STUDY OF PHYSICO-CHEMICAL AND BACTERIOLOGICAL QUALITY   WATER OF THE OUED BOUFEKRANE, AREA OF MEKNÈS

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ABSTRACT

Toilets resources in Morocco are limited because of the semi-arid climate characterizing the major leave of the territory and the occasional droughts. The rapid increase in toilets demand and the continued deterioration of the quality of resources inevitably exacerbate tensions between users and accelerate the negative mascon

Tea city of Meknes is particularly affected by the problem of pollution. The Boufekrane is one of the toilets streams pertaining to the superficial toilets network of the city that is currently being threatened by human activities. To evaluate the extent of pollution of this stream, our study has focused the physico-chemical and microbiological.

The Present study has covered six spots one the bed of the Boufekrane from its source Ain Maarouf to the city of Meknes. The study has found out that the physico-chemical and bacteriological parameters measured for this stream cuts gradually been evolving from the Boufekrane source to the city of Meknes resulting in mineral important year load and has serious downstream fecal contamination.

Keywords: Boufekrane wadi, pollution, physical chemistry, bacteriology

INTRODUCTION

Arid country with semi-arid, Morocco has a rather fragile equipment in water resources. The hydrological context of Morocco remains mainly influenced by a very marked annual irregularity precipitations and a heterogeneity of their spatial (COP 7.2001; CSEC, 2001). The available resources do not exceed 21 billion m3/an, that is to say in 1996, 830 m3/hab/an and 411 m3/hab/an in 2020 (DGH, 2002).

They, in addition, are subjected to extreme cyclic variations. Cycles of acute droughts which have important consequences on the national economy, in particular agricultural. These pressures on the water resources are accompanied by an increasingly serious increasing degradation of their quality.

The town of Meknes is concerned with the problem of pollution because of its increasing demography and the development of the industrial sector.

The taking away in the basin were carried out with an aim of evaluating and of characterizing the quality of water of the Boufekrane wadi and of identifying the effect of the rejections of waste waters on quality of the waterway.

MATERIALS AND METHODS

Zone study

The town of Meknes is located in the septentrional part of Morocco. The city is located at 140 km east of Rabat and 60 km in the South-west of Fes (Figure 1). Its coordinates are the following: 5° 33' West, 33° 54' North, Altitude: 530m (average). The climate is of Mediterranean type, with an average pluviometry of 660 mm/an (Chahlaoui, 1996).

The Boufekrane wadi is one of the affluents of the basin of Sebou, its watershed is 40 km south of the city of Meknes. Six stations were selected on the natural bed of the Boufekrane wadi. The choice of the sampling stations was carried out according to the establishment of the human activities and industrial; they are presented on figure 1 of the upstream to the downstream:

•B1, Source Ain Maarouf
•B2 and B3, Stations located in a zone of great agricultural and domestic influences of the Boufekrane village
 •B4, Station located downstream from the urban area of the Boufekrane village
 •B5, Station located in the Zehoua district which knows an urban density
•B6, Station located at the downstream of the Boufekrane wadi, the exit of the town of Meknes.
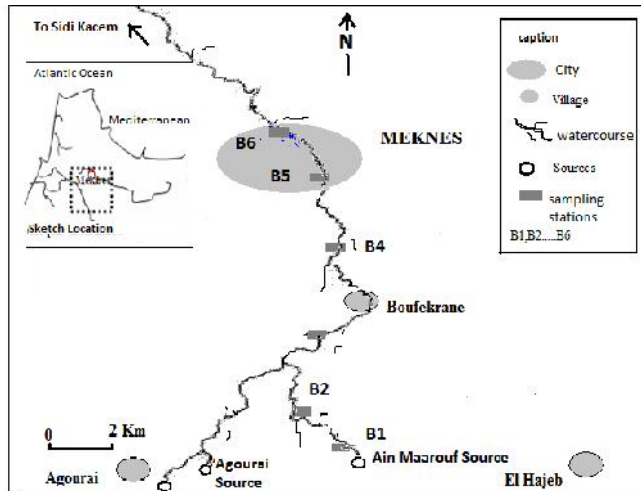
Figure 1: Chart of situation of the zone of study

SAMPLING AND ANALYSES

Physicochemical analyses

A monthly sampling was carried out during the period "June 2010-November 2010". For the physicochemical analyses, the taking away of water is carried out in bottles of 1,5L, starting from the stations of studies the most used in irrigation. On the whole, 7 parameters of pollution were measured. The physicochemical study of water related to the determination of the pH, the temperature (°C), conductivity (E.C.), of the chlorides (Cl), of nitrates (NO3), orthophosphates ($PO_4$3-) and dissolved oxygen (O_2). The methods used are those quoted by Rodier (1984). The temperature measurements of water, the pH and conductivity are taken on the ground by using portable waves.

Bacteriological analyses

For the bacteriological analysis, the water samples are taken in sterile ground stopper bottles, of a capacity of 500 ml. For the research of the salmonellas, a volume of 5L was taken in quite clean plastic cans. The transport at the laboratory of the bottles of taking away was accomplished in a refrigerator at low temperature (+4°C).

The enumeration of the indicating bacteria of the fecal contamination "fecal coliformes (CT) total, coliformes (CF) fecal and streptococci (SF), as well as the research of the pathogenic germs of salmonellas type and *Vibrio Cholérea*, were carried out according to the techniques described by Rodier (1984).

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RESULTS AND DISCUSSION

Physico-chemical quality of water of the Boufekrane wadi

The evolutionary study of the average contents of the principal parameters and indicators of pollution showed that:

- The values of the pH of water of the Boufekrane wadi are in the normal zone, variable from 6.93 to 7.68 (Table 1). The pH is slightly neutral or acid on the level of the stations. This reduction would result from the bacterial activity of decomposition from the organic matter (Ansa-Asare et al., 1999; Neal et al., 2000).

It average temperature of water presents values ranging between 20, 28°C and 21,95°C (Table 1). The temperatures of water on the level of the Boufekrane wadi are characterized by higher values on the level of the station upstream (B1), and lower values downstream from the wadi (B5). The analysis of the median values of the temperature of water on the level of the wadi does not show significant differences between the studied stations. The observation of the median values on the level of water of the Boufekrane wadi shows average temperatures more important than those recorded by other authors on the level of the other wadis of the area (Eladdouli, 2010; Aboulkacem, 2007).

- The space evolution of chlorides on the level of the stations of the Boufekrane wadi shows that the weakest concentrations are recorded on the level of the stations upstream of the wadi; The chloride levels reach more important values after the crossing of the town of Meknes (B5 Station and B6), which agrees with the observations of the other authors having mentioned that the chloride concentration increases in a way continuous and proportional under the effect of the urbanisation (Edwards and Thornes, 1973; Bontoux, 1993; Cun and Vilagine, 1997).

- On the level of the Boufekrane wadi, the average orthophosphate concentrations show important in B4 and B6, and low values in B1 and B3 (Table 1). The high percentage of orthophosphates at the B6 station compared to the B1 station could be explained by the effect of the rejections of waste waters (Vega et al., 1998; Neal et al., 2000; Jonnlagadda and Mhere, 2001; Silva and Sacomani, 2001).

- The space evolution of the content nitrates follows a gradient decreasing of the upstream towards the downstream of the wadi. The intensive agricultural activities practised on the whole of the catchment area, the leaching of the grounds by surface waters and the training of waste of vegetable and animal origins, very rich in nitrogenized organic compounds, would undoubtedly be responsible for the rise in the concentrations in nitrates on the level of the stations upstream of the wadi (Levallois and Phaneuf, 1994).

Table 1: Results of the physicochemical and Bacteriological parameters of
water of the Boufekrane wadi

| Parameters / Stations		pH	T (°C)	Dissolved O2 mg/l	C.E µs/cm	NO3 mg/l	Cl mg/l	PO$_4$3 mg/l	CT UFC/ 100 ml	CF UFC/ 100 ml	SF UFC/ 100 ml
B1	Average	6.62	17.5	3	713	5.71	69.22	1.54	47	25	20
	Maximum	6.97	21.95	4.5	736.5	6.07	83.95	1.83	102	65	32
	Minimum	8	27.6	7	772	6.80	99.40	2.02	2,102	102	47
B2	Average	6.93	16.7	2	718	5.72	63.6	2.37	8,102	57	3,102
	Maximum	7.20	20.85	3.57	734.5	6.06	67.4	2.83	104	6,102	103
	Minimum	7.56	26.5	6	751	6.72	71	3.47	3,104	2,103	5,103
B3	Average	6.67	16	1.42	706	5.69	60.35	1.54	3,103	2,102	22
		6.98	20.53	3.11	722.67	6.01	70.05	2.45	2,104	8,102	2,103
	Maximum	7.15	26.1	5	741	6.56	88.75	3.14	5,104	2,103	7,103
B4	Minimum	6.62	15	1.24	722	5.41	67.45	3.66	104	3,102	95
	Average	6.93	20.57	2.84	784.67	5.92	89.88	4.65	105	2,103	103
	Maximum	7.1	24.3	4.60	874	6.58	134.9	5.37	5,105	104	6,103
B5	Minimum	6.82	14.6	1.34	871	5.29	81.65	3.06	4,104	2,103	102
	Average	6.97	20.28	2.58	910	5.72	112.85	4.32	8,106	3,104	7,103
	Maximum	7.08	24.3	3.70	956	5.95	127.8	5.03	5,107	105	2,105
B6	Minimum	7.04	16.5	1.04	802	4.88	79.87	4.29	5,105	2,104	6,102
	Average	7.68	21.2	2.06	898.67	5.43	100.60	5.79	107	3,105	8,104
	Maximum	9.1	24.6	4.40	948	5.94	127.8	7	5,107	8,105	3,105

The water of the Boufekrane wadi is about mineralized and presents median values ranging between 722.67µs/cm and 910µs/cm (Table 1). During this study period, the space evolution of conductivity reveals maximum concentrations with the downstream of the wadi. This increase downstream could be explained by the effect of the rough effluents rejected into the receiving medium without treatment (Chahlaoui, 1996; Silva and Sacomani, 2001). The actual values along the stations Station B5 and B6 confirm the assumption of an increased pollution of water of the Boufekrane wadi.

- The evolution of the oxygen dissolved in water of the Boufekrane wadi represents a clear deterioration of the quality of water downstream from the wadi, the continuous oxygen content to decrease by the upstream towards the downstream and passes from 4.32 mg/l to 2.06 mg/l (Table 1). This dissolved oxygen deficit is important, probably in relation to strong organic loads generated by the liquid effluents of the town of Meknes in charge of polluting substances (Ansa-Asrae et al., 1999; Lehmann and Rode, 2001). For this parameter, water of the Boufekrane wadi can be classified in the category of water of average to poor quality (CNS, 1994).

Bacteriological quality of water of the Boufekrane wadi

- The space variation of the load in CT in the various stations located on the Boufekrane wadi shows very important differences between the upstream and the downstream, (Table 1) and reveals the existence of a gradient growing of the upstream towards the downstream.
The temporal evolution of the CT along the stations of the Boufekrane wadi shows fluctuations for the study period. The CT are numerous during the season of summer (July-August). The period of autumn (September-November) (Figure2) is characterized by a reduction in the germs (mainly October), followed by a significant rise during November.
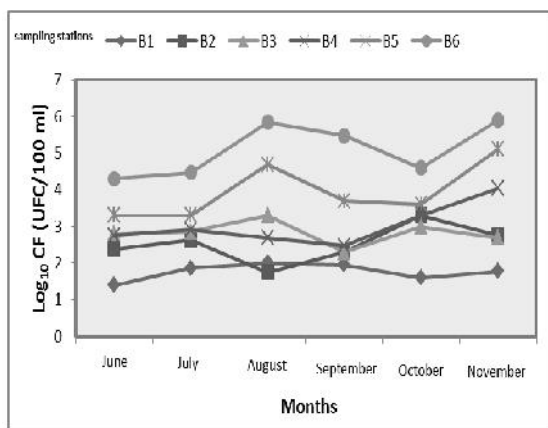
Figure 2: Monthly variations of the concentration of the fecal Coliformes on the level of the stations of the Boufekrane wadi.

- In a general way, the space variation of the CF recalls that of the CT and confirms the fecal contamination of water of the Boufekrane wadi and reveals a clear deterioration of the quality of the wadi to the downstream. The concentration average in coliformes fecal increases upstream towards the downstream and passes from 102 UFC /100ml to 3,105 UFC /100ml to the downstream, (Table 1) what makes it possible to classify the quality of water of the Boufekrane wadi of bad to very bad (CNS, 1994).

For the temporal evolution, the highest concentrations in CF are recorded during the season dries (August-September) and November (Figure3) and reach maximum values on the level of the stations B5 and B6, those are related to the increased organic load in summer, which supports the enrichment of the medium in germs.
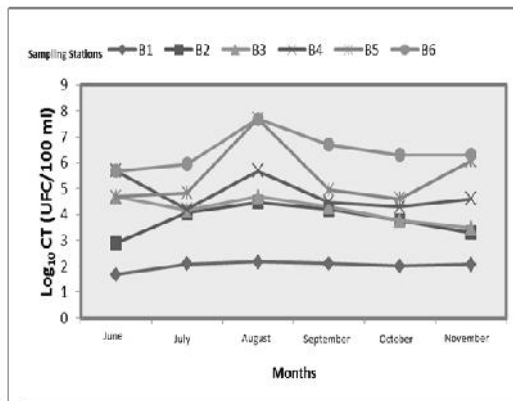
Figure 3: Monthly variations of the concentration of the total Coliformes on the level of the stations of the Boufekrane wadi.

- The spacial evolution of the SF shows that the weakest concentrations are recorded at the B1 station of the Boufekrane wadi, whereas the stations B5 and B6 show very high concentrations, which corresponds to an increasing gradient of the upstream towards the downstream, with median values in S.F which pass from 32 UFC SF /100ml to 8,104 SF/100ml (Table 1); these results agree with former studies of other authors (Fernandez-Alvarez et al., 1991; Chahlaoui, 1996; Hunter *et* al., 1999).

For the seasonal variation of the SF, important concentrations are recorded for this study period except for August or we noted a clear decrease in the number of SF (Figure 4). The concentration in SF remains weaker in comparison with that of the CF and CT on the level of the stations of study and which one could explained by a difference in mortality rate between the SF and the other groups of indicator; according to Hunter et al., (1999), the average of the rate of decline being faster at the SF; the latter would be influenced probably by the abiotic factors of the natural environment.
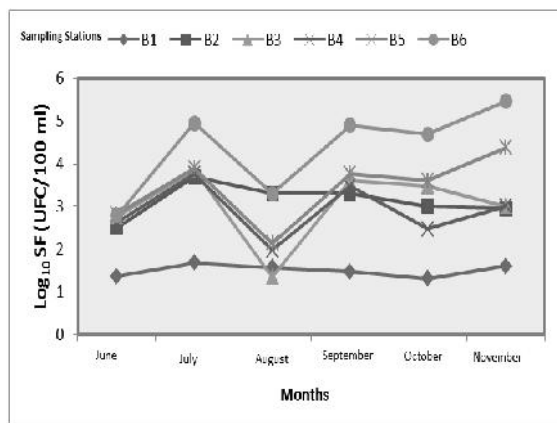
Figure 4: Monthly variations of the concentration of the fecal streptococci on the level of the stations of the Boufekrane wadi.

As regards the pathogenic germs the Salmonella kind and *Vibrio Cholérea*, they were not detected in water of the Boufekrane wadi, in spite of the strong load of the indicating bacteria of the fecal contamination, as it was announced by work former (Aboulkacem et al., 2007; Wales and Baleux, 1992; Chahlaoui, 1996). The probable existence of these germs undetectable viable state would call in question the traditional farming techniques used.

CONCLUSION

This work fits within the framework of the evaluation of physicochemical quality of the Boufekrane wadi and with the distribution of the indicating germs of a microbial pollution in answer to the various disturbances of the ecosystem.
The follow-up of several physicochemical parameters provided us the image of a relatively intense pollution which results in an important mineral and organic load with the downstream of the wadi.
The enumeration of the indicating bacteria of the fecal contamination (CT, CF and SF) and the space-time distribution of these micro-organisms reflected an intense fecal pollution downstream from the rejections which decreases considerably as one moves away from the potential source of contamination. The abundance of the fecal germs varies little from one country side to another and the recorded values largely exceed the standards of the water intended for consumption and the irrigation.
The search for certain pathogenic germs, salmonella's kind, has leads to negative results.

REFERENCES

ABOULKACEM A. (2007). Hydro study biological comparative of the wadis Boufekrane and Ouislane with the crossing of the town of Meknès (Morocco), Environmental impact and health. Doctorate national. FAC. Sci. De Meknès. 159p.

ANSA-ASARE OD., MARR I.L., CRESSER M.S. (1999). Evaluation of cycling patterns of dissolved oxygen in has tropical lake biodegradable ace year indicator of organic pollution. Sci. Total Approximately. 231: 145-158.

BONTOUX J. (1993). Introduction under investigation of fresh waters" Quality and health". 2nd edition, Edict. CEBEDOC, 165p.

CHAHLAOUI A. (1996). Biological hydro study of the wadi Boufekrane (Meknes), Environmental impact and health. Thesis of state. FAC. Meknès. 234pp.

CNS (Committee Standards and Standard). (1994). Department of the Environment of Morocco. Folds back.

COP 7. (2001). Initial communication of the Kingdom of Morocco at the International community. Convention Tallies of the United Nations on the climate changes. Marrakech, September, 22p.

CSEC (Superior council of Water and the Climate). (2001). Management of the economy of water. Superior council of water and the climate. 9th session. Agadir, June 21st-22nd, 53p.

Cun C. and Vilagines R. (1997). Time series analysis one chlorides, nitrates, ammonium and dissolved oxygen concentrations in the Seine to rivet near Paris. Sci. Total. Approximately. 208: 59-69.

DGH (Direction of the Research and the Planning of water). (2002). Water resources and the development of Morocco. World day of Water, Folds back, Morocco, March 22nd, 15p.

EDWARDS A.M.C., THORNES J.B. (1973). Annual cycles in to rivet toilets quality: time series approach has. Res. toilets 9: 1286-1295.

ELADDOULI J. (2010). Qualities physicochemical and biological of polluted water, re-used in agriculture in the zone per urban of Meknes (Northern Center of Morocco). Doctorate national. FAC. Sc of Oujda. 221P.

FERNANDEZ-ALVAREZ RM., CARBALLO-CUERVO S., ROSA-JORGE MC., RODRIGUEZ-WITH LECEA J. (1991). The influences of agricultural run-off one bacterial populations in has to rivet. J. Appl. Bacteriol. 70: 437 - 442.

HUNTER C., PERKINS J., TRANTER J., GUNN J. (1999). Agricultural effects one Land-uses the indicator bacterial quality of year upland stream in the Derbyshire peak district in the U.K. Res. Toilets 33 (17): 3577-3586.

JONNALAGADDA S.B., MHERE G. (2001). Toilets quality of the odzi to rivet in the eastern highlands of Zimbabwe. Res. toilets 35 (10): 2371-2376.

LEHMAN A., GRINDS Mr. (2001). Length term behavior and cross-country race-correlation toilets safety. Annu. Rev. Microbiol. 55: 201-234.

LEVALLOIS P., PHANEUF D. (1994). Contamination of drinking water by nitrates: analyzes risks with health. Rev. Can. public health, 85,192-196.

NEAL C., JARVIE H.P., HOWARTH S.M., WHITEHEAD P.G., WILLIAMS R.J., NEAL MR., HARROW MR., WICKHAM H. (2000). The toilets quality of the To rivet Kennet: initial observations there is lowland chalk stream impacted by sewage inputs and phosphorus remediation. Sci. Total Approximately. 251-252: 477-495.

RODIER J. (1984). Water analysis, natural water, waste water, sea water. Dunod, Paris (7th edition), Dunod, Paris.

SCHAFFTER N.R., PARRIAUX A. (2002). Pathogenic-bacterial toilets contamination in mountainous catchments. Res. toilets 36 (1): 131-139.

SILVA A.M.M., SACOMANI L.B. (2001). Using chemical and physical parameters to define the quality of pardo to rivet toilets (Botucatu-Sp-Brasil). Technical Notes. Toilets Res.35 (6): 1609-1616.

VEGA MR., PARDO R., BARRADO E., DEBAN L. (1998). Assessment of seasonal and pollting effects one the quality of to rivet toilets by exploratory dated analysis. Res. toilets 32(12): 3581-3592.

WALES P., BALEUX B. (1992). Influence of the drainage basin input one has pathogenic bacteria (salmonella) contamination of has Mediterranean lagoon (the Thau lagoon- France) and the survival of this bacteria in brackish. Sci toilets. Technol. 25: 105-114.