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Impact of urban wastewaters on groundwater quality in the watershed of Middle Sebou (Morocco)

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Abstract

The study has been carried out in November 2007 and July 2008 on eight wells located in the vicinity of Fez stream and Sebou River which waters are polluted from discharges issued from the urban area of Fez city. The obtained results showed important concentrations in heavy metals mainly in wells drilled inside the alluvial aquifers and located more meadows of the Fez stream and Sebou River. The comparison of the contents of heavy metals between shallow aquifers and surface waters along Sebou River indicated a very narrow correlation which can be explained by hydrogeologic interaction between these waters.

Keywords: Groundwater, heavy metals, pollution, Fez stream, Sebou River, Morocco.

Introduction

In Morocco, groundwater is an important part of the hydraulic heritage of the country (MATE 2001). Groundwater is generally an excellent source of drinking water. The filter consists of natural geological

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materials produces mostly high quality water, including very low contents of microorganisms and other substances in suspension. It follows that the use of groundwater has significant economic benefits, because they require little treatment, sometimes even no treatment prior to their distribution in a drinking water system.

Groundwater is in close relationship with surface water. The water supply can be either surface water to groundwater, or, conversely, groundwater to surface water. The meaning of these exchanges varies depending on the sectors and their hydrological and hydrogeological characteristics and the seasons, in an area where water exploitation is important in summer, the water table is lowered and consequently, the river is drained and nourishes the aquifer water. In normal times, the waters of the aquifer feed the river. With the existence of such exchanges, any pollution of surface water can cause the contamination of groundwater. Groundwater pollution is one of the most disturbing phenomenons and the use of these waters for food issues represents a risk to human health (Laferrière et al. 1999). Consumption of water contaminated by micro-organisms can be the cause of epidemics (Angulo et al. 1997, Balbus and Embrey 2002).

Materials and Methods

The study of the metallic quality of groundwater is of great importance, either to identify their structures and functioning, or to consider the possibilities of their use.

For this study, two measurement campaigns were carried out: November 2007 (flood period) and July 2008 (low water period). Samples were collected from different wells in the vicinity and along two water courses; Fez stream Sebou River (Figure 1).

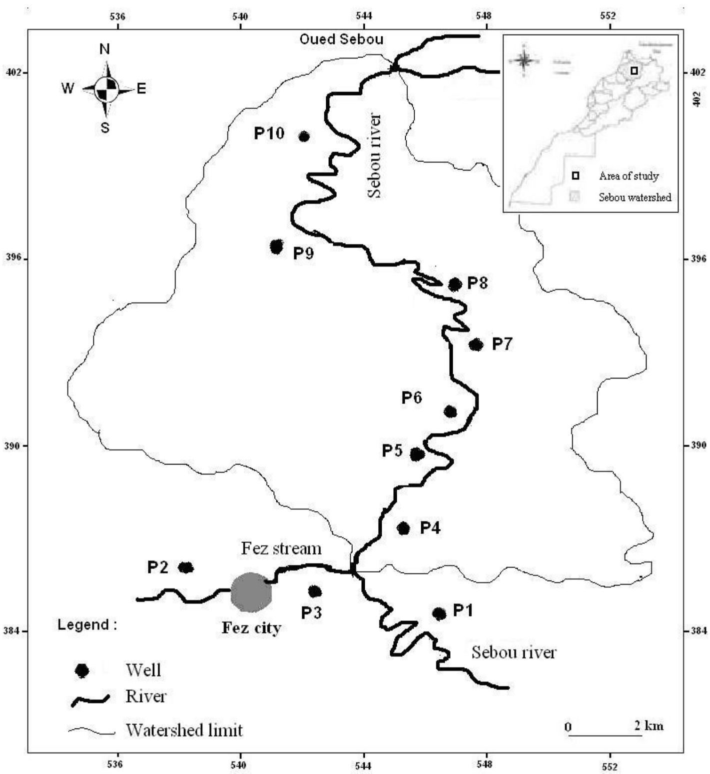

Figure 1. Situation of sampling points

Sampling of waters

Water samples for the analysis of heavy metals were carried out during two seasons, winter, November 2007 and summer, July 2008) upstream Sebou River and downstream of discharges from the city and, downstream the confluence of Fez stream and Sebou River. The conservation of wastewater samples was done according to the general guide for the conservation and handling of samples from (ISO 5667/3, 1994) and to the guide of good practice of the National Office of Potable Water (ONEP 1999).

Methods of analysis

The determination of heavy metals (Pb, Cd, Cr, Zn, Ni and Cu) was carried out using an inductively coupled plasma atomic emission spectroscopy ICP-AES, Model JOVAN YVAN) at the CNRST of Rabat

(Morocco). The detection limits for various heavy metals are 0.0005, 0.002, 0004, 0001 and 0.0008 for Cr, Zn, Cu, Pb and Cd respectively.

Results and Discussions

Cadmium

In this study, concentrations of Cd ranged from 0.0003 g/l as minimum value and 0.0007 g/l as maximum value. There is a gradual increase of the cadmium concentration from the station P_3 for both measurement campaigns (Figure 2). This low content may be caused by rain from the fumes in the region. Besides, the presence of Cd as a contaminant in fertilizers used in agriculture can contribute to this pollution. Nonetheless, recorded concentrations remain well below the standards set by WHO (1996).

The toxicity of cadmium is mainly due to the inhibition of thiol enzymes as well as its affinity for the hydroxyl and carboxyl. It is also the causative agent of the disease "Itai-Itai" which is manifested by bone disorders and increased alkaline phosphatase (Nomiyama 1973, Purves 1977). Chronic exposure to low doses of cadmium causes damage to the renal tubules, followed by proteinuria, pulmonary lesions and arterial hypertension (Bertouille 1978).

Chromium

Chromium is present in small quantities in nature, it is more important in rocks of a basic type than in those of silica type (Rodier et al. 1996). The toxicity of chromium depends on its physico-chemical shape; hexavalent salts are considered the most dangerous (Lauwerys 1992).

Chromium concentrations ranged from 0001 g/l as a minimum value and 0.12 g/l as maximum value. There is an increase of Cr content in the P_3 station that reaches the maximum value 0.12 μg/l for July campaign (Figure 2), this increase may be due to infiltration through the soil of large amounts of chromium from the Fez stream that collects wastewater issued from tanneries in the old medina of Fez. Concentrations recorded in the different wells remain below the WHO standards (1996). So this water is classified favorable for consumption.

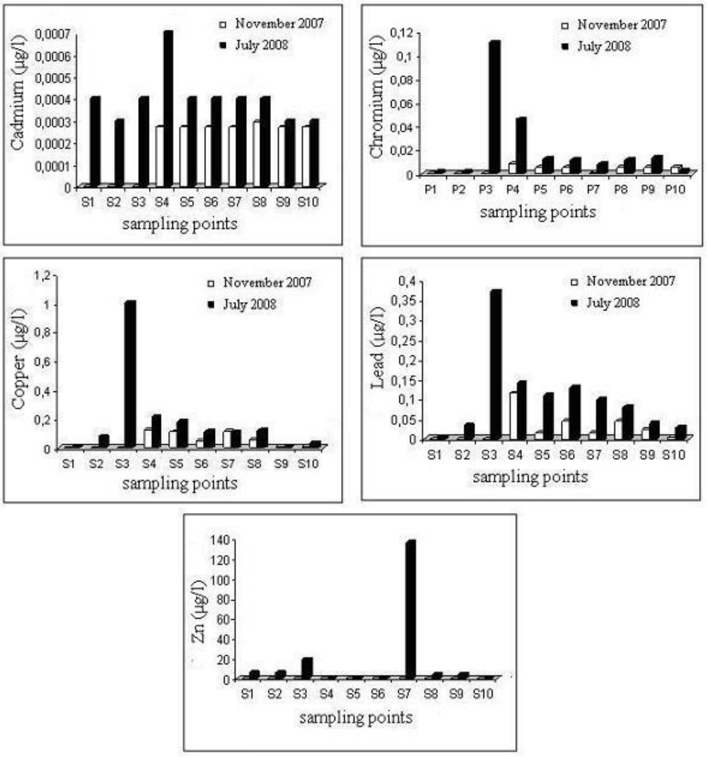

Figure 2. Changes in concentrations of heavy metals into groundwater during the two campaigns (November 2007 and July 2008)

Copper

Copper is found in nature in the form of native copper ores, oxidized minerals or sulphide. In the air, it is covered with a thin layer of basic carbon (Rodier et al. 1996).

Copper concentrations ranged from 0005 g/l and minimum value as 1 g/l as maximum value. There is an increase of copper in the P_3 station that reaches the maximum value 1 μg/l for the campaign of July (Figure 2). This increase is due either to agricultural uses or to industrial pollution generated in the urban area of Fez city. But the recorded concentrations remain below the standards (WHO 1996).

Lead

Lead occurs naturally in the environment. However, the most significant concentrations of this element, found in the environment are the result of human activities.

In this study, the lead content reaches its maximum at station P_3 (drought period), the high level of this station comes from industrial activities or solids waste (Figure 2). Generally, the various concentrations recorded in wells are below the WHO standard (50 μg/l) (WHO1996). So the water remains usable.

The toxicity of lead according to the nervous system and kidney has been stressed by Roony et al. (1999). Lead poisoning was the first recognized occupational disease in France (Derache 1989).

Zinc

Zinc concentrations in different wells ranged from 0.6 g/l as a minimum value and 140 g/l as maximum value. The contents recorded are due to human activities: industrial manufacturing alloys pigment dye and pesticides) and pollutants from the municipal discharge of the city of Fez. Downstream towards stations P_9 and P_{10} (Figure 2), a decrease in zinc concentrations to return to the same concentrations recorded at the reference stations (P_1 and P_2). According to WHO (1996), these contents remain below 5 mg/l, so this water remains usable.

Conclusion

Slightly higher rates of heavy metals vary depending on the nature and location of pollution sources in relation to study sites. Indeed, industries: brick, plastic and leather (tanneries) are probably the origin of the contents in chromium and cadmium. Agricultural uses and industrial pollution are the source of copper content in the area. The importance of values in lead would be connected with industrial or solid waste. In sectors of connexion river- aquifer, transmission of toxic elements can be easily achieved by dilution and drainage (Schoeller 1962).

Although the concentrations recorded during this study do not lead to immediate concerns and may not be the cause of acute toxicity, it should be noted that the ecotoxicological risk is the cumulative nature of the heavy metals that are involved in the phenomena of bioaccumulation or biomagnification (Tarras et al. 2001, Ramade 1992 and Cheggour et al. 1999).

The protection of groundwater against contamination variety is necessary and imperative to ensure that these waters continue to serve any purpose.

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