



Research Article

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Organic pollution of surface waters in the watershed of the Bouna-moussa Wadi Region (North-East Algeria)

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ABSTRACT

In Algeria, the water quality in the streams is deteriorating. One of the causes of this environmental pollution is the crop fertilization practices such as the addition of nitrates, eutrophication which causes the degradation of continental marine and aquatic environments from nitrogen inputs. The objective of this study is to evaluate nitrogen pollution in surface waters of the Bouna-moussa Wadi using a physico-chemical approach. This watercourse drains into a watershed mainly characterized by agricultural activities based on irrigated crops and livestock raising sheep and cattle. Fertilizers and livestock waste are important and potential sources of pollution, in the form of mineral and organic nitrogen, having for final destination the hydro-system of this watershed. The analysis of water and soil samples showed that the Bouna-moussa Wadi's index of organic pollution has gone from one class to another in the different periods. This is mainly due to the lack of control of different discharges and untreated water.

Key words: Bouna-moussa, Nitrate, Nitrogen, pollution, wadi, watershed.

INTRODUCTION

The protection and conservation of natural environments, especially the quality of aquatic eco-systems and water resources has become a major concern in the areas of sustainable development. Indeed, the context of increasing scarcity of national water resources and the degradation of water quality, has led our country to grant parallel efforts for development and water resources management; with particular interest in the economy of water, and control of all types of water pollution.[5]

In Algeria, the surface water resources are one of the capital resources of the country. The water is a finite and vulnerable resource that is essential to life thus, its' protection and proper management is absolutely necessary. [9]

Water shortages, for exaggeration have been most often associated with natural phenomenon (desertification, and climate change), with human errors in management of this resource compounding the issues Expert Burton J explains: "Today there is a water crisis, but this crisis is not about having too little to meet our needs; rather it is the result of bad management of this resource from which billions of people and the environment suffer greatly".[6]

The region of El-Tarf is essentially rural. Its water resources are heavily used for agricultural activities and drinking water supply. The degradation of the quality of natural water is caused by leaching farmland, domestic and industrial liquid waste. The load of these discharges is increasingly growing with the socio-economic development of this region.[11]

The problems of water quality in the rivers are most associated with the areas devoted to annual crops that require large amounts of fertilizer. In this problematic context, our work is a contribution to the study of water pollution in wadi Bouna-moussa by the various chemical forms of nitrogen.

EXPERIMENTAL SECTION

Geological setting of the province of El-Tarf

The region of El-Tarf is located in the extreme north-east of the Algerian and Tunisian border. This region has been created during the last administrative division of 1984.

The region of El-Tarf covers an area of approximately 891 km²; it is limited to the north by the Mediterranean Sea, south-west and south by the provinces of Souk Ahras and Guelma, to the west by the wilaya Annaba and East by the Algerian-Tunisian border.[4]

The El Tarf Wilaya consists of a hydrographic network composed of the Oued El Kebir and the secondary tributary as Bouhaloufs and Amisida wadi, Wadi Boulatane bougous makes a delta to the area of El-Battah with wadi Bounamoussa.[8]

Wadi Bouna-moussa is one of the major rivers of the province of El-Tarf. It flows in the south-east part of Annaba meandering with a fairly cashed bed of quaternary alluvium. Before leaving the mountains of Cheffia (Prov. El - Taref), the river drains the small plain of Asfour that is attached to the plains of Annaba in eastern Zerizer before reaching the dune area. It has a junction with wadi Mafragh that crosses the dunes and empties into the Mediterranean Sea. However, the mouth has relatively low water flow speeds and is predominantly closed by a sandy barrier.[1]

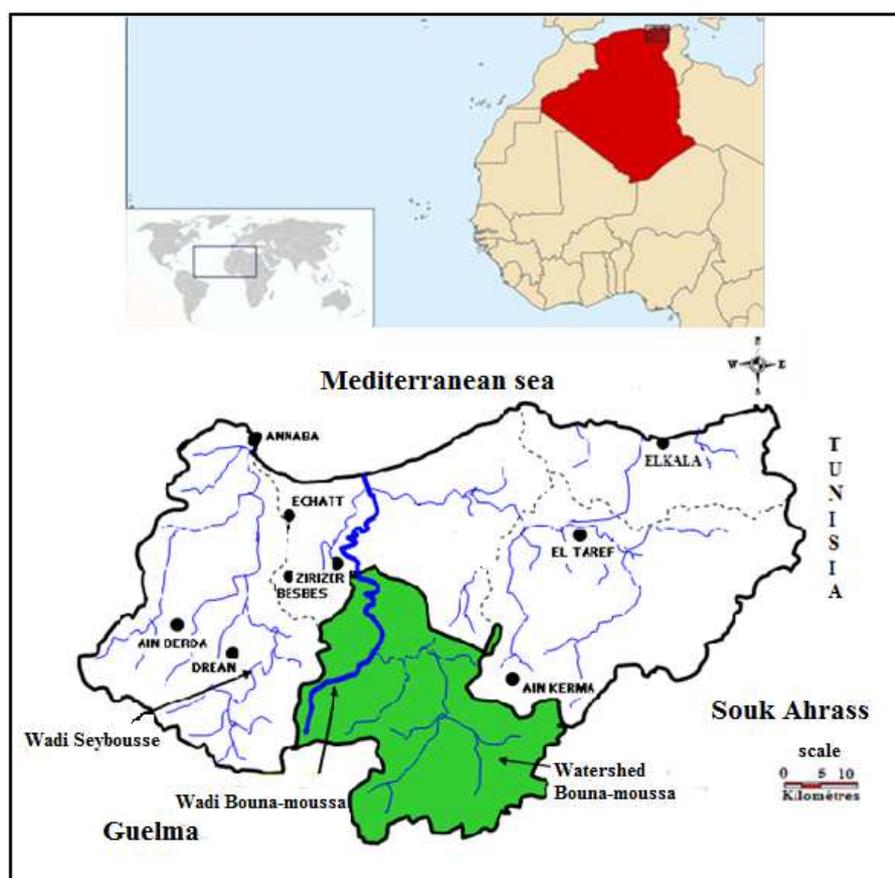


Figure 01. Geographical location of the watershed Wadi Bouna-moussa

For this study, we have chosen ten sampling water and soils stations. Accessibility, proximity to high population density urban areas and confluence points of contributory water running along agricultural areas; are the reasons that led us to choose these ten stations which are located between the El Cheffia's dam and its outfall, the Bouna-moussa wadi, El-Battah station, in the downstream sequence of the Bouna-moussa wadi to El Cheffia's dam.

Sampling

Water samples were taken in ten different stations and they were observed at the times of high water (H.W) and the periods of scurvy water (SW) on the dates of 28/09/2013 (H.W), 28/12/2013 (H.W), 28/03/2014 (S.W) and

28/07/2014 (H.W), in the best operating conditions in order to maximize their conservation in the physic-chemical laboratory.

Table 01. The Geographic Locations of Sampling Stations

Station Name	Number	Abbreviation	Latitude	Longitude
Borj Essammar	01	BJ	36°47'41.1 N	007°49'56''E
Pont Zérizer	02	PZ	36°43'33.6 N	007°56'35.2''E
Nchayma (1)	03	N1	36°42'44.9 N	007°57'30.1''E
Nchayma (2)	04	N2	36°38'41.6 N	007°56'47.4''E
Skoufi	05	SF	36°54'48.6 N	007°59'52.4''E
Bouzitouna	06	BZ	36°38'40.6 N	007°54'47.4''E
Barrage El-Cherfia	07	BE	36°35'49.3 N	007°58'57.6''E
Pont Ben Mhidi	08	PB	36°44'24.2 N	007°55'22.7''E
Griette	09	GR	36°50'06.1 N	007°57'13.8''E
Station El-Batah	10	SB	36°50'31.2 N	007°57'13.8''E

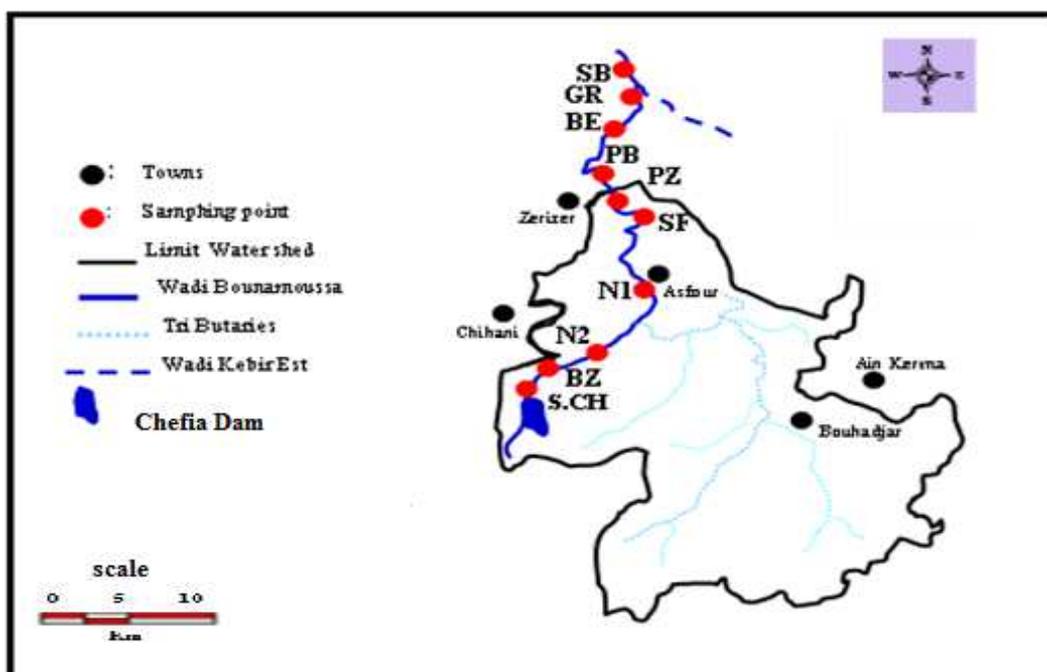


Figure 02. Map of the location of water sampling stations in the Bouna-moussa wadi

Physico-chemical analysis of water samples

The physico-chemical parameters of the water samples are: the pH, temperature, and electrical conductivity which were measured in situ using a multi-parameters device. The other parameters were analyzed in the building of FERTIALE, an International Company located in Annaba-Algeria.

The exact dosages of Nitrite, nitrate, and ammonium dosages have been performed in the National Sanitation Office (ONA) Annaba according to these standardized methods:

- Ammonium: NH₄ N FT90-015.laboratoire of Annaba WWTP.
- Nitrates: Annaba treatment ISO13395 complex.
- Nitrites: ISO sewage 6777-1-1984 Annaba complex.

Table 02. Discharges near Ten Stations of Samples in the Watershed of wadi Bouna-moussa

Sampling stations	Releases
Borj Essamar	- Wastewater discharge agglomeration. - Agricultural leaching.
Pont Zérizér	- Rejection of the wastewater treatment plant in the village Zerizer. - Rejection of the tomato canning "El Boustene".
Nchayma (1)	- Agricultural leaching. - Urban waste.
Nchayma (2)	- Agricultural leaching. - Various human activities.
Skoufi	- Rejection of the treatment plant of El Asfour. - Waste water discharges. - Agricultural leaching
Bouzitouna	- Use of water for domestic purposes (wool scouring)
Pont Ben Mhidi	- Rejection generated by all bordering the river.
Griette	- The addition of Oued Bounamoussa and Oued El Kebir rivers Carrying toxic waste (sewage, dead animals, debris, etc.)
Station El Batah	Various human activities.

RESULTS AND DISCUSSION

Nitrogen mineral concentration in the waters of the downstream sequence of wadi Bouna-moussa

The results of analysis from different water samples related to ammonium ions, nitrites, and nitrates are discussed on the basis of graphed information and each station's environment. The observations focused on the spatial and temporal variations of the nitrogen concentrations, their sources, and the water quality's state in the downstream of the Bouna-moussa wadi.

Ammonium

In natural waters, ammonium ions usually translate an incomplete chemical and micro-biological degradation process of organic matter. It may be considered an excellent indicator of pollution in surface waters by agricultural or domestic waste.

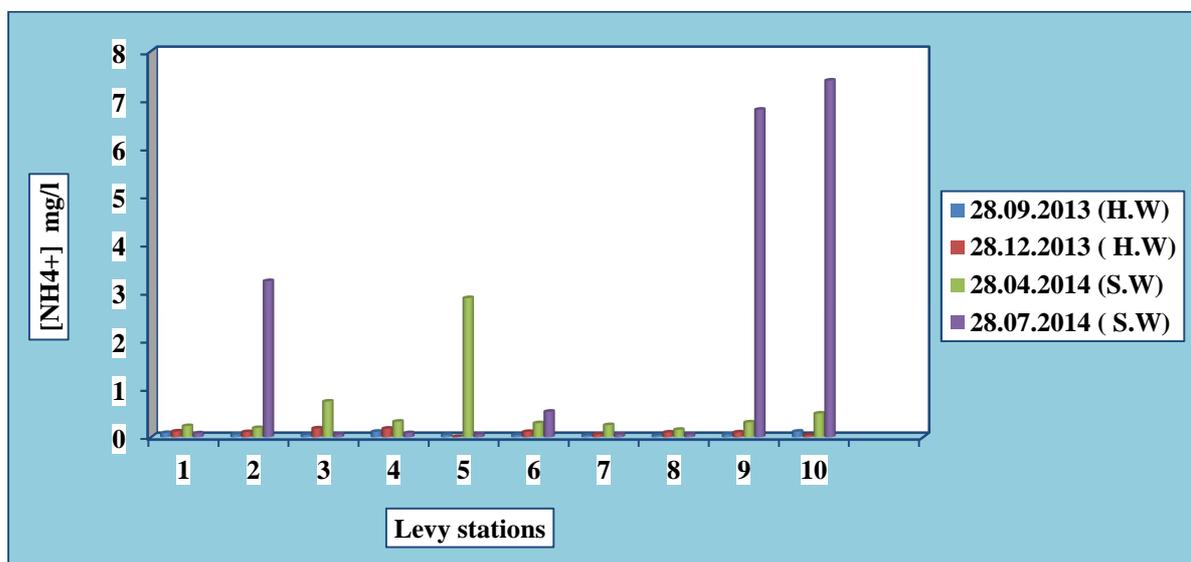


Figure 03. Variations of ammonium ion concentrations in the downstream sequence water of the Bouna-moussa wadi

For all results (Fig03), we notice that highest values were recorded during periods of low water, regularly in the months of April and July at stations (S2), (S5) (S9) and (S10) with the maximum value of the ammonium concentration being 7,4 mg/ l. These values exceed by far the contamination threshold fixed by the OMS for drinkable water which is 0,5mg/L. These results allow us to deduce that these effluents are not acceptable for the irrigation of the crops. [2]

Nitrite

Nitrite is a product of several oxidation reaction and reduction involved in the various nitrogen transformation processes.[7]

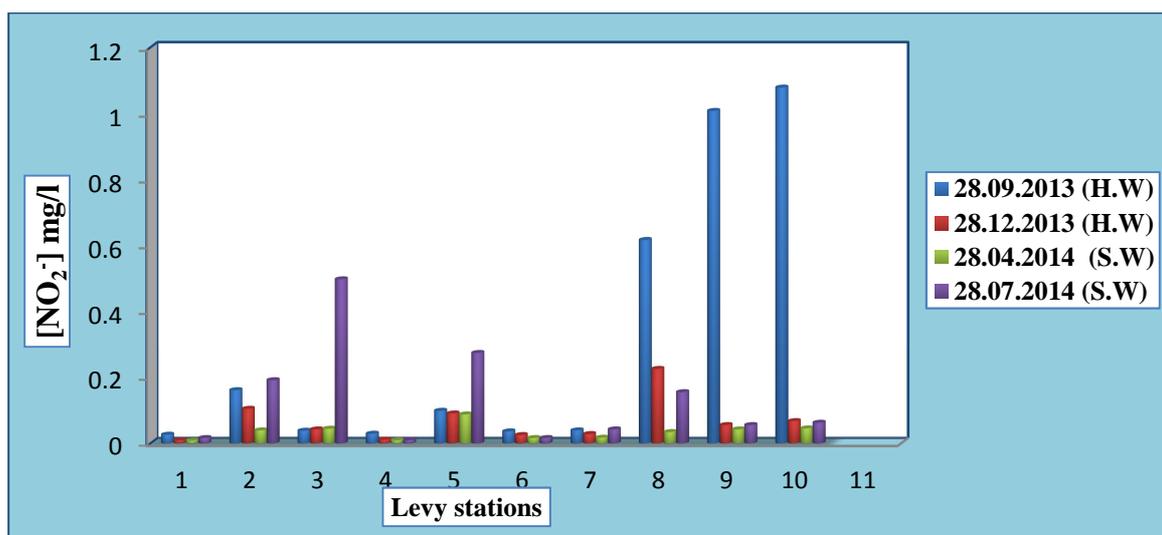


Figure 04. Variations of nitrite ions concentrations in downstream sequence water of the Bouna-moussa wadi

In natural aquatic or edaphic environments influenced by soil, nitrite ions are generally produced through a chemical species in the nitrification process when the medium is oxygen and denitrification occurs when the environment is anoxic.[10]

Nitrite ions are especially abundant in low oxygen, rich aquatic organic matter, fairly deep sediments and in little streams invigorated from receiving domestic wastewater.

The nitrite ions' seasonal average concentrations found in the water samples of the Bouna-moussa wadi were relatively high in September at station 10 with a value of 1,08 mg / l.

These results exceed the acceptable values fixed by the OMS for drinkable water which is 0,1 mg/l. [2]

This might be the confirmation that the surface waters of the Bouna-moussa Wadi are waters contaminated by the Nitrate ions.

Nitrate

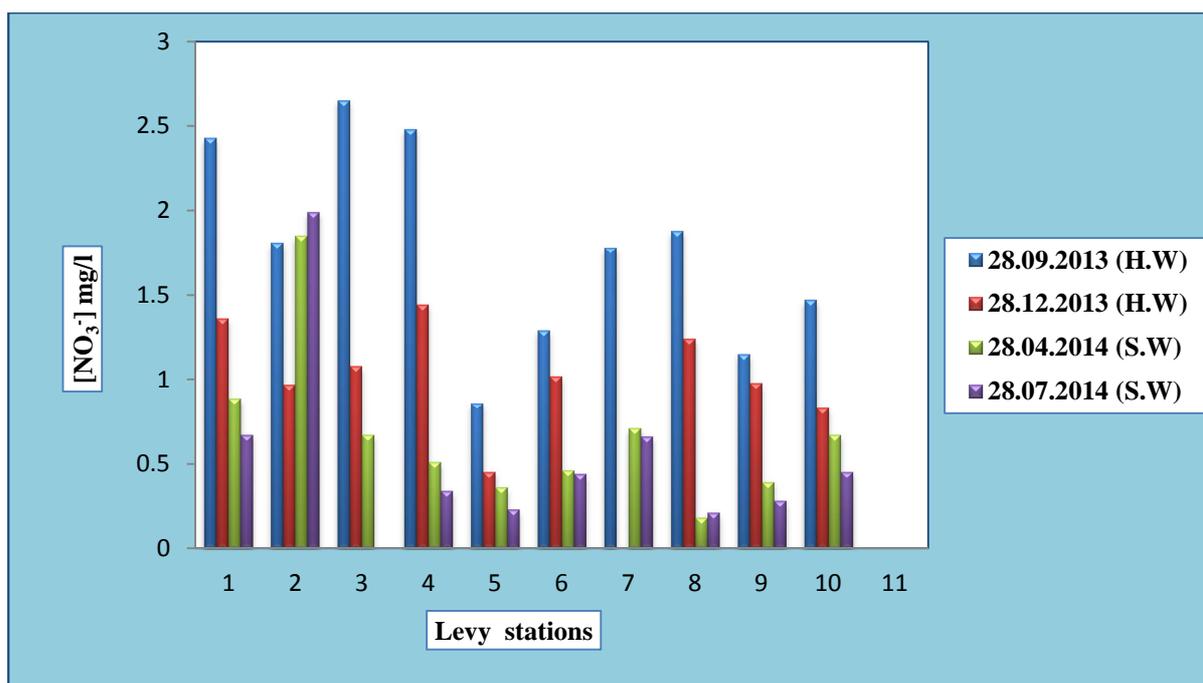


Figure 05. Variations of nitrate ion concentrations in downstream sequence water of the Bouna-moussa wadi

In the case of the Bouna-moussa wadi, the concentrations of nitrate ions are higher in periods of higher water levels. This was observed during September at stations 1.3 and 4 with the values of 2,43 mg/l , 2,48 mg/l and 2,65mg/l and in December at stations 1 and 4 with the values of 1,36 mg / l and 1,44 mg / l respectively. These stations were positioned in a purely agricultural area with leaching as the major source of the enrichment of the water producing these nitrate ions [Table 2].

Organic pollution index

The information on the degradation of the quality requires us to determine the degree of organic pollution.

Nitrite, nitrate, and ammonium can be used to estimate the organic pollution of aquatic environment by calculating organic pollution index using the *Leclercq and Maquet (1987)* method. They categorize the values of nitrogen parameters in 5 classes and determine the analytical results from the corresponding class number. [11]

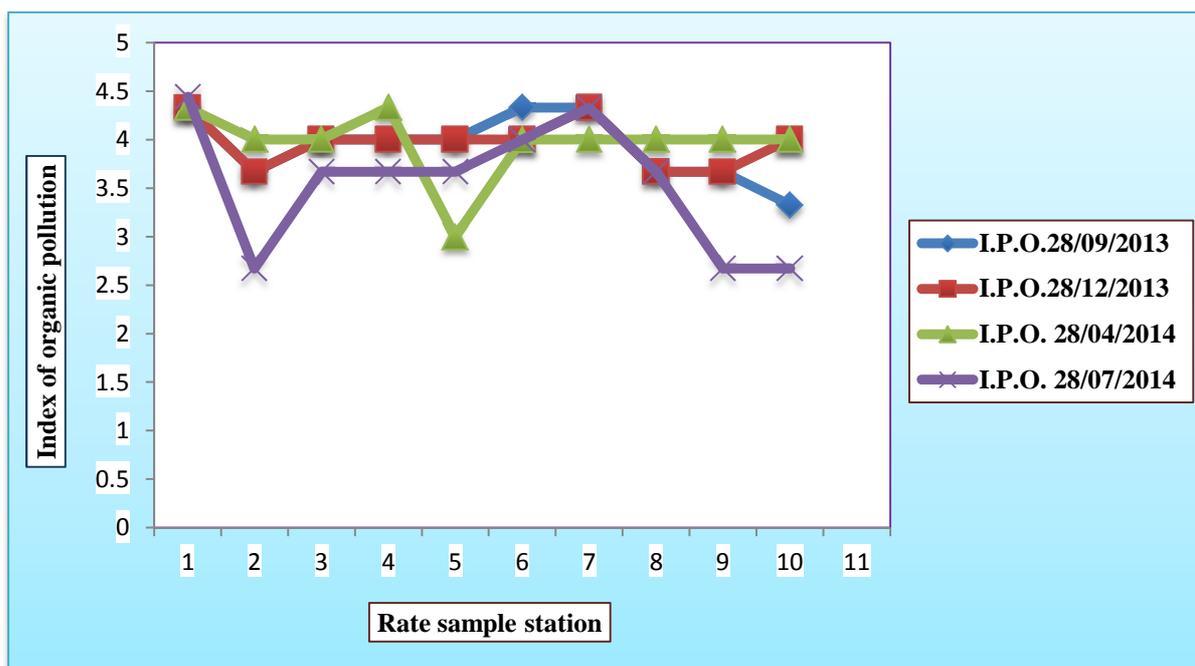


Figure 06. Variations in the index of the organic pollution

The classification of organic parameters is done according to five quality classes corresponding to accepted interval:

- IPO = 5.0 to 4.6: zero organic pollution.
- IPO = 4.5 to 4.0: low organic pollution.
- IPO = 3.9 to 3.0: moderate organic pollution.
- IPO = 2.9 to 2.0: strong organic pollution.
- IPO = 1.9 to 1.0: very strong organic pollution.[3]

The values of organic pollution index in the waters of the Bouna-moussa wadi are shown in the (Fig06). These indices indicate that the water quality of the Bouna-moussa wadi moving from a low organic pollution in the period of high water to a high organic pollution in the low water. Changing values of this index along the studied flow of the river during the low water period show that its' pollution is related to leaching of agricultural deposits and waste water from the agglomerations of Borj Esammar, El Asfour, Ben Mhidi, and Zerizer areas.

CONCLUSION

In this study, the mineral forms of nitrogen were followed in the downstream of the Bouna-moussa wadi during two different periods of time: low and high water levels. A global evolution of pollution origins in these river surface-waters during periods of dry weather and wet weather was established. Discharges of urban waste water and leaching of agricultural soils in the watershed can be considered as the main sources of nitrogen and organic pollution of the streams.

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