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Study of the Quality of Surface Water in the Upper Cheliff Basin

Touhari Fadhila, Mehaiguene Madjid, Meddi Mohamed

Abstract**—**This work aims to assess the quality of water dams based on the monitoring of physical-chemical parameters by the National Agency of Water Resources (ANRH) for a period of 10 years (1999-2008). Quality sheets of surface water for the four dams in the region of upper Cheliff (Ghrib, Deurdeur, Harreza, and Ouled Mellouk) show a degradation of the quality (organic pollution expressed in COD and OM) over time. Indeed, the registered amount of COD often exceeds 50 mg/ l, and the OM exceeds 15 mg/l. This pollution is caused by discharges of wastewater and eutrophication. The waters of dams show a very high salinity (TDS = 2574 mg/l in 2008 for the waters of the dam Ghrib, standard = 1500 mg/l). The concentration of nitrogenous substances (NH_4^+, NO_2^-) in water is high in 2008 at Ouled Melloukdam. This pollution is caused by the oxidation of nitrogenous organic matter. On the other hand, we studied the relationship between the evolution of quality parameters and filling dams. We observed a decrease in the salinity and COD following an improvement of the filling state of dams, this resides in the dilution water through the contribution of rainwater. While increased levels of nitrates and phosphorus in the waters of four dams studied during the rainy season is compared to the dry period, this increase may be due to leaching from fertilizers used in agricultural soils situated in watersheds.

Keywords**—**Surface water quality, pollution, physical-chemical parameters, upper Cheliff basin.

I. Introduction

THE mobilization problem of water resources does not arise only in terms of quantity available; the quality of the water begins to pose serious problems [1].

The Upper Cheliff basin represents the bulk of water resources in the region of Cheliff watershed. It is a major challenge for agricultural development. However, the overexploitation of natural resources and the use of pesticides to intensify agriculture contributed to the siltation of dams and degradation of water quality [2], [3]. We examined the quality of water dams (Ghrib, Deurdeur, Harreza and Ouled Mellouk). For each of the four dams monitored by the ANRH, a water quality sheet summarizes the annual evolution of this quality for the period from 1999 to 2008.

II. Materials and Methods

Monitoring and evaluation of the qualitative status of water require a measuring network of the water quality, regular analysis, interpretation of these analyses and the comparison of results with accepted quality standards.

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The study of the quality of upper Cheliff dam waters will cover four dams in operation Ghrib, Deurdeur, Harreza, and Ouled Mellouk (Fig. 1), which are the subject of the water quality monitoring by the existence of the ANRH monitoring stations.

The water sampling was carried out monthly (with a frequency of one sample per month) by ANRH during a ten-year study cycle (1999-2008). Analyses are performed on raw water dam collected at different depths. The study focused on the in-situ measurement of pH and dissolved oxygen and the determination of other elements laboratory (TDS, OM, BOD5, COD, PO_4^{3-}, NO_2^-, NH_4^+ and NO_3^-).

Water samples were collected using plastic bottles, previously rinsed with water to be analyzed. Samples were transported in coolers at 4 °C, and analyzes were performed according to methods approved by Rodier [4].

The assessment of water quality based on the comparison of the levels of various chemical elements analyzed (often called parameters) standards or thresholds (Table I). All thresholds for the parameters taken into consideration constitute a quality grid, through which it is possible to attribute a class of quality of the dam water [5].

TABLE I
Water Quality Grid of Dams Adopted by ANRH [5]

Parametrs	Unit	Quality Scale			
		good	medium	poor	Very poor
pH		6.5 – 8.5	6.5-8.5	8.5-9	>9 et <6.5
Dissolved O_2	%	100-90	90-50	50-30	<30
NH_4^+	mg/l	0-0.01	0.01-0.1	0.1-3	>3
NO_2	mg/l	0-0.01	0.01-0.1	0.1-3	>3
NO_3	mg/l	<10	10-20	20-40	>40
BOD_5	mg/l	<5	5-10	10-15	>15
COD	mg/l	<20	20-40	40-50	>50
PO_4^{3-}	mg/l	0-0.01	0.01-0.1	0.1-3	>3
OM	mg/l	<5	5-10	10-15	>15
TDS	mg/l	300-1000	1000-1200	1200-1600	>1600

For a better representation of different levels of water pollution, we attribute a color per class that defines a quality grid adopted by the ANRH:

- Waters of good quality are represented in blue.
- The medium quality of water represented in green.
- Waters of poor quality are represented in yellow.
- Waters of very poor quality are represented in red.

III. Results and Discussion

A. Ghrib Dam

1.Annual Evolution of Water Quality (1999-2008)

Fig. 2 illustrates that the waters of the Ghribdam have a very poor mineralization expressed as TDS during the observation period. A continuous degradation of COD, what explains the increase in the mean concentrations of organic matters on the one hand,and the quantity of oxygen necessary for the oxidation energy of organic matters on the other hand. The water quality of the Ghribdam deteriorates. Indeed, the water quality was medium for 1999, has become very poor in 2006. The origin of this pollution is due to the contributions of pollutants from discharges of urban waste water and to the eutrophication process [3], [6].

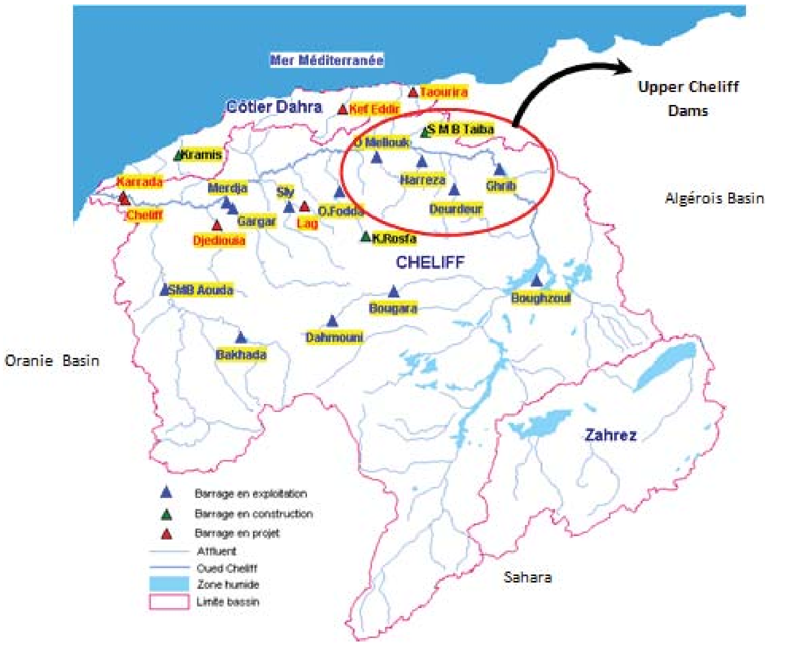


Fig. 1 Distribution of dams in the upper Cheliff basin [3]

Water dam also exhibits poor quality expressed as ammonium, nitrite and phosphate (Fig. 2), the contents are due to the oxidation of organic matter and nitrogen in irrational use of fertilizers. The Ghrib dam requires immediate action and a very thorough treatment process because its water is also intended for drinking water supply [5].

B. Deurdeur Dam: Annual Evolution of Water Quality (1999-2008)

There is a degradation of the quality of water over time according to the annual quality sheet of the Deurdeur dam, because of the increase in the organic matter concentration represented by COD, and a medium quality of the dissolved oxygen which implies a pollution contribution of pollutants from the wastewater discharges and biological process (eutrophication) by accumulation of elements in the tanks [6]. Oxidation of the nitrogen-containing organic matter causes an increase of the concentrations of NH^+_4 and NO^-_2.

TDS gave a good quality in 1999, but poor quality in 2002 (Fig. 3) and is returned to medium quality in 2007and 2008. We see a high concentration of phosphate especially in the last four years; this is the result the excessive use of fertilizers [3].

C. Harreza Dam: The Annual Evolution of Water Quality (1999-2008)

The waters of the Harreza dam show a deterioration in the physical and chemical quality expressed as TDS in the two years 2006 and 2007 (it reached 1.5 g / l in March 2007) (Fig. 4), this quality had become good in 2008. The waters of this dam are loaded NH^+_4, NO^-_2 and PO^{3-}_4 (Fig. 4). This increase is due to oxidation of nitrogen-containing organic matter and the misuse of fertilizers [3].

The improvement of water quality of this dam necessitates treatment in order to decrease the NH^+_4, NO^-_2 content in first, and phosphates [5].

D. Ouled Mellouk Dam: The Annual Evolution of Water Quality (2004-2008)

The water quality of this dam is medium for the majority of parameters. Except for super saturation with oxygen which reaches 128% in June 2005 and a high phosphate concentration ($PO4_3^-$=3.4mg/l) registered in November 2007which confirms the excessive use of fertilizers as well as pollutants from discharges of urban waste water and the eutrophication process (Fig. 5) [3].

E. Relationship Quality Parameters Evolution - Filling Dams

In order to establish a relationship between the evolution of different physicochemical parameters and the state of filling of the dams of Upper Cheliff, comparison graphs were established between evolution in certain parameters and evolution in the volume of water stored in dams studied during the period 1999-2008.

Measuring TDS is a good assessment of the degree of mineralization of water. The monthly average values recorded show significant variations (Figs. 6 (a)-(d)). Note that the salinity increases with decreasing volume of water in all the studied dams, including Ghrib dam where there was a TDS content equal to 2.8 g / l (> standard 1.5 g/l) while the volume of water stored was 51 Hm^3 in 2000. Similarly, it was found that for the month of April 2006 TDS content was 1.9 g /l for a volume of water that barely exceeds 20 Hm^3. This excessive mineralization is attributed to wastewater agglomerations located upstream of the dam [7], [8].

In addition, we noticed a decrease in salinity in March 2003 (TDS=1.2 g /l) and July2004 (TDS=1.3g /l) following an improvement in the filling level of the Ghrib dam (129$hm^3$and 154hm^3, respectively). The explanation for this decrease during the wet period is the dilution by the rainwater.

Figs. 7 (a)-(d) shows an increase in the COD of water dams, particularly in the dry period. the DCO recorded contents at Ghrib dams is about 148 mg / l for a volume of water stored at 25.6 Hm3 in September 2006, Deurdeur; COD = 123mg/l; V = 34.4 Hm3 in September 2001, Harreza: COD = 131 mg/l; V = 6.5 Hm3 in April 2006 and O. Mellouk: COD = 91mg/l; V = 11.5 Hm3 in February 2006. Indeed, the study area receives untreated wastewater rich in organic matter and nutrients from urban agglomerations, causing a considerable increase in the organic load of surface water in a restricted space.

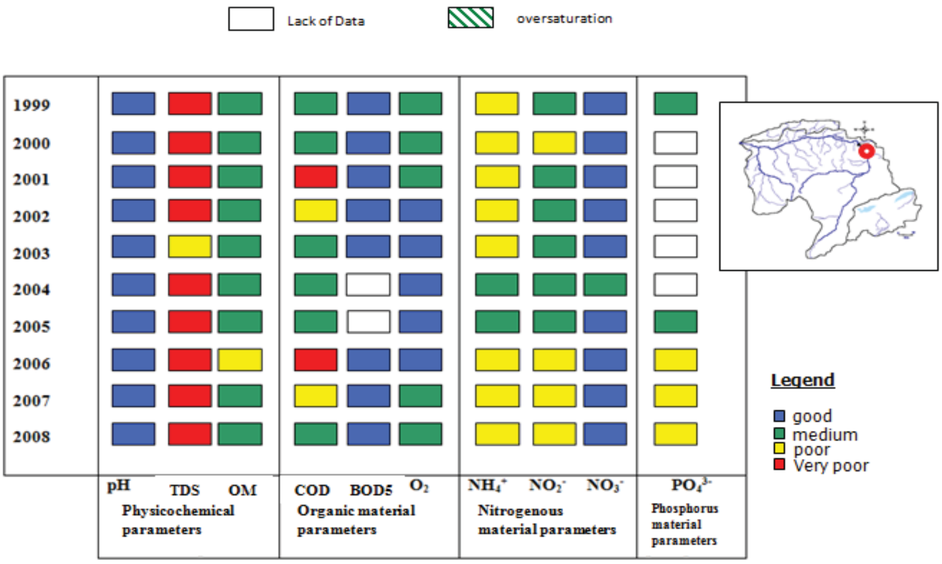


Fig. 2 Average annual Quality Sheet of Ghrib dam waters (1999-2008)

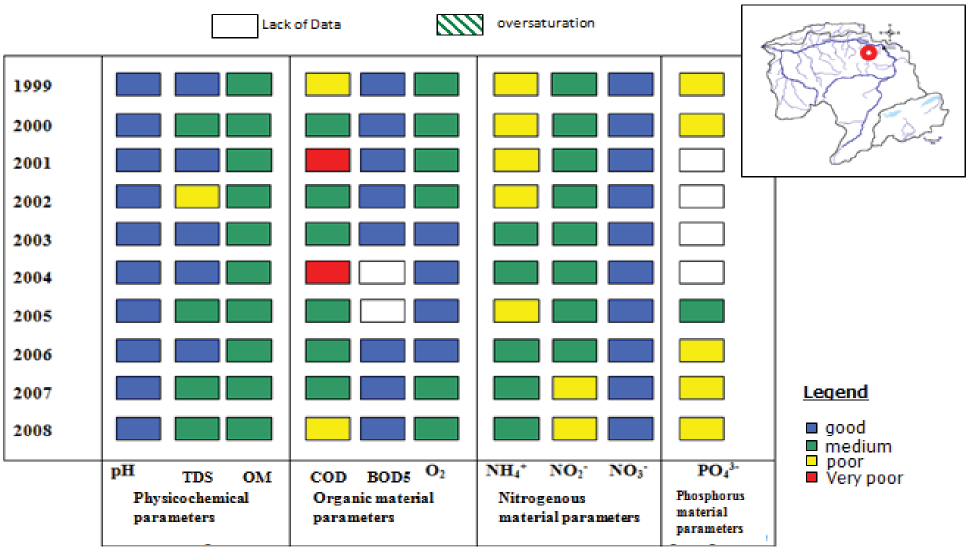


Fig. 3 Average annual Quality Sheet of Deurdeur dam waters (1999-2008)

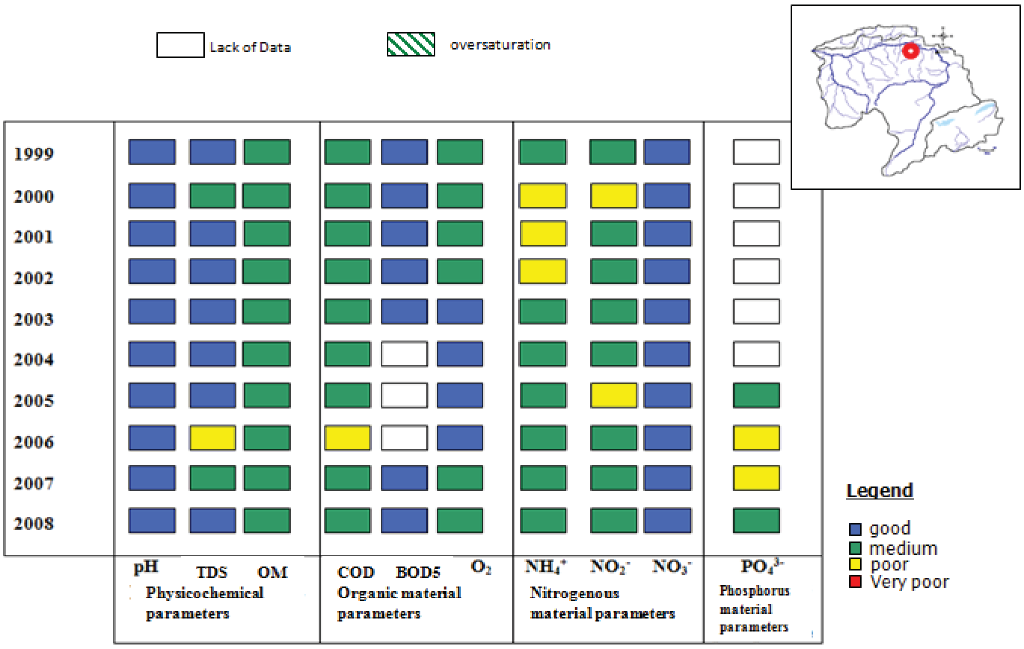


Fig. 4 Average annual Quality Sheet of Harrezadam waters (1999-2008)

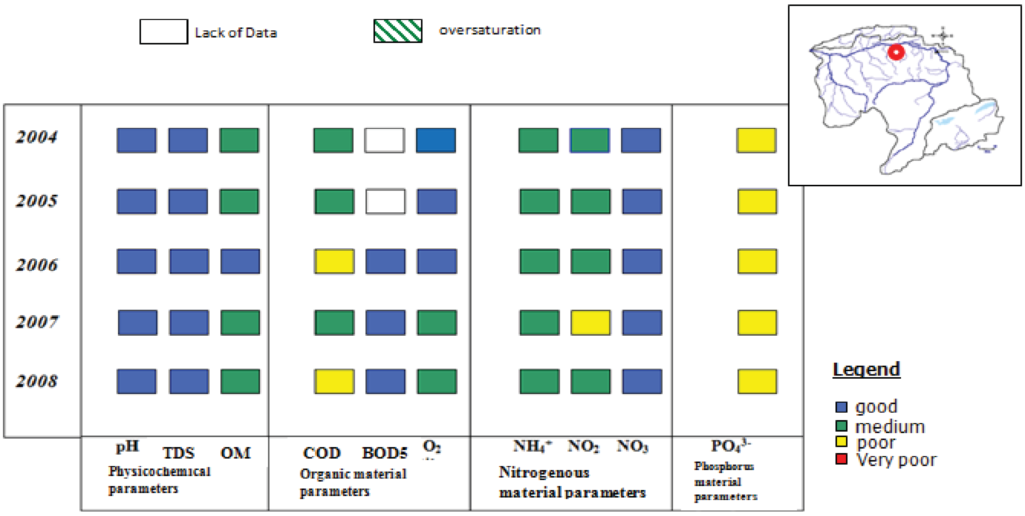
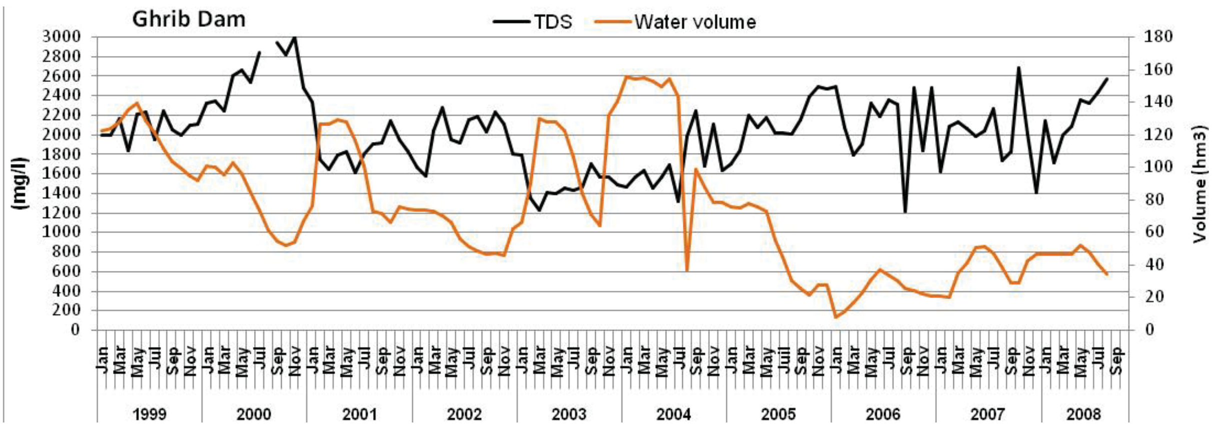
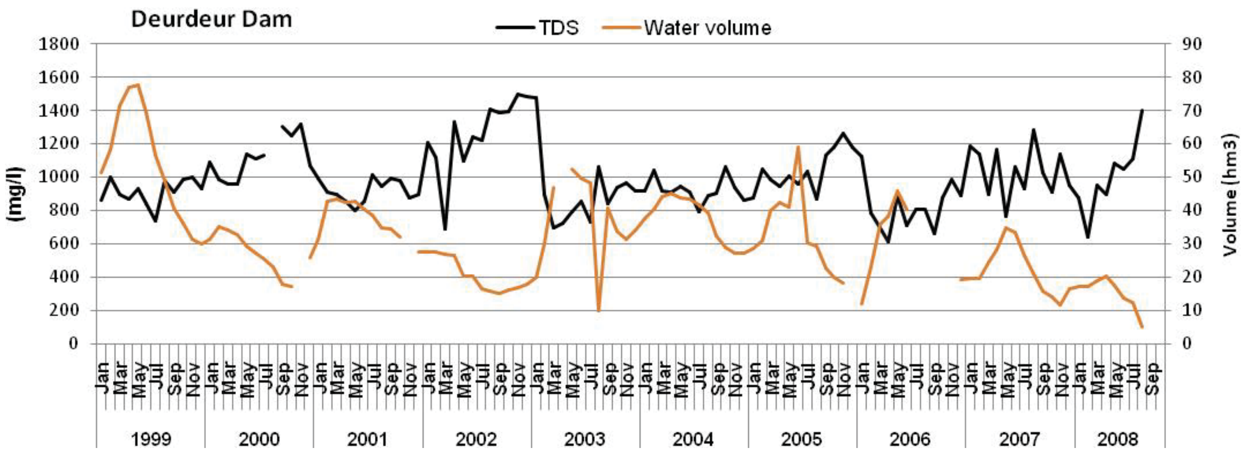


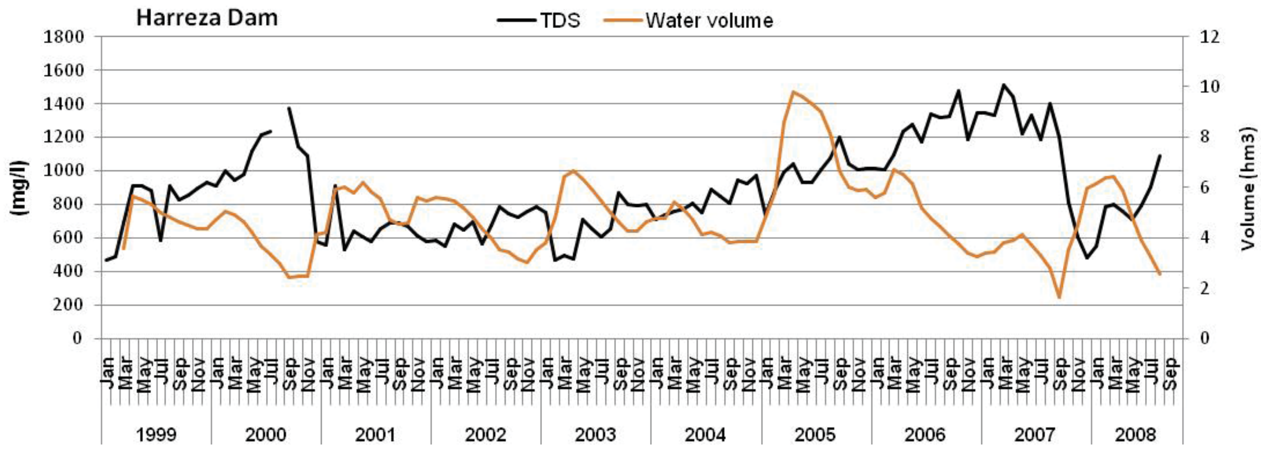
Fig. 5 Average annual Quality Sheet of Ouled Melloukdam waters (1999-2008)



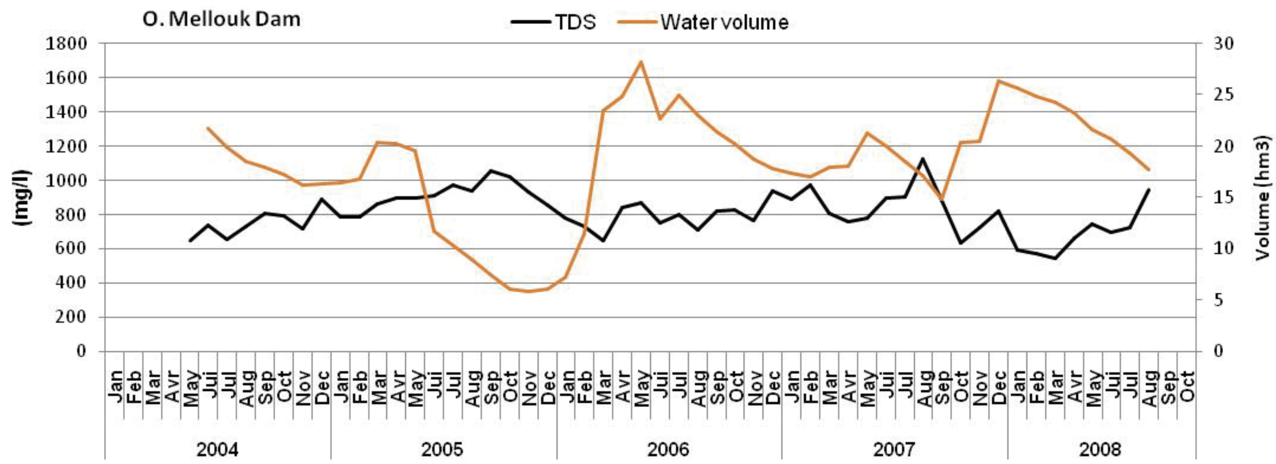
(a)



(b)



(c)



(d)

Fig. 6 Evolution of TDS and the volume of water in (a) Ghrib dam, (b) Deurdeur dam, (c) Harreza Dam, (d) O. Mellouk Dam

In wet period, however, rain water contributes to the dilution of the organic load from wastewater of riverside towns [7], [8]. The observed concentrations are significantly lower namely 9 mg/l in April 2004 for a volume of water stored in the order of 152.7 Hm3 registered in Ghrib dam, the Deurdeurdam 9.1mg / l; 41.17 Hm3 in May 2005, Harreza: 17.9mg / l; 9.79 Hm3 in April 2005 and the dam O. Mellouk: 9 mg/l; 20.2 Hm3 in April 2005.

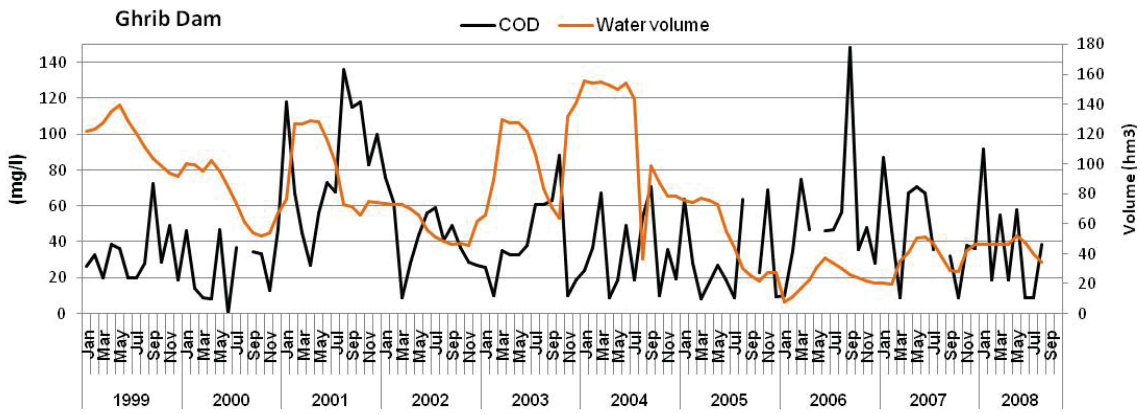
The increase in nitrate concentrations in the waters of the four dams studied (Figs. 8 (a)-(d)) during the rainy period compared to the dry period may be due to leaching of fertilizers used in agricultural soils situated in watersheds.

Particularly the case of Ghrib dam where nitrate concentrations show a strong variation (31 mg / l in April 2004) related to the improvement of the dam filling rate (152.7 Hm3). The same for the Harreza dam where we recorded a nitrate value of 45mg/l in May 2003.

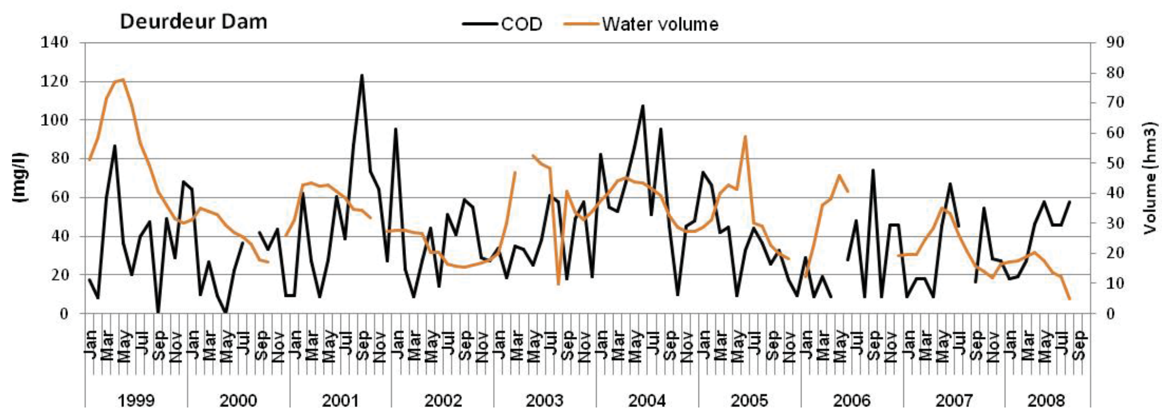
However, the low values observed during the dry season could be attributed to the wastewater discharges which have undergone any previous treatment [7], [8].

IV. Conclusion

In the upper Cheliff region, the quantity of water used is increasing because of population development and improving lifestyles. Consequently, the percentage of water extracted rises also [9], [10]. Added to this is the evolution of quality parameters over time. Thus, water for all our uses becomes rarefied, and we are heading towards a water crisis. Freshwater resources are further reduced by pollution. The importance and seriousness of this pollution are confirmed by the results observed in the study of the quality of surface waters in the region of upper Cheliff.



(a)



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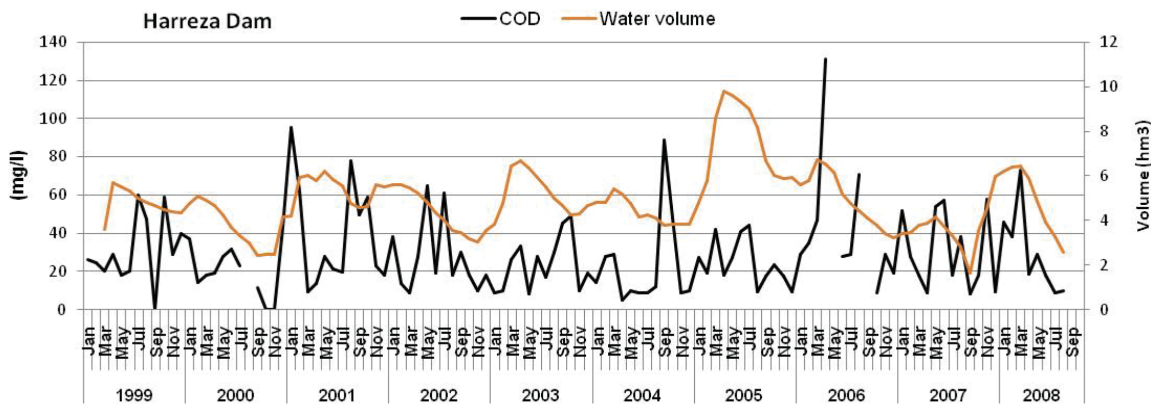

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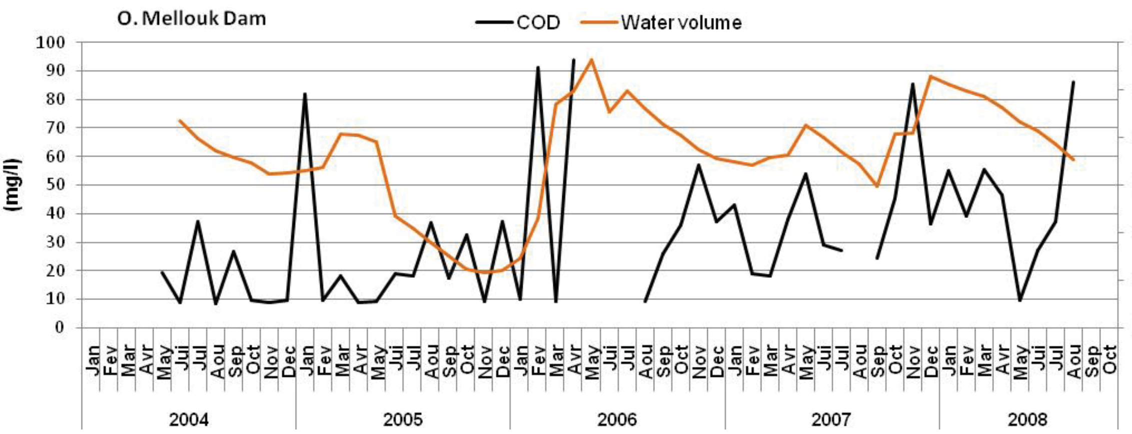
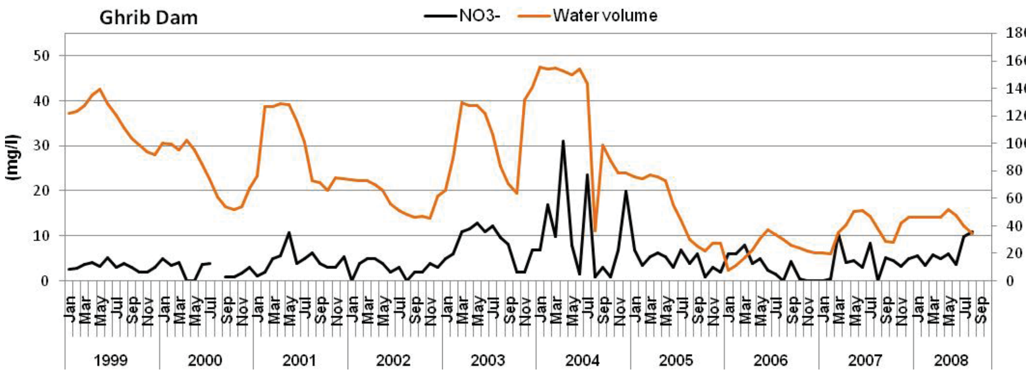


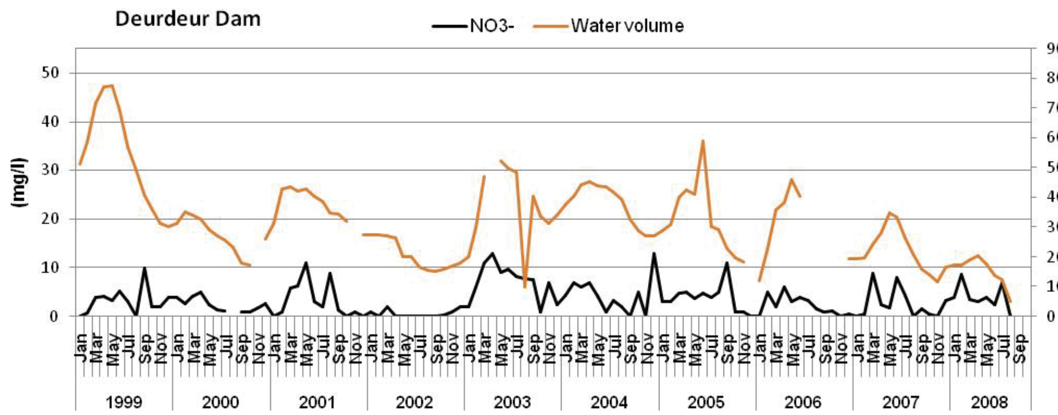
(d)

Fig. 7 Evolution of COD and the volume of water in(a) Ghrib dam, (b) Deurdeur dam, (c) Harreza Dam, (d) O. Mellouk Dam

- Quality sheets of the studied dams show degradation over time from 1999 to 2008. This is due to organic pollution, nitrogen and phosphate expressed as COD, MO, BOD_5, NH_4^+, NO_2^-, NO_3^- and PO_4^{3-}.
- And sometimes an excessive salinity (TDS> 1,600 mg/l), for example, the analyses made by ANRH showed a value of 2574 mg/l in 2008 for the waters of the Ghrib dam. The concentration of water in substances containing nitrogen (NH_4^+, NO_2) in 2008 is elevated in the dam O. Mellouk. This pollution is caused by the oxidation of nitrogen-containing organic matter.
- In the other hand, we studied the evolutionary relationship of the quality parameters and filling dams where we saw a decrease in salinity and COD due to an improvement in the filling state of the dams; this resides in the dilution water by the contribution of rainwater. While the increased nitrate concentrations and phosphorus in the waters of four dams studied during the rainy period compared to the dry period, this increase may be due to leaching of fertilizers used in agricultural soils situated in watersheds.



(a)



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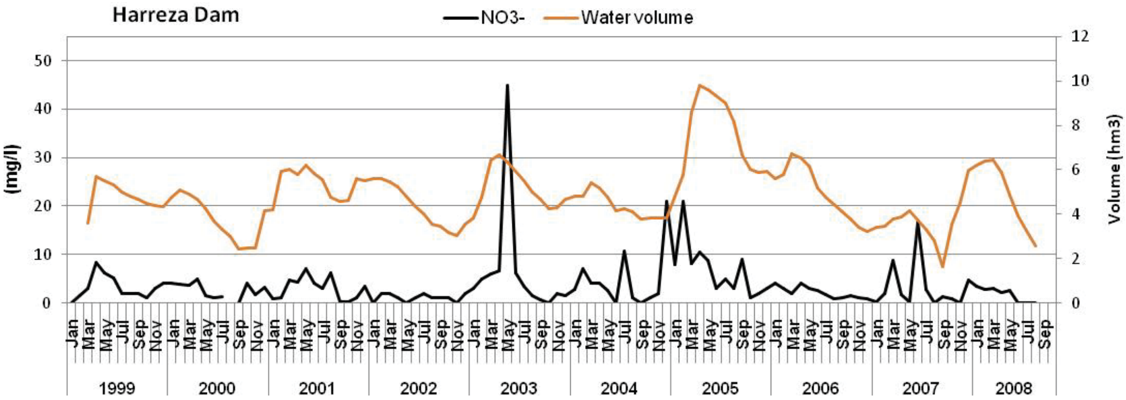

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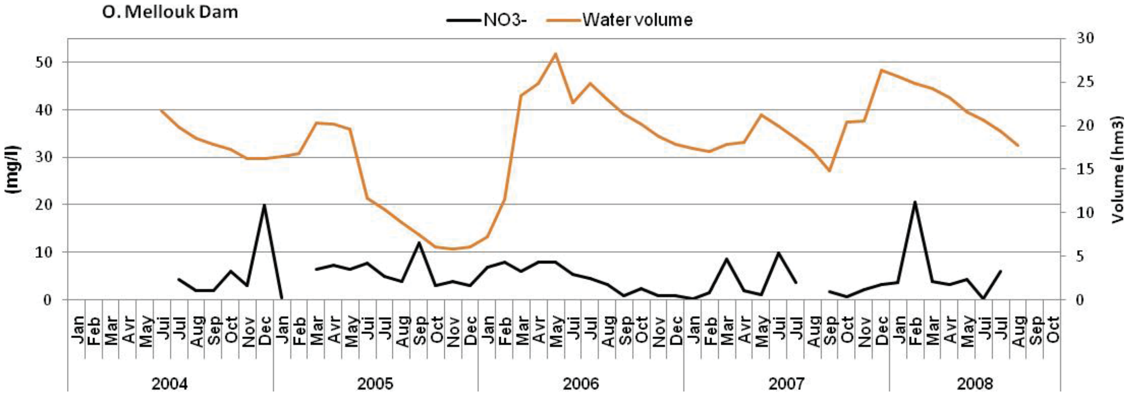

(d)

Fig. 8 Evolution of NO_3^-andthe volume of water in (a) Ghrib dam, (b) Deurdeur dam, (c) Harreza Dam, (d) O. Mellouk Dam

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