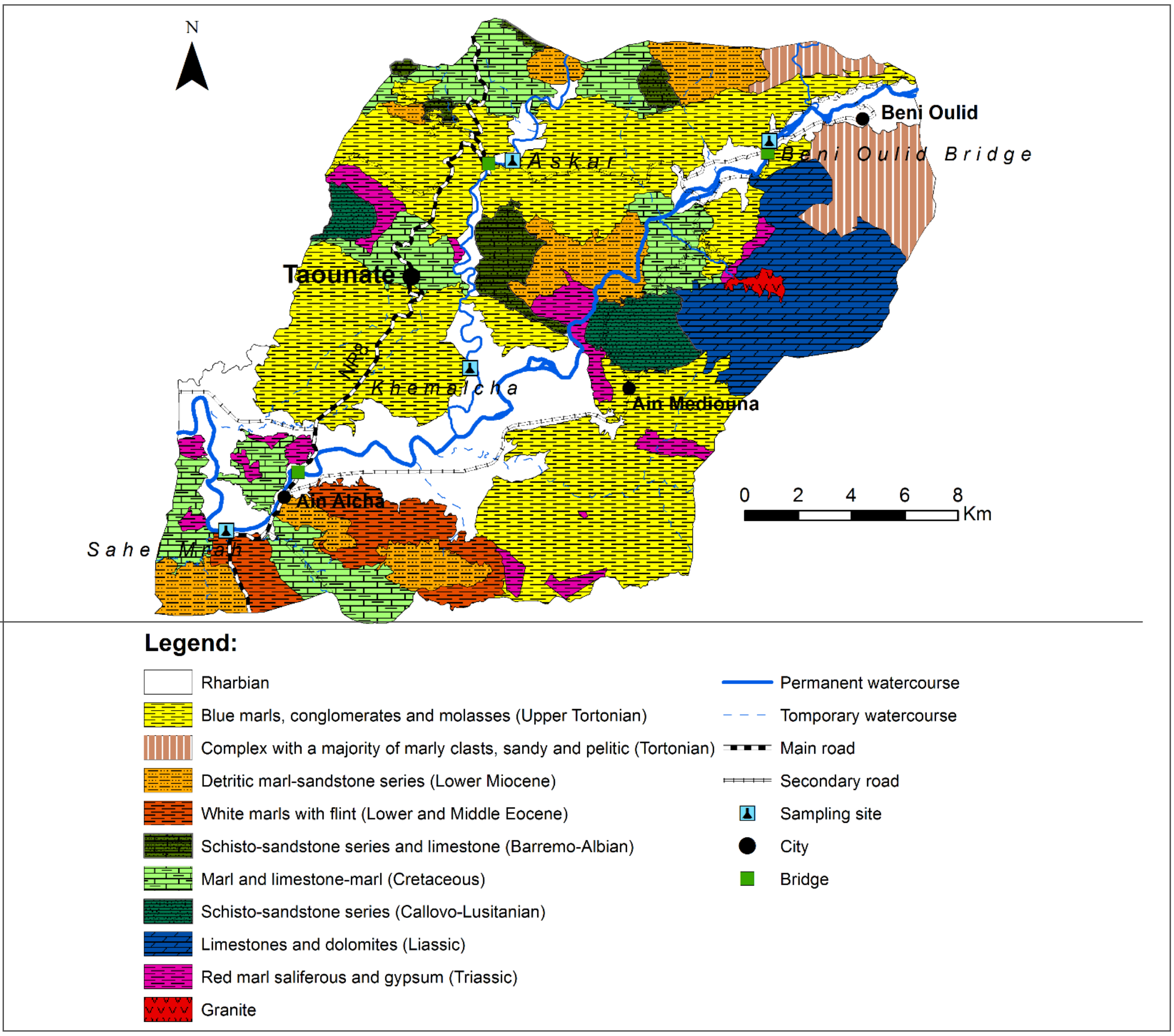


FIG. 5: STRUCTURAL GEOLOGICAL SCHEME AT 1/50.000 OF THE TAOUNATE REGION.

Geological Systems are

- **Trias:** formed essentially by salt red marl and gypsum;
- **Jurassic:** the formations are largely developed in two main facies, dolomitic limestones of the Liassic that form large massifs and a shale-sandstone flysch of Callovo-Oxfordian;
- **Cretaceous:** characterized by marls and marl-limestone, at the Aptian-Albian the detrital terrigenous character of the sedimentation is accentuated and corresponds to the flysch of Albo-Aptian;
- **Eocene:** the lower and middle Eocene are in the form of white flinty marls;
- **Quaternary:** the Quaternary evolution is reflected on the course of the big wadis, by a developed system of seven terraces;

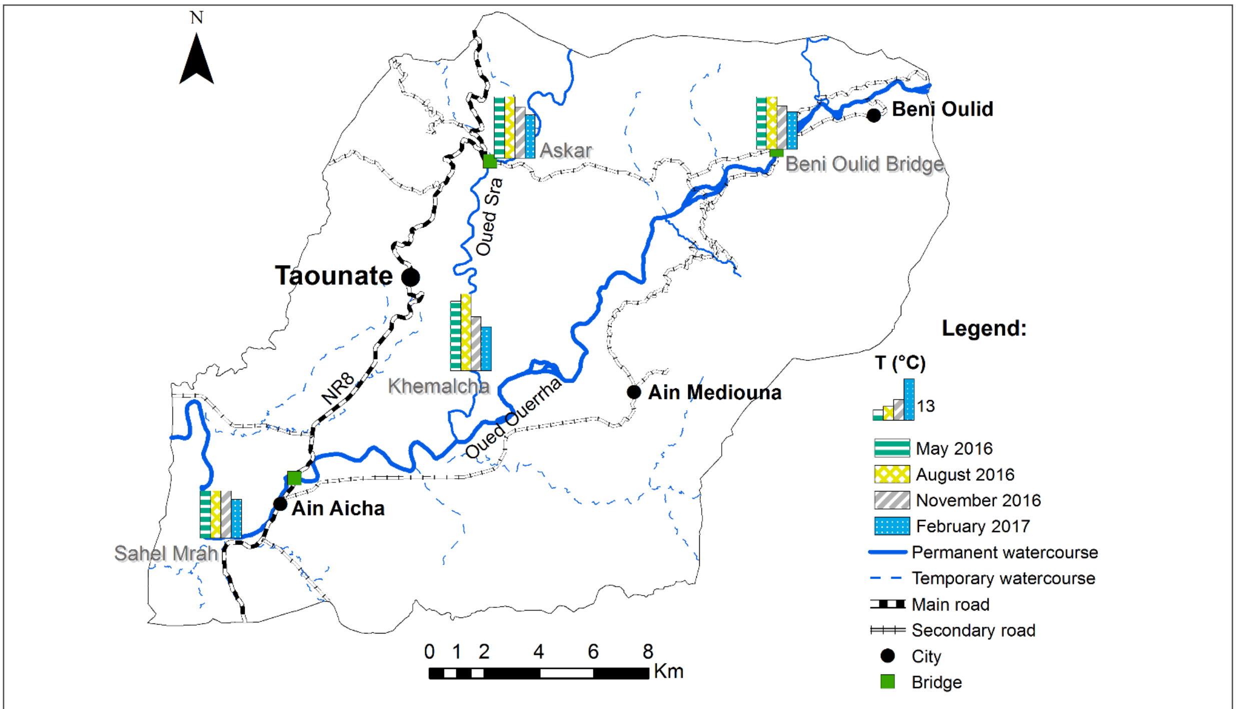
III. Results and Discussion

3.1. Temperature (T)

Plays an important role in the functioning of aquatic ecosystems. Indeed, it influences the solubility of oxygen, as well as other elements. Depends on daily and seasonal variations in ambient temperature and anthropogenic discharges [2].

The temperature of the water is an essential element for the treatment or interpretation of other parameters. Since pH measurement requires knowledge of temperature, as well as the saturation of dissolved gases and temperature function [3].

The seasonal variation of the temperature shows a slight fluctuation, the lowest values are recorded during the February 2017 campaign, with a minimum of 12 ° C, the maximum value is recorded during the summer period (August 2016) of 26.5 ° C (Fig. 6). The general limit value for discharge to surface waters is 30 ° C [4]. This is closely related to air temperature and wastewater discharges, air temperature and wastewater discharges, in each station this increase can lead to the dissolution of the compounds fixing the ETM.



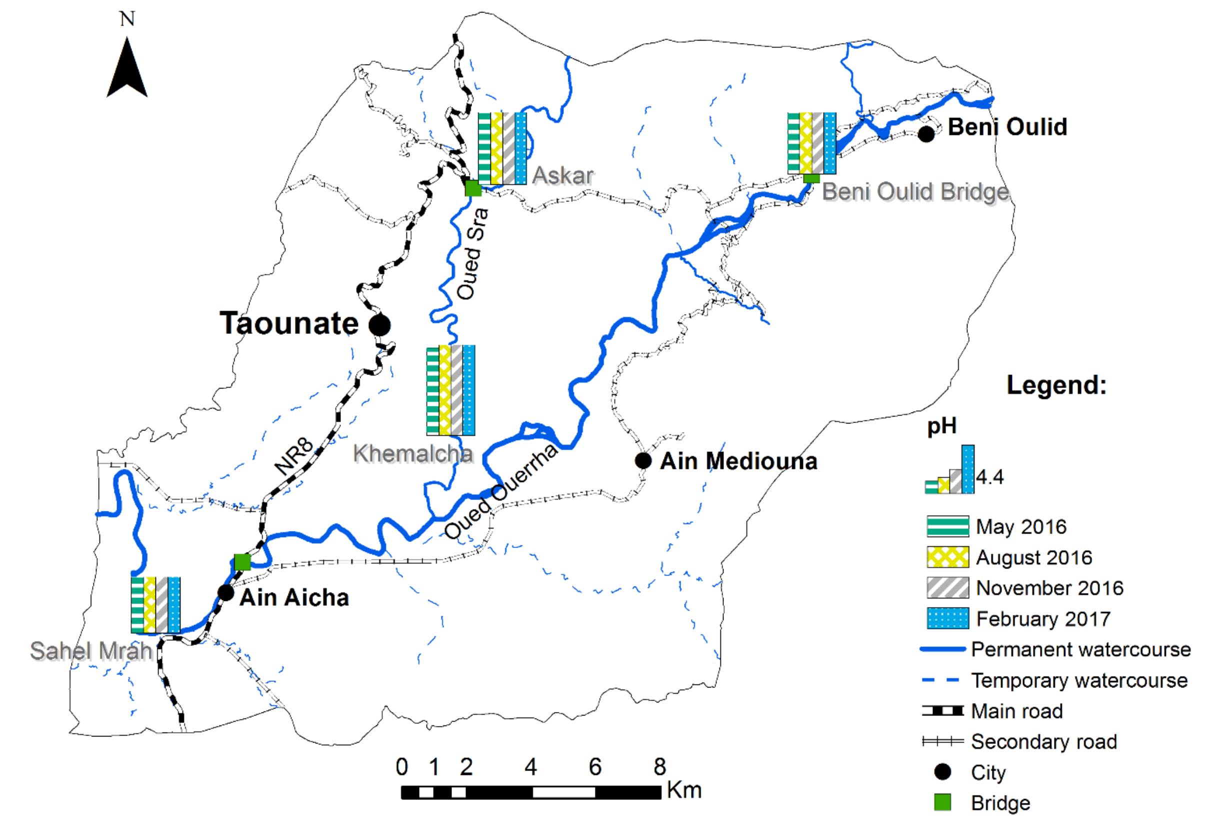
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	°C	21	22	14	12
2	Askar		22	21	16.5	14
3	Khemalcha		22.5	26.5	17.5	14.25
4	Sahel Mrah		18	24	15.5	12.5

FIG. 6: SPATIO-TEMPORAL EVOLUTION OF THE TEMPERATURE (T)OF NATURAL WATERS OF TAOUNATE.

3.2. Hydrogen potential (pH)

The pH of the water can be used to determine the acidity, basicity or alkalinity of water. It measures the concentration of H^+ protons contained in the water. The pH of freshwater in natural environment is between 6 and 8,5. The measurement of the pH, can give information on the different chemical forms of the elements present in the water, the release of heavy metals by the solid matrix, as well as their toxicity [5].

The surface waters of the middle Ouerrha are characterized by a basic pH, since in most stations the pH is close to 8 units (Fig. 7). According to Moroccan standards for water intended for irrigation, the value must be between 6,5 and 8,5 units. According to Zhang (2014) [6] the pH of surface waters varies between 7,7 and 9,4 units. This basic character could be related to the nature of the lands crossed especially during rainy events or wastewater discharges.



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	-	8.29	7.97	7.81	8.14
2	Askar		8.82	8.38	7.27	8.44
3	Khemalcha		8	8.4	8.42	8.62
4	Sahel Mrah		8.16	8.15	8.01	8.28

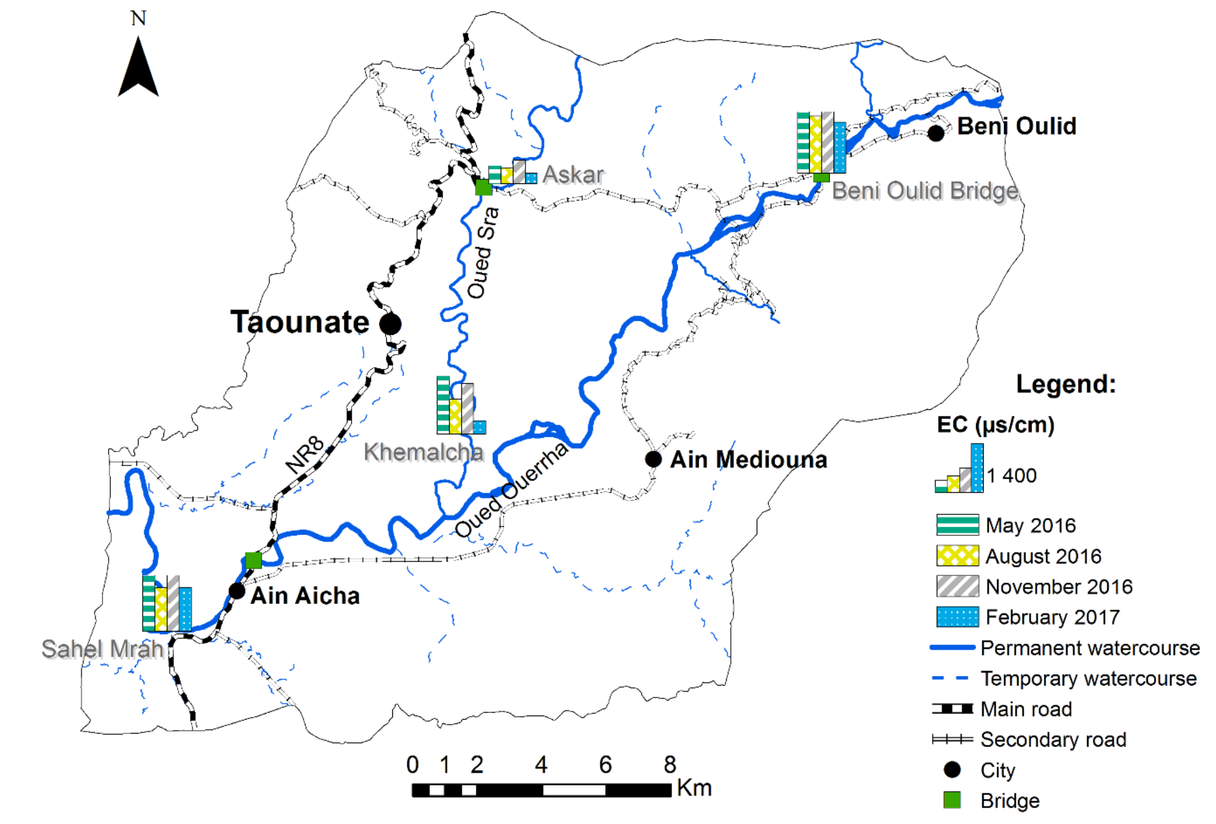
FIG.7: SPATIO-TEMPORAL EVOLUTION OF THE HYDROGEN POTENTIAL (PH) OF NATURAL WATERS OF TAOUNATE.

3.3. Electrical conductivity (CE)

Presents the ability of water to conduct an electric current and depends on the concentration of ions present in solution. The majority of natural waters are characterized by a conductivity between 10 and 1000 µs/cm [7].

The conductivity of a watercourse depends on the drained substrate, the least mineralized waters drain quartzose sandstones and granites, while the most mineralized waters drainevites rich in halite or gypsu, while the most mineralized waters drain evaporites rich in halite or gypsum. The conductivity of surface waters is generally less than 1500 µs/cm [8].

OuedOuerrha is characterized by strong mineralization especially in the upstream part (BeniOulid Bridge Station), the maximum value is recorded in November 2016 (2710 µs/cm) (Fig. 8), this value is greater than that determined by Zhang (2014) [6], of 2340 µs/cm raised in surface water. The increase of the conductivity and subsequently the ionic forces of the waters and by ion exchange, allows the release of adsorbed metals on sedimentary particles [9].



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	µs/cm	1853	1598	2710	1428
2	Askar		496	429	660	296
3	Khemalcha		1628	978	1431	385
4	Sahel Mrah		1751	1219	2390	1217

FIG.8: SPATIO-TEMPORAL EVOLUTION OF ELECTRICAL CONDUCTIVITY (EC)OF NATURAL WATERS OF TAOUNATE.

3.4. Color

It is an organoleptic parameter related to the presence of dissolved or dispersed elements in the colloidal state [10].The color of the water is due to the absorption of certain wavelengths of the normal light radiation of the dissolved substances.To substances that absorb white or ultraviolet light, to fluorescence [11], to the presence of suspended solids and finally to the preferential dispersion of shortwave radiation by small suspended particles [12].

Surface waters are usually white, blue, green or brown depending on the color of the suspended particles that reflect light. In Khemalcha, the color of the water downstream of OuedSrâ is greenish, mainly from wastewater discharges (Table 1). On the other hand, in BeniOulid Bridge and Sahel Mrah stations is sometimes brown, generally due to the opening of the Asfelloudam valves and OuedOuerrha flows during the flood periods. Usually, the color of the water has no change in the quality of the water; it is eliminated by flocculation [13].

TABLE 1
COLORS OF SURFACE WATERS OF TAOUNATE.

Coler / Station	Campagne			
	May 2016	August 2016	November 2016	February 2017
Beni Oulid Bridge	Blue	Brown	White	Brown
Askar	Blue	Blue	White	Blue
Khemalcha	Greenish	Pale green	Pale green	Pale green
Sahel Mrah	Brown	Brown	Blue	Brown

3.5. Turbidity

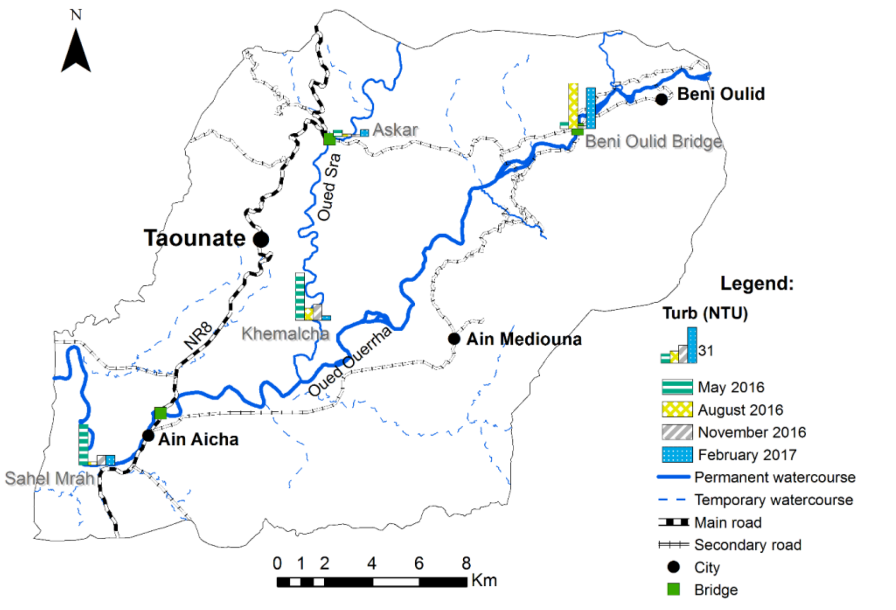
Characterizes the clarity of water or its transparency, by the presence of suspended matter undissolved in water, that comes from the erosion or leaching of agricultural lands that are causing the water trouble.

In stagnant waters (lakes), turbidity is due to colloidal or fine dispersions. However in fast flowing rivers, particles are characterized by a larger size, since most particles are inorganic in the watercourse [14].

The high turbidity value recorded in the BeniOulid Bridge station during the summer period is due to the Asfellou Dam water (61,9 NTU), consequently, the waters downstream of OuedOuerrha become trouble (Table 2 and Fig. 9).As against, those recorded in the Khemacha and Sahel Mrah stations are due to wastewater discharges from the TaounateWWTP.

TABLE 2
THE DIFFERENT TURBIDITY CLASSES IN NTU [15].

Turbidity	Water type
$NTU < 5$	Clear water
$5 < NTU < 30$	Slightly troubled water
$NTU > 50$	Troubled Water



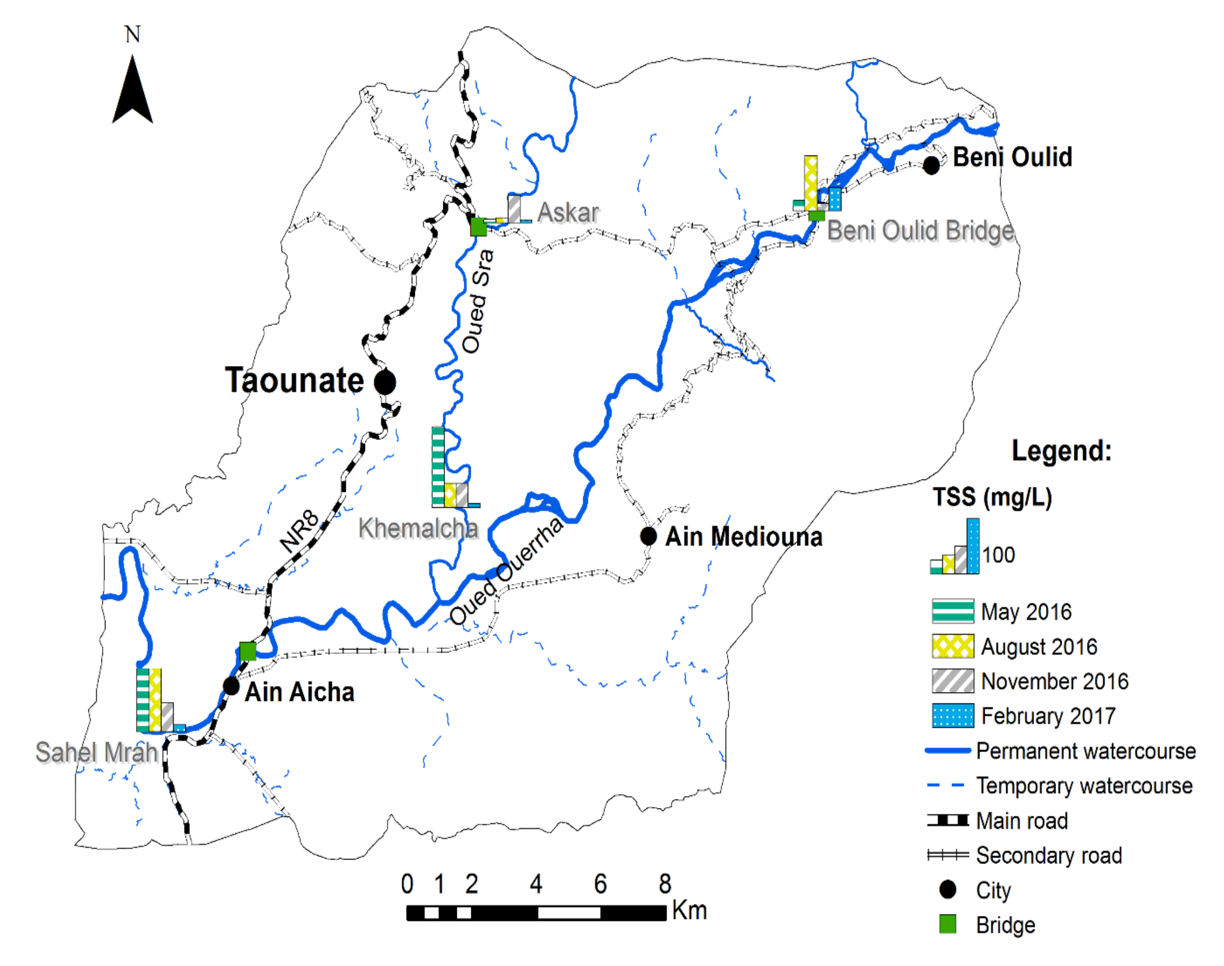
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	NTU	5.4	61.9	2.28	35.7
2	Askar		5.5	1.97	1.54	5.64
3	Khemalcha		41.6	10.6	14.2	4.05
4	Sahel Mrah		40.3	2.8	8.43	8.59

FIG. 9: SPATIO-TEMPORAL EVOLUTION OF TURBIDITY OF NATURAL WATERS OF TAOUNATE.

3.6. Total suspended solids (TSS)

Total suspended solids represents all the mineral and organic particles contained in the water. They move in watercourse with the flow velocity, without contact with the bottom [16].The TSS depends on the nature of the lands crossed, the season, the rainfall, as well as the nature of the discharges. In fact, they are involved in the composition of water by their effects of ion exchange or adsorption, on trace elements and microorganisms [17].

During the four seasons, TSS increases considerably from upstream to downstream. In the Sahel Mrah station the levels vary between 12,5 and 206,8 mg/L (Fig.10). WHO sets a guideline level of 15 mg/L for irrigation [18]. Outside flood periods, the total suspended solids content is usually less than 25 mg/L. The high concentrations recorded in the BeniOulid and Askar stations are mainly due to the water from the Asfellou and Bouhouda dam, come largely from soil erosion. Therefore, climatic factors, mainly heavy rainfall, are the cause of erosion due to increased particle stripping forces and their transport by runoff during floods. Soil erosion is also influenced by the topography (elevation, slope, inclination) of the watershed, its lithology, the nature of the vegetation cover, and anthropogenic activities.



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg/L	19	103.6	13.2	44
2	Askar		6	8.8	52	4.8
3	Khemalcha		152	46.4	46	8
4	Sahel Mrah		122	206.8	54.4	13.2

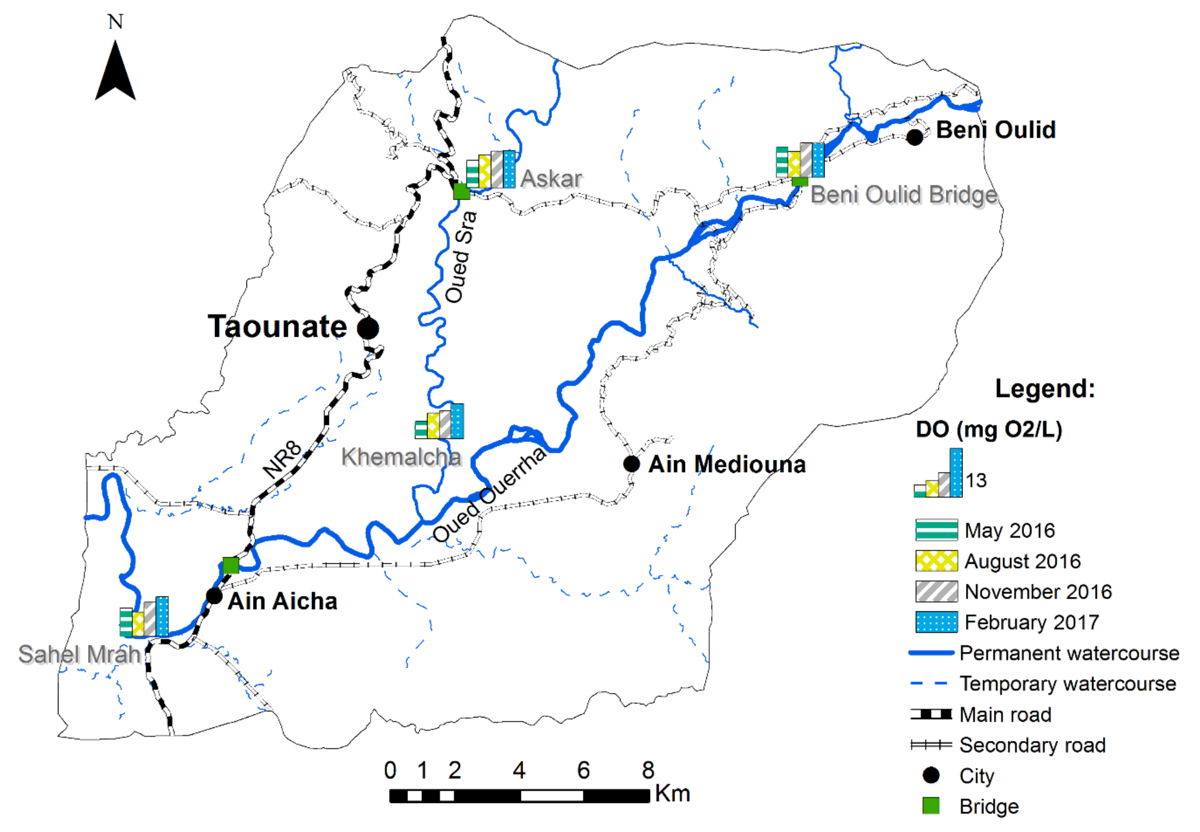
FIG. 10: SPATIO-TEMPORAL EVOLUTION OF TOTAL SUSPENDED SOLIDS (TSS) OF NATURAL WATERS OF TAOUNATE.

3.7. Dissolved oxygen (DO)

Dissolved oxygen is a key element in the control mechanisms of water pollution. It comes mainly from the atmosphere and photosynthetic activity of aquatic plants. The strong oxygenation of rivers can cause acidification of the environment by chemical or microbial oxidation of sulphides, iron or manganese with release of metals and hydrogen ions [19].

The spatio-temporal variation in dissolved oxygen shows some oxygenation during the flood period (February 2017), from 9,3 to 10,8 mg O_2/L in OuedOuerrha, and from 10,2 to 9,6 mg O_2/L in OuedSra (Fig. 11). The minimum value is recorded in the Khemalcha station during the May 2016 campaign (4.8 mg O_2/L).

In addition, the temporal evolution shows a greater oxygenation during the winter period compared to the low water level.The decrease in dissolved oxygen in the Khemalcha station is essentially due to the presence of significant amounts of organic matter resulting from the eutrophication phenomenon, or brought by the domestic discharges.



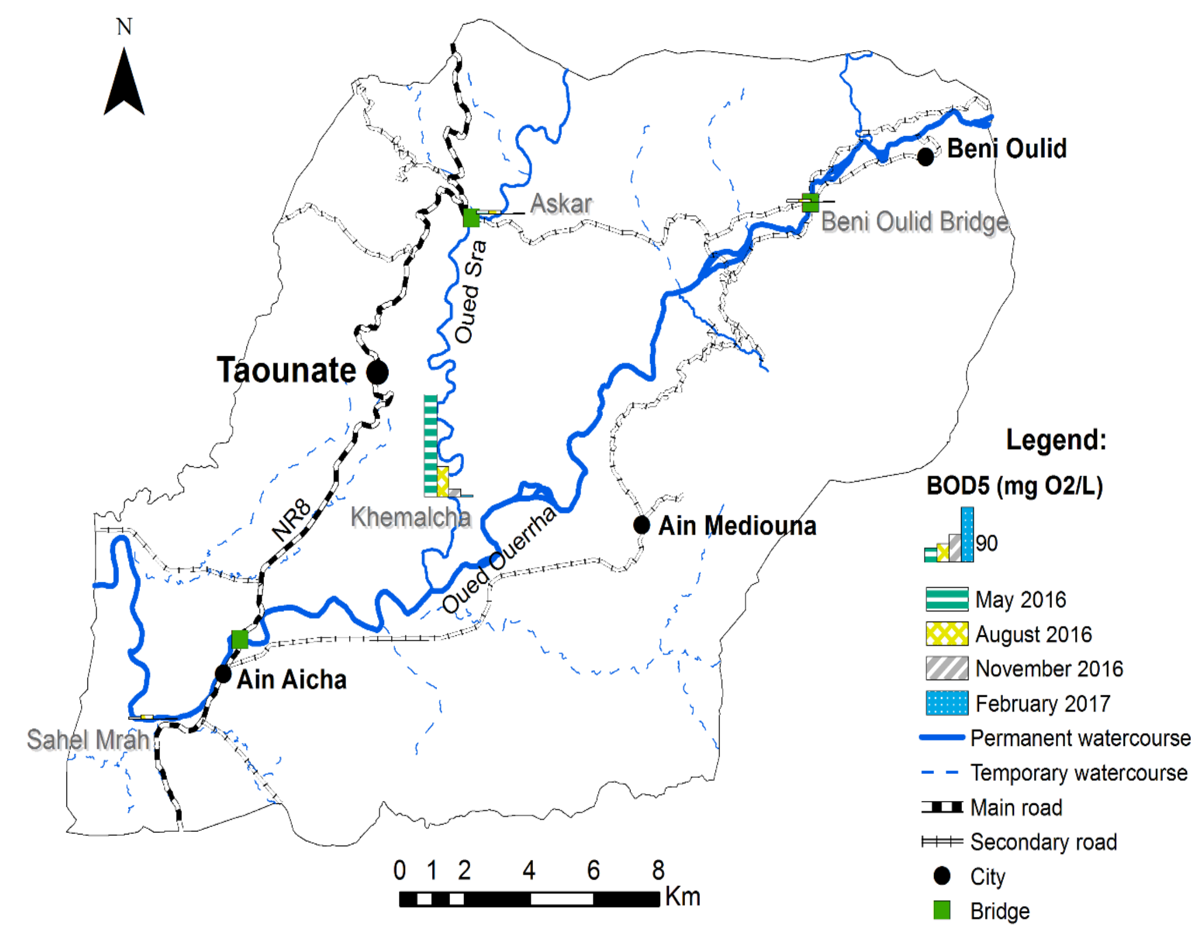
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg O_2/L	8.2	6.97	9.43	9.3
2	Askar		7.5	9.04	9.96	10.2
3	Khemalcha		4.8	7.12	7.68	9.6
4	Sahel Mrah		7.7	6.68	9.3	10.8

FIG. 11: SPATIO-TEMPORAL EVOLUTION OF DISSOLVED OXYGEN (DO) OF NATURAL WATERS OF TAOUNATE.

3.8. Biochemical oxygen demand (BOD_5)

The biochemical oxygen demand represents the amount of oxygen used by the microorganisms to partially decompose or completely oxidize oxidizablebiochemicals materials present in the water for 5 days. In natural waters BOD_5 is less than or equal to 2 mg O_2/L, while in watercourses receiving domestic wastewater discharges have levels greater than 10 mg O_2/L [20].

The highest values are recorded in the Khemalcha station immediately downstream of the WWTP releases. They vary between 2 and 180 mg O_2/L, before decreasing in the Sahel Mrah station (Fig. 12), and this by the dilution effect of OuedOuerrha. According to Brion (2015), BOD_5 levels range from 1,7 to 4,8 mg O_2/L in surface water [21].



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg O_2/L	4	4	0	1
2	Askar		5	5	0	1
3	Khemalcha		180	50	13	2
4	Sahel Mrah		4	7	0	1

FIG. 12: SPATIO-TEMPORAL EVOLUTION OF BIOCHEMICAL OXYGEN DEMAND (BOD_5) OF NATURAL WATERS OF TAOUNATE.

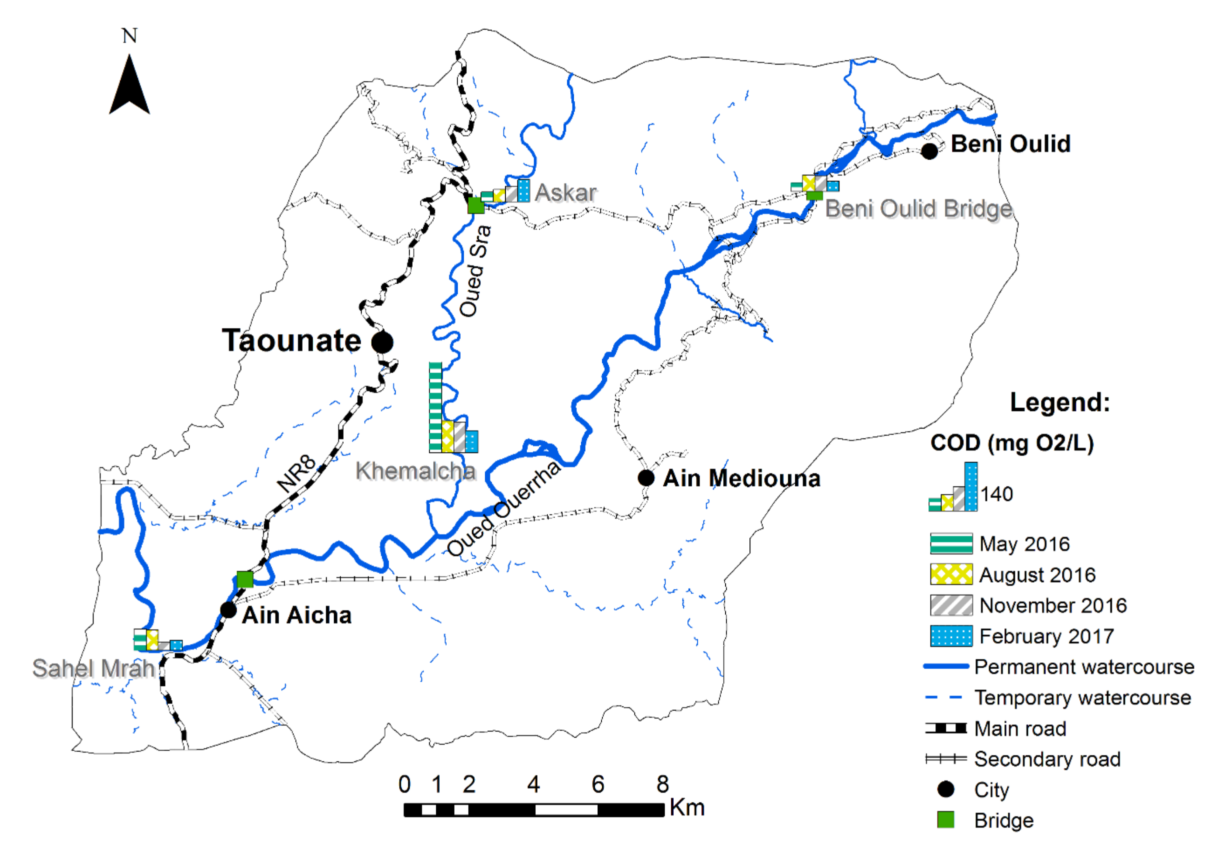
3.9. Chemicaloxygendemand (COD)

Corresponds to the amount of oxygen required for the oxidation of organic matter; plants, animal or mineral contained in the water. Chemical degradation is done by a strong oxidant of the organic compounds present in the water. COD is used to measure the concentrations of total organic matter, except some non-biodegradable compounds. It is considered as a very important parameter for the characterization of a global pollution of a watercourse.

The COD analysis results show a parallel increase with the BOD_5. In surface waters, the values vary between 23 and 288 mg O_2/L (Fig. 13). The works of Brion (2015) show contents that vary between 8,3 and 34 mg P/L [21]. The COD/BOD_5Ratio shows that organic matter is easily or moderately biodegradable during the summer period, but during the winter period it will be difficult or even non-biodegradable (Table 3).

TABLE 3
ABILITY TO BIODEGRADE INDUSTRIAL EFFLUENT [22]

DCO/DBO_5 **Ratio**	**Biodegradation**
$COD/BOD_5 < 3$	Effluent easily biodegradable
$3 < COD/BOD_5 < 5$	Moderatelybiodegradable effluent
$COD/BOD_5 > 5$	Effluent not easily biodegradable or non-biodegradable



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	$mg\ O_2/L$	24	48	46	30
2	Askar		29	36	46	66
3	Khemalcha		288	96	92	66
4	Sahel Mrah		63	60	23	30

FIG. 13: SPATIO-TEMPORAL EVOLUTION OF DEMANDEBIOCHIMIQUE EN OXYGÈNE (BOD_5) OF NATURAL WATERS OF TAOUNATE.

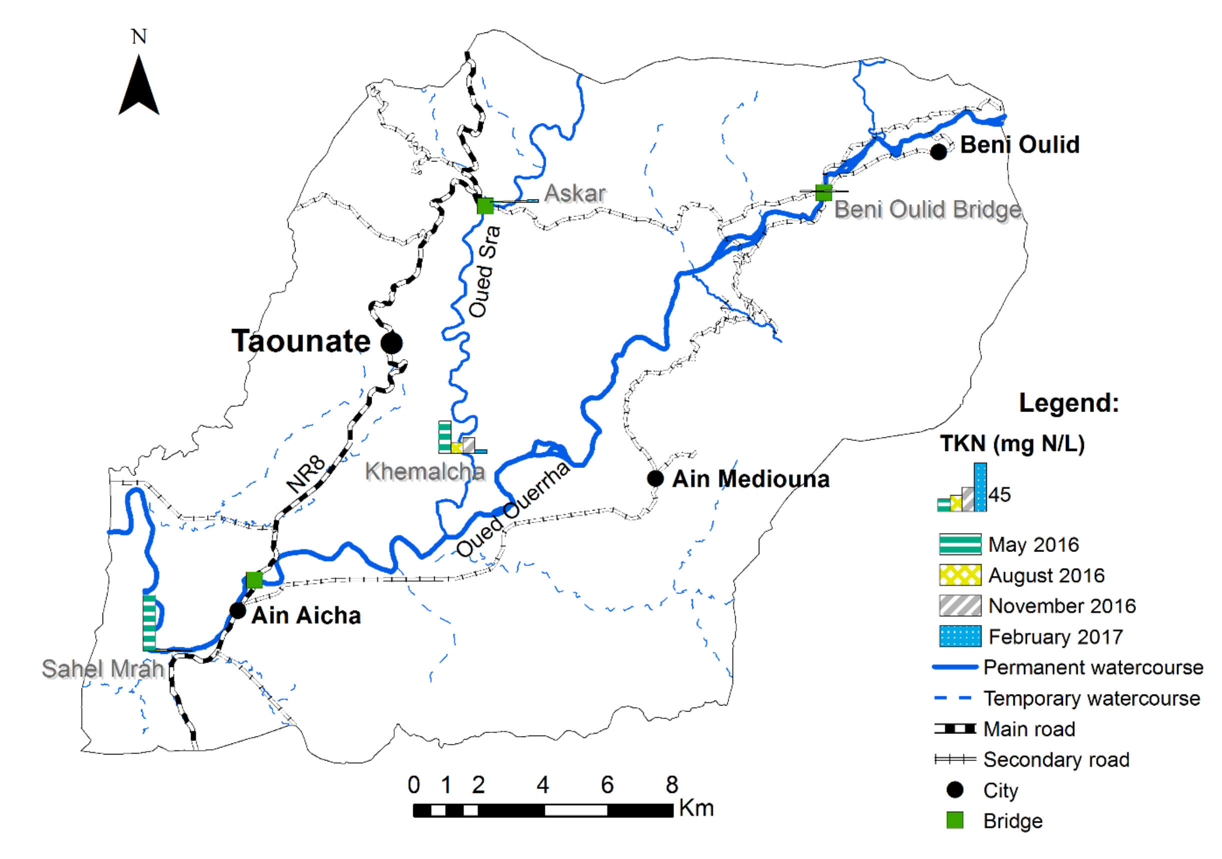
3.10. Total Kjeldahl nitrogen or (TKN)

Total Kjeldahl nitrogen is generally the sum of organic and ammoniacal nitrogen present in water (equation 1). The origin of the organic nitrogen can be the decomposition of organic waste, the human or animal organic waste and adjuvants of some detergents [23].Ammonia nitrogen can originate from plant matter in watercourses, animal or human organic matter, industrial discharges, fertilizers etc [22]:

$$NTK = N_{Org} + N - NH_4^+ \qquad (1)$$

Nitrogen can also exist as nitrous and nitric nitrogen independently of nitrogen gas (neutral form). Their origin in the surface waters is related to the leaching of soils enriched in nitrogen fertilizers, to urban or industrial discharges.

The concentrations recorded in downstream stations are clearly higher than those recorded upstream, since in the Khemalcha station, the TKN contents vary between 3,4 and 30,4 mg N/L, while in the Sahel Mrah station they vary between 0,3 and 90,2 mg N/L (Fig. 14).However, the maximum discharge value in surface water is 40 mg N/L. In practice, total Kjeldahl nitrogen is an indicator of environmental pollution and its control makes it possible to follow the evolution of contaminations.



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg N/L	1.3	0.7	1.2	0.6
2	Askar		1	1.4	1.6	2.1
3	Khemalcha		30.4	10.4	15.1	3.4
4	Sahel Mrah		90.2	1.4	0.6	0.3

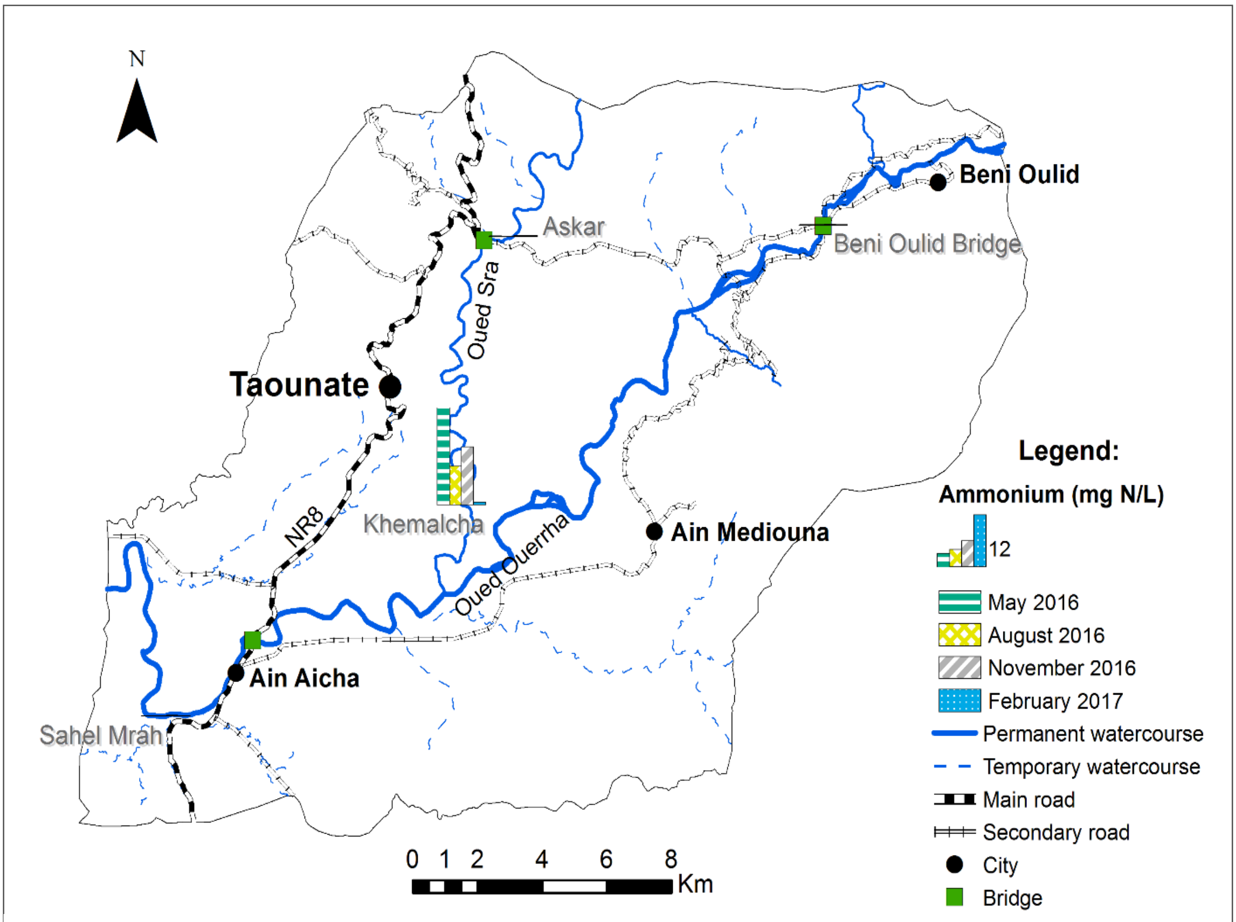
FIG. 14: SPATIO-TEMPORAL EVOLUTION OF TOTAL KJELDAHL NITROGEN OR (TKN) OF NATURAL WATERS OF TAOUNATE.

3.11. Ammonium

Provides a good indicator of watercourse pollution from domestic wastewater, residuals of industrial origin or by runoff from agricultural land.The maximum ammonium concentrations are recorded in the Khemacha station, they vary between 0,682 and 23,4 mg N/L (Fig. 15). According to studies by Yan Zhang (2014) [6], these levels in surface water range from 0,8 to 32,5 mg N/L. The presence of ammoniacal nitrogen in surface waters is related to other elements, such as nitrites and nitrates.

Purified wastewater generally contains ammonium whose content varies according to the purification process adopted, it contributes to the consumption of dissolved oxygen in the water. Ammonium levels in WWTP releases range from 4,476 to 57,05 mg N/L.

The presence of nitrites and ammonium depends on the denitrification process by oxygen consumption. Then the high content of CO_2 and the low oxygen content increase its concentration in water. The different components of the carbon cycle include carbon fixation by photosynthesis, respiration, fermentation, methanogenesis and oxidation of CH_4 with reduction of sulfur, iron and nitrates [24].



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg N/L	0.02	0.04	0.143	0.081
2	Askar		0.02	0.01	0.153	0.161
3	Khemalcha		23.4	8.69	13.07	0.682
4	Sahel Mrah		0.1	0.09	0.19	0.058

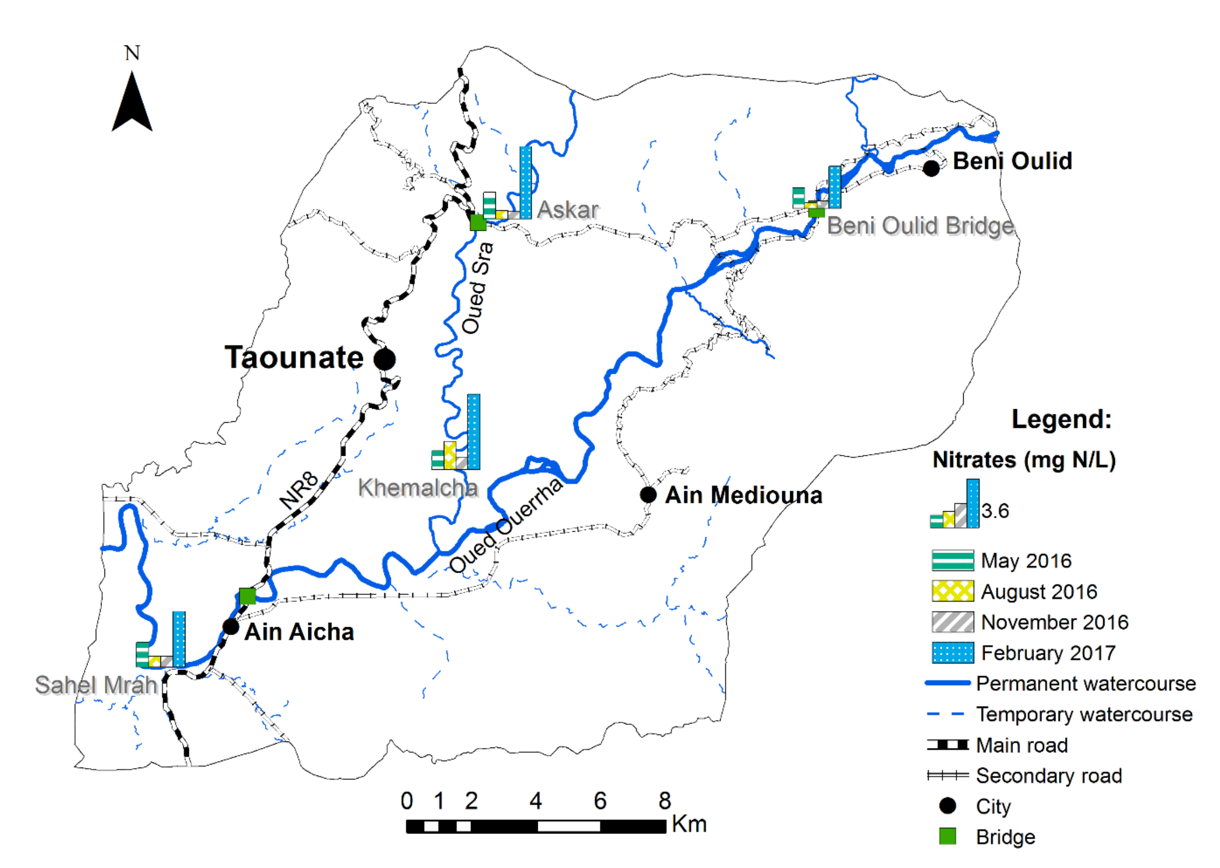
FIG. 15: SPATIO-TEMPORAL EVOLUTION OF AMMONIUM OF NATURAL WATERS OF TAOUNATE.

3.12. Nitrates

Nitrates are the most soluble forms of nitrogen in water, Indeed, their concentrations vary according to the hydrological events. They are the final stage of nitrogen oxidation and represent the highest nitrogen form of oxidation in water. Nitrates usually come from the decomposition of nitrogenous organic matter or from the dissolution of rocks or soils. In natural waters nitrates rarely exceed 0,45 mg N/L [20].

The highest nitrate fluxes and concentrations are observed in winter (February 2017), because the rains are effective and the needs of the plants fall. In the middle Ouerrha the nitrate contents vary between 0,4 and 7,13 mg N/L (Fig. 16). According to Yan Zhang (2014) [6], these concentrations in surface waters range from 0,2 to 29,6 mg N/L. In a reducing medium, devoid of oxygen, nitrates are converted into gaseous nitrogens by the denitrification process (equation 2) in poorly drained soils where the water is stagnant and depletes oxygen. This is the case for clay soils, with low permeability saturated with water [25] or for particular topographical situations of valley bottoms where water converges and saturates the soil even if it is permeable [26].

$$NO_3^- + H_3O^+ \rightleftharpoons N_2 + 3\,H_2O + {}^{5}/_{2}\,O_2 \qquad (2)$$



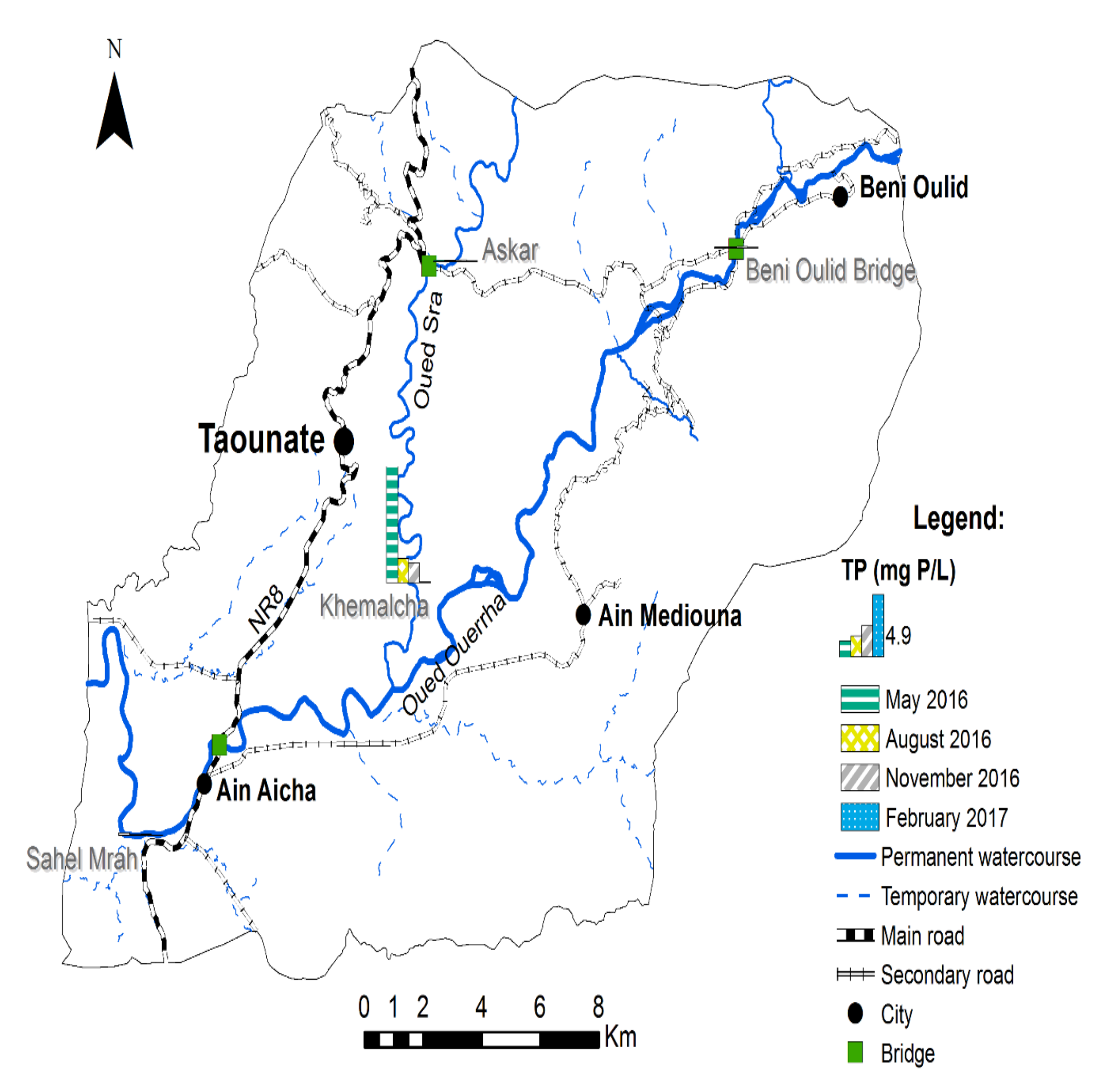
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg N/L	1.5	0.4	0.53	3.1
2	Askar		1.95	0.6	0.53	7.13
3	Khemalcha		1.4	2.1	0.89	5.58
4	Sahel Mrah		1.8	0.8	0.8	5.8

FIG. 16: SPATIO-TEMPORAL EVOLUTION OF NITRATES OF NATURAL WATERS OF TAOUNATE.

3.13. Total phosphorus (TP)

In water, the total phosphorus is distributed between the dissolved phase and the particulate phase. The dissolved phase comprises two main forms the directly available mineral form present in phosphorus ion form and the organic form, mainly groups nucleic acids, phospholipids, phosphoric sugar acids and their degraded forms [27-28]. Particulate phosphorus corresponds to phosphorus compounds associated with organic matter and soil minerals, thanks to the strong affinity of orthophosphates (PO_4^{3-}) for clay minerals and for iron oxyhydroxides, with behavior similar to that of arsenic.

In the Khemalcha station downstream of OuedSra, just after the release of the Taounate WWTP, it shows the highest levels of total phosphorus that can reach 9,8 mg P/L in the May 2016 campaign (Fig. 17).According to Brion (2015), TP levels range from 0,2 and 1 mg P/L in surface water [21]. The limit value for releases into surface water is 15 mg P/L. Total phosphorus comes from effluents mostly detergents, fertilizers, decomposition of organic matter and leaching minerals from volcanic and sedimentary rocks. It is present in small quantities in unpolluted watercourses. Their decrease in the OuedOuerrha downstream station can be explained either that the phosphorus is not very mobile or is easily absorbed by soil colloids [29]. Thus, this element is mainly eliminated by mechanical erosion processes. Either their concentrations are regulated in the watercourse by several biogeochemical processes, such as bed sediment adsorption, apatite precipitation [30] and aquatic plant consumption [31].



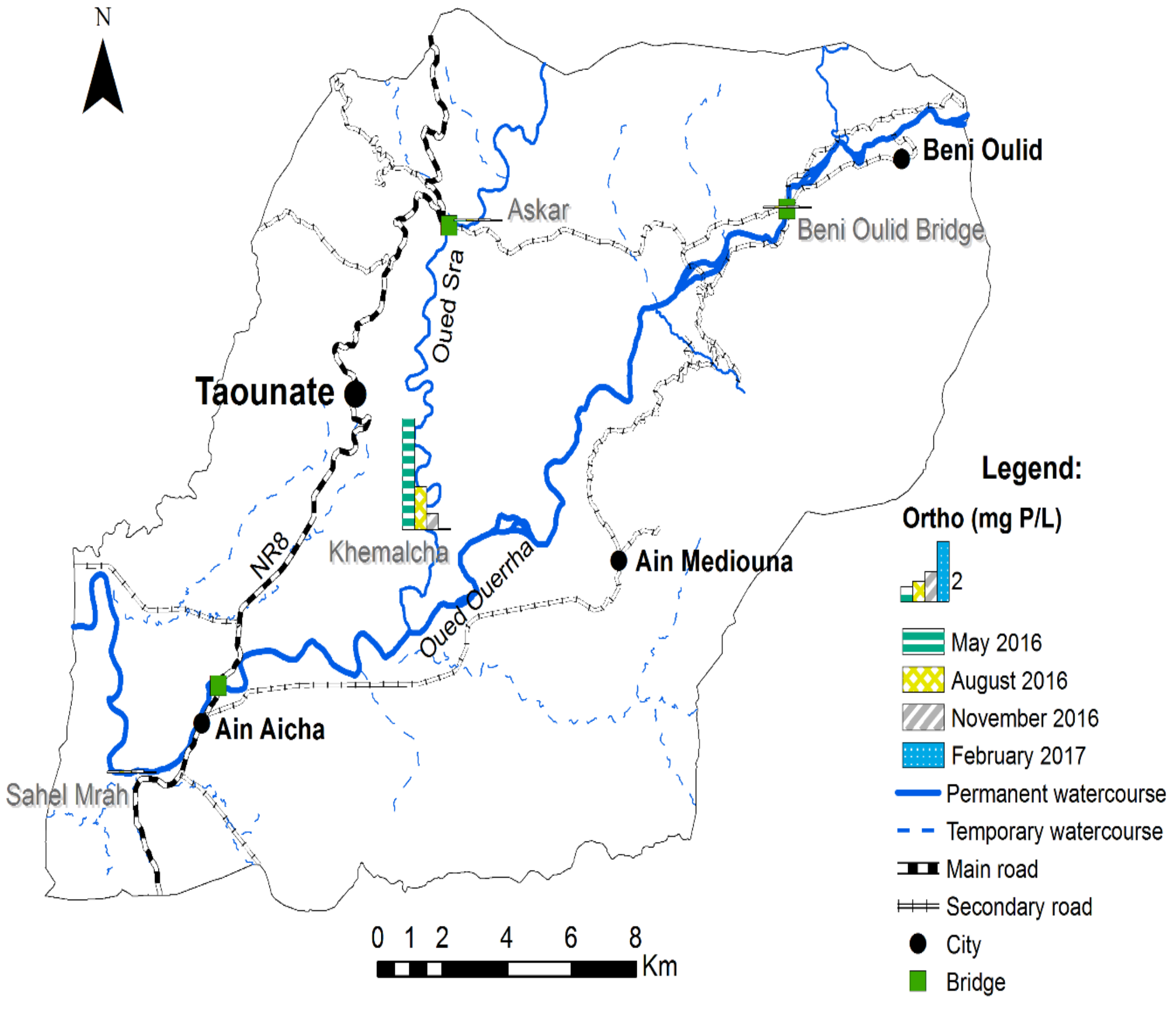
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg P/L	0.05	0.05	0.09	0.03
2	Askar		0.05	0.05	0.11	0.02
3	Khemalcha		9.8	1.94	1.60	0.09
4	Sahel Mrah		0.21	0.05	0.111	0.01

FIG. 17: SPATIO-TEMPORAL EVOLUTION OF TOTAL PHOSPHORUS (TP) OF NATURAL WATERS OF TAOUNATE.

3.14. Orthophosphates

Orthophosphates come from part of the hydrolysis of inorganic phosphate and organic phosphorus. They can result from washing and cleaning products, industrial waste (slaughterhouses, specialized industrial and chemical laundries, etc.) and agricultural waste [32].As nitrates are a major nutrient plant and can cause their proliferation from 0,2 mg P/L. They constitute the limiting element of eutrophication phenomena [23].

The spatio-temporal variation of orthophosphates in surface waters shows very high levels in the Khemalcha station with slight fluctuations, ranging from 0,05 to 4 mg P/L (Fig. 18).



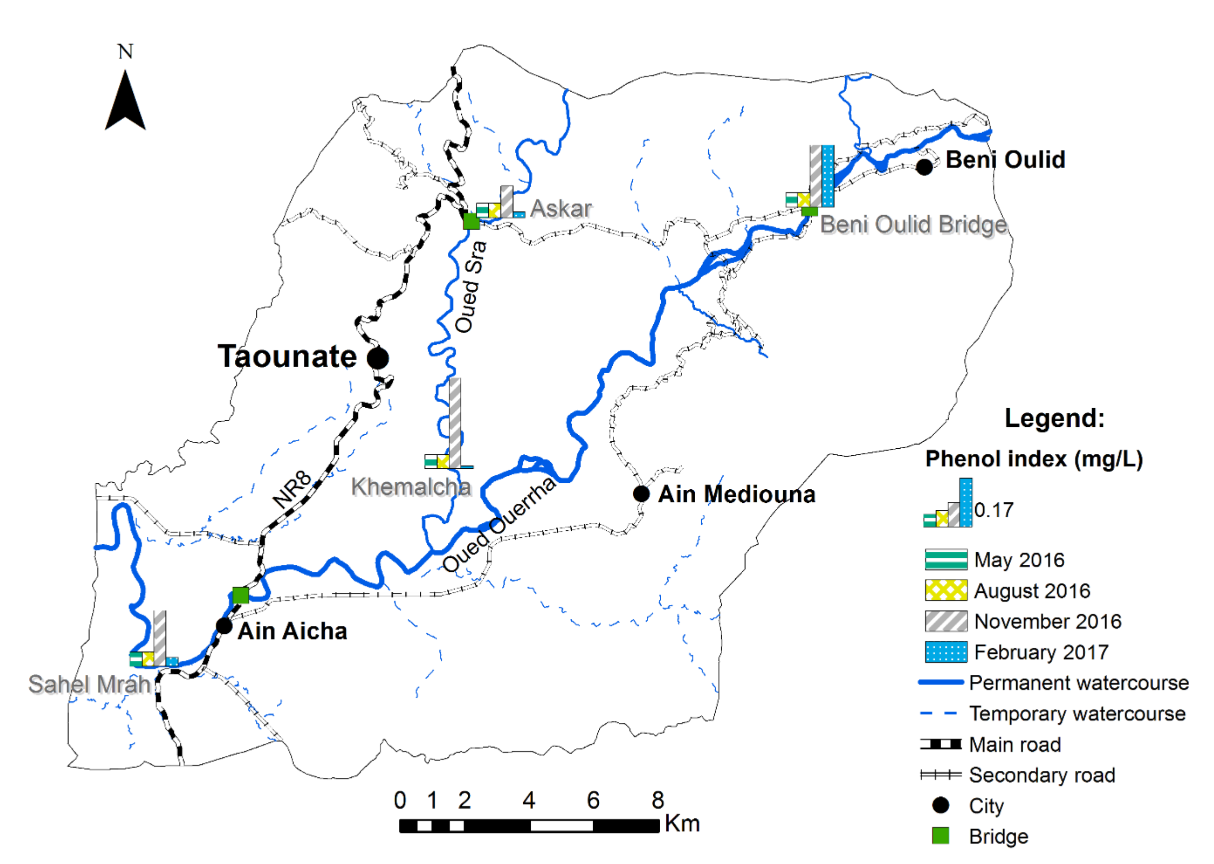
N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg P/L	0.05	0.05	0.08	0.02
2	Askar		0.05	0.05	0.09	0.02
3	Khemalcha		4	1.45	0.55	0.05
4	Sahel Mrah		0.05	0.05	0.09	0.02

FIG. 18: SPATIO-TEMPORAL EVOLUTION OF ORTHOPHOSPHATES OF NATURAL WATERS OF TAOUNATE.

3.15. Phenol index

Usually refers to as phenol index is a set of hydroxylated compounds of benzene. Its presence in water has most often, originated from industrial pollution (Huileries). These products oxidize weakly; they bind little and filter easily [22]. The margins are characterized by an acidic pH of 3 to 5 units and a very high electrical conductivity. They can be considered as a complex charged with organic and mineral matter [33].

In November 2016 the results show very high concentrations in surface water compared with other campaigns (0,35 mg/L) (Fig. 19), The general limit value for rejection to surface waters is 0,5 mg/L. This increase is mainly due to effluent rejection from huileries (Margins), their release into aquatic environments leads to a decrease in the concentration of dissolved oxygen, since these phenolic compounds oxidize easily with the oxygen of the medium, which renders the environment unbreathable with asphyxiation of all aquatic life. This phenomenon therefore leads to a degradation of the quality of surface water by inhibiting the development of microorganisms, especially bacteria [34]. Consequently, the natural self-purification capacity would be limited.



N°	Station	Unit	Campaign			
			May 2016	August 2016	November 2016	February 2017
1	Beni Oulid Bridge	mg/L	0.05	0.05	0.24	0.32
2	Askar		0.05	0.05	0.11	0.02
3	Khemalcha		0.05	0.05	0.32	0.01
4	Sahel Mrah		0.05	0.05	0.34	0.03

FIG. 19: SPATIO-TEMPORAL EVOLUTION OF PHENOL INDEXOF NATURAL WATERS OF TAOUNATE.

IV. CONCLUSION

After the analysis of the different physico-chemical parameters carried out on the four sampling stations of the surface waters, have shown that OuedOuerrha and its tributary OuedSra are polluted rivers in downstream stations. However, the pollution parameters observed in the Khemalcha station, downstream from the OuedSrâ, show high concentrations of BOD_5, COD, ammonium, total phosphorus and orthophosphates, essentially due to the rejection of the WWTP from the city of Taounate.

The results of the phenol index represent high levels in November and February (trituration period of margins). Indeed, this increase depends on the nature of the rejections of the margins, the variability of the type of olive, of their maturation according to the season of collection, the procedure of the extraction of olive oil and the climatic conditions.

Finally, it is recommended that several initiatives be put in place when the reuse of wastewater when treating margins:

- Reuse of all or part of the wastewater in irrigation, would reduce the quantitative and qualitative human pressure on the water resources;
- The watering of green spaces and urban landscaping also allowed people to have a better living environment;
- Installation of several natural lagoon treatment plants near major agglomerations, as the region does not contain greatfactories producing toxic chemicals or heavy metals;

- Water saving associated with the reuse of wastewater would allow sustainable management of these water resources;
- Margins treatment processes, consisting of trapping, concentrating or transforming polluting substances to reduce the polluting characteristics of industrial effluents before rejection;
- Finally, construction of sufficient basins of accumulation of margins in the province-wide production rate.

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