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Evaluation of irrigation water quality of dam Dahmouni in Cheliff watershed upstream of Boughzoul, Algeria

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Abstract
Despite their agronomic values, discharges of badly treated wastewater of the city of Tiaret in dam Dahmouni, could seriously affect the quality of its waters intended exclusively for the irrigation of large agricultural areas in the Cheliff watershed upstream of Boughzoul. The ratios adopted for assessing the quality of the urban effluents allowed to highlight their domestic origin and the partial biodegradability of their organic matter. According to the same criteria, we could deduce the non-biodegradability of the organic matter contained in the waters of dam Dahmouni. Moreover, the physico-chemical and bacteriological analyzes of waters have revealed some deviations from FAO (1985) and WHO (1989) standards, which deserves to be mentioned. On physico-chemical level, the results showed a slight excess of cadmium and a slight to moderate degree of restriction, according to the FAO (1985) classification for irrigation water in periods of study (2008 and 2009). Bacteriologically, important values of faecal coliforms were identified in all samples despite the existence of WWTP upstream of dam Dahmouni. To endow the WWTP of Tiaret with a suitable disinfection system, followed by a regular monitoring can significantly improve the quality of these waters.

Key words: Discharges, Cheliff, Irrigation, Standards, Faecal coliforms, Disinfection

1. Introduction
The impact of anthropogenic pollution generated by badly or untreated urban and industrial wastewater discharges, takes a worrisome trend through its effects on the mobilization of surface water in Algeria which is committed to an all-out mobilization policy to overcome its water deficit, estimated at 1 billion cubic meters at 2025 [1]. Hence, the reuse of wastewater for agriculture has became a real alternative for many reasons, not least of which is a practical solution to overcome water scarcity, especially in arid and semi-arid regions [2], ensure a nutrient value and environmental protection [3-4].
It's acknowledged that, the use of untreated urban and industrial effluents in irrigation can pose a serious threat to the quality of soil & crops and to the health of human beings [5]. Also, number of risk factors has been identified in wastewater reuse; some of them are short term whereas others have longer-term impacts that increase with the continued use of recycled water [6-7]. So, many guidelines have been issued to give a quality criteria and guidance on how treated wastewater should be reused for irrigation purposes [8-9].
In addition, salinity is a problem since thousands of years, especially in arid area [10]. On a worldwide scale, the salted grounds occupy approximately 24% of the agricultural lands, and constitute a major problem for agriculture. Their geographical distribution is almost superimposed entirely on that of the arid and semi arid regions of the globe and the coastal areas [11].
The transfer of urban wastewater of Tiaret city from adjacent watershed (Tributary of oued Mina) to the dam of Dahmouni located upstream (area of study) provides a very significant additional water and enable to increase hydric potential of dam Dahmouni.
However, the presence of toxic chemical constituents and pathogens could produce adverse consequences on both human health and environment [12].
The study focused on the nature and the consistency of wastewater effluents discharge due to the risks which these waters involve.

The adopted approach allowed to study the waters quality of dam Dahmouni and their suitability for the irrigation purpose, according to the FAO (1985) classification [13] and the WHO (1989) guidelines (1989) [9].

2. Experimental details

2.1 Study area

Situated in the western center of the North of Algeria, the hydrographic basin "Chellif" extends over a surface of 43750 km^2, it is the biggest watershed in the north of the country. It is divided in three sub basins [14].

- The sub basin of low Cheliff and Mina
- The sub basin of the top and middle Cheliff
- The sub basin of Chellif upstream of Boughzoul

On the hydrographic plan, the watershed of Chellif upstream of Boughzoul is drained by two big tributaries oued Touil and Nahr Ouassel whose confluence constitutes the starting point of the biggest Oued of Algeria, the Cheliff (759 km), at the dam of Boughzoul where it controls more than 40% of the flow area of the great watershed "The Chellif".

On the administrative plan, the Chellif upstream of Boughzoul, covers 40 municipalities of five wilayas, totaling a population of 706740 inhabitants

It spreads out on a surface of 19645 km2, characterized by vast areas of land appreciably flat establishing the junction of the mountain ranges from the Tell to the Saharan Atlas by a landscape with steppe dominance.

The study area also called SERSOU (Fig.1), provide most of irrigation water by the mobilization of dams Dahmouni and Bougara on oued Nahr Ouassel.

This area is characterized by a strong agricultural population which juxtapose three production systems: Cereal cultivation, breeding, and a mixed system of pastoral breeding and cereal cultivation. The latter system remains the dominant characteristic for all the basin [15].

The attractiveness of rural population by the assets and potentialities that conceals in the north of watershed, especially fertile soils and rainfalls offered unfair conditions of development between the north and the south.

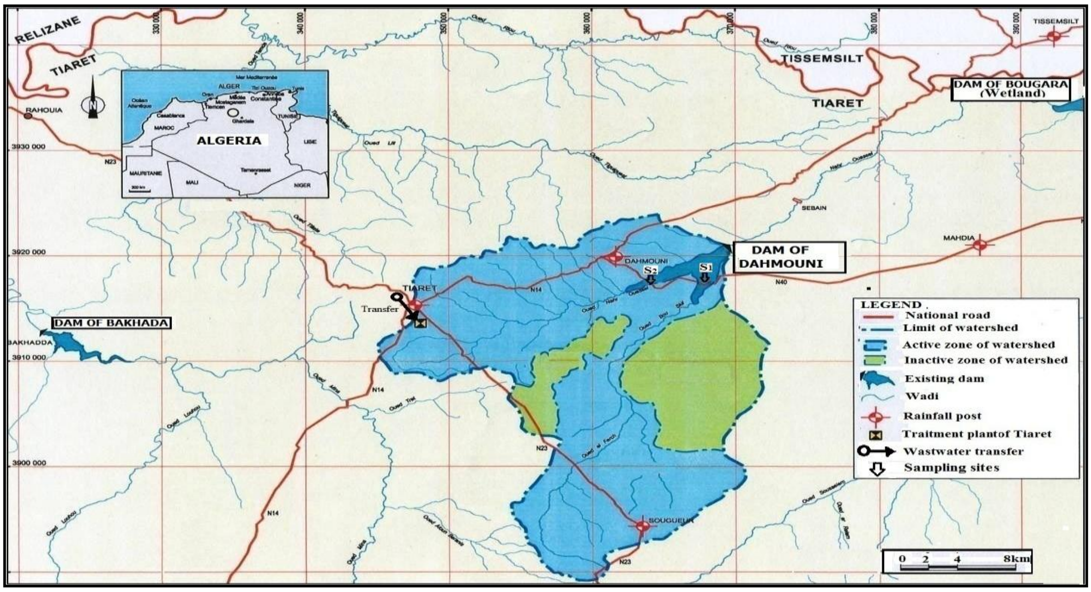

Figure 1: Location of dam Dahmouni

2.2. Characterization of the wastewater quality

Polluted water may contain a very large number of molecules which can be mineral or organic, soluble or particulate, very toxic or not, often including pathogen bacteria.

To evaluate the water pollution, the following global parameters are used:

pH, temperature, conductivity, salinity, TSS, dissolved oxygen, COD, BOD5, nitrogen and phosphorus ... etc.

We can also use reports to appreciate the degree of wastewater organic pollution, this ratios COD/BOD_5, BOD_5/COD, TSS / BOD_5 present important interests.

The characterization by these parameters constitutes a good way to identify the nature and the origin of the effluents pollution and allows to propose a mode of suitable treatment [16-17-18].

- Ratio COD / BOD

  The ratio COD/BOD_5 allows to deduce if wastewater has the characteristics of domestic wastewater (COD/BOD_5 lower than 3) [19]. The results of this relationship constitute an indication of the importance of the polluting materials and their biodegradability [20].

  $COD/BOD_5 < 2$: The effluent is easily biodegradable.

  $2 < COD/BOD_5 < 3$: The effluent is biodegradable with selected strains.

  $COD/BOD_5 > 3$: The effluent is not biodegradable.

- Ratio BOD_5/COD

  This report is used to characterize an industrial pollution. It often gives very interesting indications on the origin of the pollution of wastewaters and its possibilities of treatment.

  For the charged rejections with organic matter this ratio is high. A report BOD_5/COD ranging between [0.2 and 0.4] implies that the organic matter contained in the effluent is partially biodegradable [21].

- Ratio TSS/DBO_5

  This ratio expresses the particulate pollution compared to dissolved pollution. This characterizes the sewer system. A high value of this report indicates the prevalence of particulate pollution [22].

The bacterial load in wastewater constitute a major threat to public health. An account higher than 1000 FC/100 ml is considered as dangerous and could constitute a risks for health, environment and all the user of the river who receives these effluents [9-23].

The discharge of metal-rich effluents is undesirable because besides their toxicity, it can lead to increased salinity of the receiving streams, negatively affect seaweeds, benthic organisms including fish species and zooplankton and can bio-accumulate in them to high concentrations such that humans that feed on them could be at risk [24-25].

2.3 Guidelines for irrigation water quality

The use of poor water quality for irrigation can create many problems, namely toxicity, water infiltration, salinity and miscellaneous.

Due to various types of water many criteria were selected to assess the water quality for irrigation, this justifies the necessity to establish a classification system and guidelines for the use of water in irrigation.

Several classifications exist for specific conditions and regions such as:

- Wilcox (1948) [26]
- Richards (1954) [27]
- Thorn and Peterson (1954) [28]
- USEPA (1992) [29]
- FAO (1985) [13]
- WHO (1989) [9]

Among the schemes that have been proposed to study the water irrigation quality of dam Dahmouni, the scheme includes FAO (1985) and WHO (1989) guidelines seems to be the most appropriate for moderate conditions use.

It should be noticed that there is no complete scheme and universal classification of irrigation water due to the complexity of the problem.

3.3 Sampling

We have carried out monthly samples during two irrigation periods 2008 and 2009, from April to June. Samples were taken in pre-washed polyethylene bottles at 50 cm from the surface of water (Fig 1).

Wastewater effluent was also sampled at the inlet and outlet of the WWTP during the period of irrigation (2009). Straight after taking the in situ measurements, the samples were kept in ice box at a temperature of 4° C and then evacuated within twenty-four hours to the laboratory of the National Agency for Water Resources (NAWR) and Technique Center laboratory of quality for physicochemical and heavy metal analyzes.

The microbiological analysis was performed by the laboratory of Algerian water society of Tissemsilt.

- The analysis procedures are deduced from the standard methods [30].
- pH, temperature, and conductivity of the water are measured in situ by portable devices HANNA (8014 Hi and Hi 8732).
- Suspended matter (TSS) was filtered by a cellulosic filter and weighed after passage to the drying oven with 105˚C.
- The biological demand of oxygen during five days (BOD_5) was measured by the apparatus BOD meter Oxi- Top.
- Chemical demand of oxygen (COD), was measured by COD meter type photometer Hanna C214.
- The determination of anions is performed by spectrophotometry kind DR2000 (HACH).
- The flame spectrophotometer (Corning 410) is used to determinate the cations.
- The atomic spectrophotometer absorption (AA800) is used for the heavy metals.
- The membrane filtration technique is used for total and feacal coliforms testing [31].

Only the months of June 2008 and 2009, are considered for heavy metals and bacteriological analyzes.

3. Results of analyzes

3.1 Analyzes *of wastewater effluents*

Table 1: Results of analyzes of raw and treated effluents in the WWTP

Parameters	Units	Raw effluent (*)	Raw effluent			Treated effluent		
Date		Feb 2008	Period 2009			Period 2009		
			April	May	Jun	April	May	Jun
Volume	m^3/j	15334	22649	17200	14828	16649	11200	9294
Température	°C	14°	13	17	21	14	18	22
pH		6.6	8	7	8	8	7	8
EC	µs/cm	1781	/	1770	1525	/	1840	2120
TSS (105°C)	mg/l	1072	234	278	245.5	56	53	37
COD	mg/l	362	269.5	516	664	105	134	129
BOD_5	mg/l	164.5	116	198	328	12.5	22	17
BOD_5/COD		0.45	0.43	0.38	0.49	0.11	0.16	0.13
COD / BOD_5		2.2	2.32	2.6	2.2	8.4	6.09	7.5
TSS/ BOD_5		6.51	2.01	1.40	0.74	4.48	2.4	2.17
NH_4	mg/l	78.9	43	40	46	20	19.2	6
Total phosphorus	mg/l	28.9	4.2	2.83	4	2.3	2	2.5
Hexa Cr	mg/l	0.9606						0.0064
Zinc	mg/l	1.4041						0.094
Nickel	mg/l	0.1436						0.0094
Cadmium	ml/l	0.1073						0.0021
Copper	mg/l	0.1473						0.064
Lead	µg/l	0.0210						<0.01
Total coliforms	FC/100ml	/						64400
Feacal coliforms	FC/100ml	/						54000

(*) In first half of 2008 the WWTP was not operational.

3.2 Analyzes of dam Dahmouni waters

Please see Table 2

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Table 2: Physico-chemical and bacteriological waters analyzes of dam Dahmouni

Paramètres	Units	Water of dam Dahmouni											
		Irrigation period 2008						Irrigation period 2009					
Sampling sites		S1			S2			S1			S2		
Date		April	May	Jun	April	May	Jun	April	May	Jun	April	May	Jun
Volumes	hm3	20	20.2	20.4	20	20.2	20.4	39.9	39.4	38.4	39.9	39.4	38.4
Température	°C	18	19	21	18,5	19	20	15	21	24	15	22	25
pH		8	7.7	8.2	8.4	7.6	7.7	7.7	8.3	8.4	8.0	7.9	8.0
EC	µS/cm	1550	1580	1560	1840	1840	1970	1291	1332	1272	1133	1150	1086
TSS (105°C)	mg/l	30	48	34	22	30	50	10	10	22	93	33	34
Sodium	mg/l	219	214	207	276	285	285	150	156	154	122	117	106
Calcium	mg/l	138	130	143	140	96	136	124	114	123	110	96	67
Magnésium	mg/l	52	58	55	58	68	70	45	57	56	43	57	58
Chloride	mg/l	218	228	222	268	302	327	170	174	167	151	133	152
Bicarbonate	mg/l	382	339	369	436	456	436	316	299	293	266	257	193
NO_3	mg/l	9	7	12	5	15	9	21	20	34	11	12	11
PO_4	mg/l	2.98	3.83	3.35	4.72	5	5.34	1.7	1.94	1.37	0.41	0.35	0.16
COD	mg/l	70	90	90	29	29	60	20	59	20	38	50	40
BOD_5	mg/l	14.7	16.5	18.6	9.3	5.2	18.5	4	7.9	3.2	6.3	8.7	6.3
COD / BOD_5		4.7	5.4	4.8	3.1	5.5	3.2	5	7.4	6.2	6	5.7	6.3
BOD_5/COD		0.21	0.18	0.2	0.32	0.17	0.3	0.2	0.13	0.16	0.16	0.17	0.15
TSS/ BOD_5		2	2.9	1.82	2.3	5.7	2.7	2.5	1.26	6.87	14.7	3.7	5.3
Cadmium	mg/l			0			0.002			0.003			0.036
Hexa Cr	mg/l			0			0.006			0.028			0.013
Nickel	mg/l			ND			0.009			0.061			0.028
Copper	mg/l			0.012			0.068			0.056			0.05
Zinc	mg/l			0.15			0.094			0.115			0.293
Lead	mg/l			< 0.01			< 0.01			< 0.01			< 0.01
Total coliforms	FC/100ml			58400			67300			53700			53000
Feacal coliforms	FC/100ml			48000			49000			39000			40200

4. Discussion

4.1Evaluation of urban wastewater quality

It should be known that a WWTP, even highly efficient with a purification rate of 95%, never eliminates all of polluting substances.At the end of process, treated effluent must fulfill the standards of discharge fixed by the legislation which takes into account the vulnerability of the receiving environment and the objective to satisfy.

At the inlet of the WWTP, the concentrations of TSS, COD, and BOD_5 are respectively 234-278 mg/l, 269.5-664 mg/l and 116-328 mg/l in 2009 against 37-56 mg/l, 105-134 mg/l and 12.5-17 mg/l at the outlet of the WWTP (Table 1).

The low values of BOD_5 recorded outlet of the WWTP show the efficiency of the treatment process.

Some deviations from Algerian standards of rejections [32] are recorded for TSS and COD.

A significant reduction of ammonia and phosphorus is recorded, average ranging from 43 to 15.06 mg/l for ammonia and 3.67 to 2.26 mg/l for phosphorus. The pH remains constant between [7 and 8].

Furthermore, the typical ratio COD/BOD_5 [33] of the domestic wastewater is often between [1.25 and 2.5]. This is in accordance with our raw effluents ratio, which is between [2.2 and 2.6], therefore our raw sewage are biodegradable (Table 1). The high values of this ratio at the outlet of the WWTP from 6.09 to 8.4 are due to the elimination of the biodegradable material by the process.

The ratio of BOD_5 /COD of raw sewage varies from 0.38 to 0.49. These values coincide substantially with ratios [0.2 to 0.4] delivered by the RCDWS [16] and reflect the partial biodegradability of the organic matter contained in these effluents.

In light of the report values ranging from $2< COD/BOD_5>3$ [20] and those of BOD_5/COD ranging from [0.2 to 0.4], these waters are loaded with organic matter partially biodegradable.

The report MES/DBO5 ranging from [0.74 to 2.01] comes to confirm the predominance of the particulate matter in this water [22].

The concentrations of heavy metals in treated effluent are very weak, but as regards an instantaneous measurement, we cannot come to a conclusion about their representativeness. Only analyzes of sludge or those of the receiving environment (see below) can provide information on the reality of their presence.

The microbiological analyzes of treated water from WWTP show a very high count of feacal coliform 54000 FC/100ml compared to the WHO standard [9]. This is due to the lack of disinfection system in the process.

4.2 Evaluation of irrigation water quality of dam Dahmouni

The criteria of FAO (1985) and WHO (1989) used to assess the physicochemical and bacteriological water quality of dam Dahmouni for irrigation revealed that (Table 3).

4.2.1 Salinity

Electrical conductivity (EC) is the most important parameter in determining the suitability of water for irrigation use and it is a good measurement of salinity hazard to crop as it reflects the TDS in water. The most negative effect on the environment is that it increases soil salinity and decreases productivity in long term by reducing the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil [34].

EC values of experimental samples varied from 1550-1970 µS/cm in 2008 to 1133-1332 µS/cm in 2009 (fig 2) indicating slight to moderate degree of restriction on the use of this water in irrigation (Table 3).

The increase of electrical conductivity in 2008 is mainly linked to the low volume stored in the dam of Dahmouni estimated at 20 10^6 cubic meters in 2008 against 39.75 10^6 cubic meters in 2009.

The urban wastewater discharges upstream of dam Dahmouni amounting to 3.410^6 cubic meters annually, equivalent at one third of watershed liquid flows [35], constitute an aggravating circumstance of the phenomenon.

4.2.2 Sodium (SAR)

Sodium content is the most troublesome of the major constituents and an important factor in irrigation water quality evaluation. Excessive sodium leads to development of an alkaline soil that can cause soil physical problems and reduce soil permeability [36]. Furthermore, irrigation water containing large amounts of sodium is of special concern due to absorbed sodium by plant roots which is transported to leaves where it can accumulate and cause injury [37]. However, there is a restriction in use of overhead sprinklers method with water contained a high level of sodium salts because these salts can be absorbed directly by plant leaves and will produce harmful effects.

Sodium hazard is usually expressed in terms of Sodium Adsorption Ratio (SAR) and it can be calculated from the ratio of sodium to calcium and magnesium. It has been calculated as follows:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$$

Na^{+}, Ca^{2+} and Mg^{2+} are in meq/l.

Sodium concentrations in the samples varied from 9 to 12.39 meq/l in 2008, and 4.61 to 6.78 meq/l in 2009, corresponding respectively at 3.72 to 5.42 of SAR in 2008, and 2.28 to 2.97 in 2009 (fig 3).
These decreasing values of SAR can be linked to the well rainfall in 2009 and the real startup of the wastewater plant of Tiaret.
Under these conditions (2009), FAO (1985) does not see any restriction.

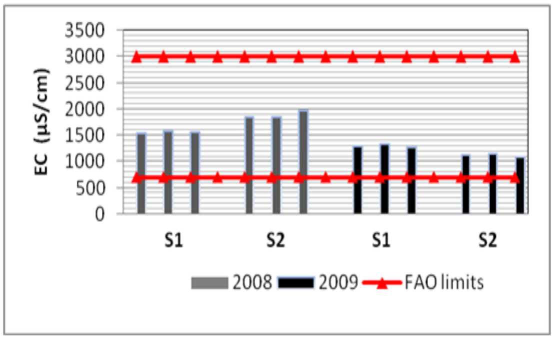

Figure 2: Electrical conductivity (µS/cm)

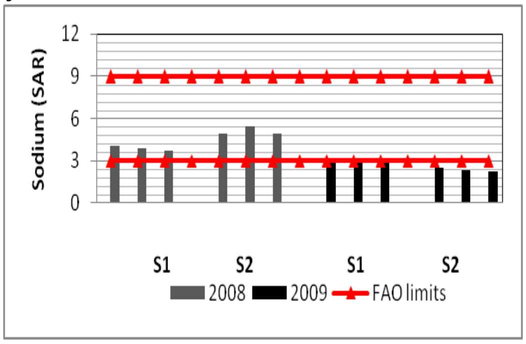

Figure 3: SAR variation

4.2.3 Hydrogen ion activity (pH)

For all the irrigation periods, the values of pH varied from 7.6 to 8.4 (fig 4) with an average value of 8, which indicates that water of lake Dahmouni is slightly alkaline. The normal pH range for irrigation water is from 6.5 to 8.4. Irrigation water with a pH outside the normal range may cause a nutritional imbalance or may contain a toxic ion [38].

4.2.4 Chloride

The most common toxicity is from chloride (Cl^{-}) in the irrigation water. (Cl^{-}) is not adsorbed or held back by soils, therefore it moves readily with the soil-water, is taken up by the crop, moves in the transpiration stream, and accumulates in the leaves. If the Cl^{-} concentration in the leaves exceeds the tolerance of the crop, injury symptoms develop such as leaf burn or drying of leaf tissue. Normally, plant injury occurs first at the leaf tips (which is common for chloride toxicity), and progresses from the tip back along the edges as severity increases. Excessive necrosis (dead tissue) is often accompanied by early leaf drop or defoliation [38].
The obtained Cl^{-} ion concentration of the samples varied from 6.1 to 9.2 meq/l in 2008 and 3.75 to 4.9 meq/l in 2009 (fig 5), representing slight to moderate degree of restriction on the use of this water in irrigation [13].

4.2.5 Nitrate

NO_3-N is a necessary primary macronutrient for plants that stimulates plant growth and is usually added as a fertilizer but can also be found in wastewater as nitrate, ammonia, organic nitrogen or nitrite [37]. The most important factor for plants is the total amount of nitrogen (N) regardless of whether it is in the form of nitrate-nitrogen (NO_3-N), ammonium nitrogen (NH_4-N) or organic-nitrogen (Org-N) but by reporting in the form of total nitrogen comparisons can be made [39]. The concentration of nitrogen required varies according to the crop with more sensitive crops being affected by nitrogen concentrations above 5 mg/l, whilst most other crops are relatively unaffected until nitrogen exceeds 30 mg/l.
NO_3-N results show a range from 5 to 9 mg/l during 2008 irrigation period and 11 to 34 mg/l in 2009 (Fig 6). Due to enriched wastewater in nutrient, the concentration of the NO_3-N is increase in 2009. However, the values indicate slight to moderate restriction, following the FAO standards of quality for irrigation water.

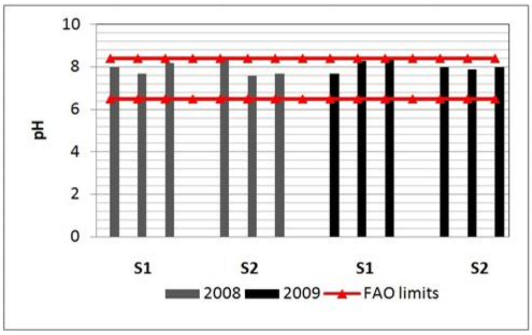

Figure 4. pH variation

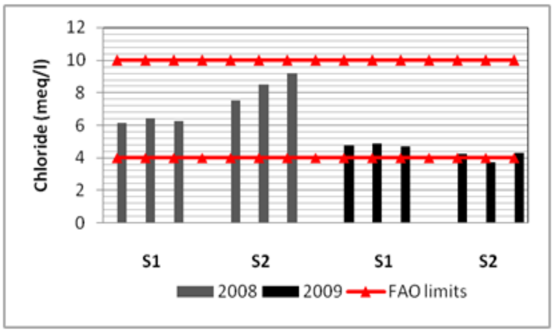

Figure 5: Chloride (meq/l)

4.2.6 Bicarbonate

Bicarbonate and carbonate ions combined with calcium or magnesium will precipitate as calcium carbonate ($CaCO_3$) or magnesium carbonate ($MgCO_3$) when the soil solution concentrates in drying conditions. The concentration of Ca and Mg decreases relative to sodium and the SAR index will be bigger. This will cause an alkalizing effect and increase the pH. Therefore when a water analysis indicates high pH level, it may be a sign of a high content of carbonate and bicarbonates ions.

All the samples take a low tendency in 2009 from 7.48 to 3.16 meq/l (fig 7) which fall within the range of slight to moderate restriction (FAO limits 1.5 to 8.5 meq/l).

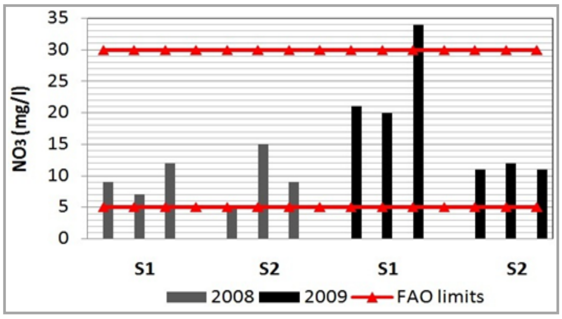

Figure 6: Nitrate (mg/l)

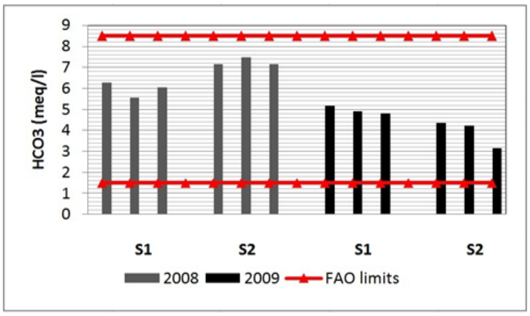

Figure 7: Bicarbonate (meq/l)

4.2.7 Heavy Metals

Soil enrichment by Zinc, Copper and Nickel can cause direct phytotoxic effects manifested as decrease growth and yield, especially where soil ph is low than 5.5 (FAO).

The element of greatest concern to human health is Cadmium which could be absorbed and accumulated by most crops and enters in food chain more readily than other metals.

The present analysis of Cadmium showed a slightly high concentration (0.036>0.01mg/l) in period 2009. The main heavy metals analyzed in the water of dam Dahmouni during irrigation periods (Table 3) were below the limits recommended by FAO (2000) [12].

4.2.8 Faecal coliforms

Many reports correlated the relation between fresh vegetables and foodborne diseases outbreaks that has led to concerns about contamination of vegetables with faecal pathogenic bacteria in the agricultural environment [9].

The high rates of total and faecal coliforms found in water samples of dam Dahmouni constitute a risk factor owing to the concentration of pathogens they contain (table 3).

The guidelines of microbiological quality of wastewater used in agriculture (WHO, 1989), have restrictions on the use of such water for crops to be eaten raw (Maximum 1000 faecal coliforms per 100ml), due to the excess of pathogens germ they have. The problem is attributed to the lack of disinfection system in treatment plant of Tiaret.

Table 3: Results of water quality parameters compared to FAO (1985) and WHO (1989) guidelines

Parameters	Units	Water of dam Dahmouni												FAO (1985&2000) Degree of restriction on use			WHO (1989)
		Irrigation period 2008						Irrigation period 2009						None	Slight to moderate	Severe	
Sampling sites		S1			S2			S1			S2						
Date		April	May	Jun	April	May	Jun	April	May	Jun	April	May	Jun				
EC	µS/cm	1550	1580	1560	1840	1840	1970	1291	1332	1272	1133	1150	1086	<700	700 – 3000	>3000	
SAR= 0-3 and EC								SAR=2.28-2.97, EC=1133-1332						>700	700 – 200	<200	
SAR= 3-6 and EC		SAR=3.72-4.93, EC=1550-1970												>1200	1200 – 300	<300	
Sodium	SAR	4.02	3.91	3.72	4.93	5.42	4.93	2.92	2.97	2.88	2.49	2.33	2.28	<3	3 – 9	>9	
Chloride	meq/l	6.14	6.42	6.25	7.55	8.51	9.21	4.79	4.90	4.70	4.25	3.75	4.28	<4	4 – 10	>10	
NO_3	mg/l	9.00	7.00	12.00	5.00	15.00	9.00	21.00	20.00	34.00	11.00	12.00	11.00	<5	5 – 30	>30	
HCO_3^-	meq/l	6.26	5.56	6.05	7.15	7.48	7.15	5.18	4.90	4.80	4.36	4.21	3.16	<1.5	1.5 – 8.5	>8.5	
pH		8	7.7	8.2	8.4	7.6	7.7	7.7	8.3	8.4	8	7.9	8	Normal range : 6.5 – 8.4			
Trace elements																	
Cadmium	mg/l			0.001			0.003			0.002			0.036	0.01			
Hexa Chromium	mg/l			0.003			0.028			0.006			0.013	0.1			
Nickel	mg/l			ND			0.061			0.009			0.028	0.2			
Copper	mg/l			0.012			0.056			0.068			0.05	0.2			
Zinc	mg/l			0.15			0.115			0.094			0.293	2			
Lead	mg/l			< 0.01			< 0.01			< 0.01			< 0.01	5			
Coliforms																	
Total coliforms	FC/100ml			53000			67300			53700			58400				
Feacal coliforms	FC/100ml			40200			49000			39000			48000				≤1000

4.2.9. Additional elements (Outside the FAO)

- *Evaluation of organic matters in waters of dam Dahmouni*

The values of COD and BOD_5 were sensibly higher in 2008 than in 2009 because of the discharge of untreated effluents in 2008 (Table 2).
The average values registered for the COD varied from 61.33 mg / l in 2008 to 37.83 mg / l in 2009. However the average values registered for the DBO5 are 13.8 mg / l in 2008 against 6 mg/l in 2009.

- The ratios DCO / DBO5 > 3 indicate that these waters are loaded with non biodegradable organic matter in 2008. This tendency increases in 2009 further to the treated effluents rich in refractory organic matter.

- The ratios of BOD_5 / COD are mostly below of 0.2 for these waters, this shows the non-biodegradability of their organic matter [18].

- The average ratio TSS / DBO5 varied from 2.45 in 2008 to 5.72 in 2009. This confirms the predominance of the particulaire pollution on the dissolved material [22].

- *Nutriments (NO_3 and PO_4)*

Despite their agronomic values [40], the excess of nutriments (N and P) in the waters of dams provokes an imbalance of the ecosystem with an anarchy development of seaweeds and causes an intense consumption of oxygen at the bottom of lakes; this is “the eutrophication”.
According to the simplified grid for the evaluation of global surface water quality [41], and according to the results of (Table 2), we note, contrary to 2008, a clear improvement of the NO_3 and PO_4 concentrations in 2009.

Indeed, thanks to the performances of the WWTP in 2009, the regression of the values took place. The observed averages are respectively 13.83mg/l for nitrate and 2.59 mg/l for phosphate.
The quality of this waters can be described as "average to good".

Conclusion

Through the results of ratios stemming from treated effluents analysis (DCO/DBO_5, DBO_5/DCO, TSS/DBO_5), we have been identified the domestic origin of the urban effluents of the WWTP as well as the partial biodegradability of their organic matter.
According to the same parameters, we could deduce the non-biodegradability of the organic matter contained in the waters of dam Dahmouni.
Compared to the quality criteria defined by the FAO (1985) and WHO (1989) guidelines, the results of study revealed that, major parameters are within the range of restriction slight to moderate, according to the classification of the FAO (1985) during irrigation periods (2008 and 2009) and there was no significant presence of heavy metals or nutriments in waters of dam Dahmouni.
Nevertheless, the situation is less shining on the microbiological plan for all samples which contained unacceptably high loads of potentially pathogenic bacteria, above those recommended by WHO (1989).
Therefore, the use of this water for irrigation of crops eaten raw is prohibited, due to the potential risks that threaten indirectly the human health and the environment.
To improve significantly the waters quality of dam Damouni for irrigation, a suitable disinfection system should be implemented for the treatment plant of Tiaret followed by a regular monitoring.

References

1. Remini B., Hydrolic and solid transport collection. (2010)182**.**
2. AL-Jasser A.O., *Journal of King Saud University. Engineering Sciences* 23 (2011) 1-8.
3. Zulu G., Toyota M., Misawa S., *Agr. Water. Manage*. 31 (1996) 269-283.
4. McNeill L. S., Almasri M. N., Mizyed N., Desalination. 248(2009) 315-321.
5. Irrigation and Power Department (IPD). An Atlas. Directorate of land Reclamation Punjab. (2008)1-132.
6. Gatica J., Cytryn E., *Environ. Sci. Pollut. Res. Int*. 20 (2013) 3529-3538.
7. AL-Jaboobi M., Tijane M., EL-Ariqi S., El Housni A., Zouahri A., Bouksaim M. *J. Mater. Environ. Sci.* 5 (3) (2014) 747-752.

8. US Environmental Protection Agency. Guidelines for Water Reuse. EPA625-R-04/018. Cincinnati. (2004).
9. WHO, Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture. Report of Scientific Group. Geneva. (1989).74.
10. Miller., Donahue., Prentice Hall. Newjerzy. ISBN: 0130958034 (1995) 649.
11. Durand J.H., Agency of cultural cooperation and technique. University press of France. (1983) 322-339.
12. Food and agriculture organization (FAO). Regional office for the Near East. Cairo. Egypt. (2000) 67.
13. Food and agriculture organization. Irrigation and drainage paper 29. Rev,1. Italy. (1985)174.
14. Hydrographic Basin Agency of Cheliff-Zahrez Hydraulic. Algeria. (2007) 51.
15. Sahli Z., Mediterranean CIHAM-option Mediterranean. Serie A. 21(1991) 49-63.
16. Regional Center for Drinking Water and Sanitation Guide. (2007) 52.
17. Hajji C., Bendou A., Hassou M., *International Journal of solar technology*. 45 (2013) 29-36.
18. Idrissi Y. A., Alemad A., Aboubaker S., Daifi H., Elkharrim K., Belghyti D., *International Journal of Innovation and Applied Studies*, Université Ibn Tofail de Kénitra, Maroc (2015). 11 (3) [556-566].
19. National Office of Drinking Water., NODW and GTZ. Rabat. (1998).
20. Kapepula L., Mateso L., Shekani A., Muyisa S., Ndikumana T.,Van der B., *Africa Science.* (*2015) 195-220.*
21. Kradolfer JP., Deront M., Adler N., Federal Polytechnic School of Lausanne. (2013) 75-132.
22. Annual balance operation of the public sanitation system (ECLA) Jura. France. (2013) 45.
23. United States Environmental Protection Agency. Laboratory: Cincinnati, OH, USA, (1985) 13.
24. Onivogui G., Balde S., Bangoura K., Barry M K., *Africa Science* 09(3) (2013) 36 – 44.
25. Weber S., Khan S., Hollender J., *Desalination 187(*2006) 53–64.
26. Wilcox LV., Edition, US Departement of agriculture. Technical bulletin. 962 (1948) 40.
27. Richards L., US salinity Laboratory. USDA. Washington. 60 (1954) 176**.**
28. Thorne D.W., Peterson H.B., Constable and company limited. London. (1954).
29. US environmental protection agency (USEPA)., Guidelines for water reuse. (2004) 478.
30. Rodier J., Analysis of water, 8th edition. Dunod. ISBN-10:2100496360; (2005) 1382.
31. APHA. Standard methods for the examination of water and wastewater. (1999).
32. Executive decree (RADP), Regulating industrial liquid effluent discharges 160 (1993).
33. Metcalf & Eddy, Inc., *4th Edition.* Mc Graw-Hill New York, ISBN-10: 0070418780; (2003) 1819 p.
34. Tatawat R.K., Singh C.P., *Environ. Monit. Assess*. 143(2008) 337-343.
35. SOGREAH, Study of detailed draft of the dam Bougara on Wad Nahr Ouassel (1986) 50.
36. Kelley W.P., Reinhold. New York. (1951).
37. Begum S., Rasul M.G., *Water Air Soil Pollut*. Focus. (9) (2009) 371-380.
38. Pescod M.B., FAO Irrigation and Drainage. Rome 47 (1985).
39. Tauxe R., Kruse H., Hedberg C., Potter M., Madden J., Wachsmuth K., *J. Food Prot.* 60 (1997) 1400.
40. Tiercelin J.R., Vidal A., 2th édition. Lavoisier, ISBN-10 : 2743009101 ; (2006) 1266.
41. Mamouni S., HTE review.147 (2010) 23-39.