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ESTIMATE OF THE METALLIC CONTAMINATION OF THE URBAN EFFLUENTS BY THE EFFLUENTS OF THE MOHAMED V HOSPITAL OF MEKNES

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Abstract

The Mohamed V hospital of Meknes is one of the most important establishments for public health in the entire region of Meknes-Tafilalet; it is also one of the biggest sanitary structures of Morocco. According to the classification of the American Hospital Association (American Hospital Association [AHA], 1986) based on the number of active beds, this hospital belongs to class 7, with a real bed capacity of 531 beds among which 416 are functional, hence this has led to the importance of the study of the impacts of its effluents on the environment.

Wastewaters of this hospital contain pollutions of microbiological, chemical, organic, mineral and metallic nature. They are rejected in the sewer system of the city without any preliminary treatment and has a loosened open-air at the level of Aïn Choubbik district where they are reused by the local residents for the irrigation of truck farm, cereal and tree-dwelling farm. Moreover, the major part of these wastewaters is poured into Bourouh river, in particular during pluvial period. Consequently, we may note direct harmful impacts on the health of Man as well as on the environment with its diverse compartments, water (Surface Water and subsoil water), ground and air.

Thus, we will try using this present study to evaluate the pollution rate by elements in state of trace, taking a case of heavy metals effluents of the Mohamed V hospital of Meknes and the consequences it could have on the environment and as well as the proposed solutions. So, we are also going to estimate the pollution rate by these elements at the levels of urban wastewaters of the Ain Choubbik district receptacles of the hospital effluents.

Keywords: Hospital effluents, pollution, irrigation, wastewaters, heavy metals

Introduction

The re-use of raw domestic wastewater in agriculture has become a current practice in developing countries such as Morocco. The shortage in water, its high cost and the unaffordable price of fertilizers are the main causes for the re-use of domestic wastewater in agriculture.

The city of Meknes occupies the second place among the Moroccan cities. Therefore, concerning the surface of the cultures irrigated by wastewater; this surface was estimated at 1400 ha in 2004. The concerned cultures are cereal, truck farming and tree-dwelling farm (Bzioui, 2004).

This wastewater contains among others, effluents of the Mohamed V hospital of Meknes of which the network of the drainage is directly linked with the urban sewer system without any preliminary treatment. They are afterward going to be loosened open-air, towards the Aïn Choubbik district. During pluvial period, they are forwarded to the Bourouh river. Along this course, these waters will be exploited by the local residents for the irrigation of the tree-dwelling farm, cereal and truck-farming cultures to be resold in the local markets. Waters of the receptacle river of these effluents are also used for irrigation as well as for the abreuvement of the cattles.

Heavy metals and elements in state of trace which is characterized by the hospitable effluents could result to damages to man's health as well as in the diverse environmental compartments (grounds, waters and air). A study in France showed a punctual presence of heavy metals in the hospital effluents, particularly mercury and silver (Leprat, 1998). Mercury results from broken thermometers or from hoarse tensiometers and the use of organomercuriel antiseptics. Salts of silver result from radiological activity.

Other metals are usually looked for to characterize the hospital effluents, namely cadmium (Cd), arsenic (As), lead (Pb), copper (Cu), nickel (Ni), zinc (Zn), and chrome (Cr) (Emmanuel, 2004).

The arsenic which is a heavy metalloid is frequently associated with heavy metals in the environmental field (Jeannot *et al.*, 2001). The United Nations studies on the atmospheric pollution mean by the term «Heavy Metals " and, in certain cases, metalloids, and their compounds which are stable and whose density is superior to 4.5 g.cm-3 (Organisation des Nations Unies, 2003). However, the term «heavy metals» is a current term; it contains all the elements that results to toxicity turned out for Man and the environment. In this measure, we are also going to fetch other toxic elements, such as manganese (Mn), cobalt (Co), iron (Fe) and aluminum (Al).

Materials and methods

We started this study at the beginning of January 2010, with a frequency of one sampling per month, between January 2010 and September 2010.

The samples of the hospital effluent were taken at the level of the main collector of all the sewers of the hospital (Figure 1). Those of the urban wastewaters of Aïn Choubbik were just taken at the exit of the open-air wastewater (Figure 1). In addition, we obtained the samples of the hospital effluent during the time period beginning from 11:30 am to noon. Therefore, the toxic load is indeed more important during this period (Coralie *et al*., 2002).

Having measured the parameters such as the temperature, the pH and the conductivity of the sample effluent taken, we immediately transported our samples in an icebox to the laboratory where the treatment and the preparation for metallic analysis is followed at once. However, we made use of the glass flasks; but for mercury, the flasks were of brown glass emery sealed (Rodier *et al*., 1996) and the volumes of samples were always superior or equal to 250 ml.

Thus, we filtered our samples at 0,45 µm, then we treated them in pure nitric acid (pH < 2) (Centre d'expertise en analyse environnementale du Québec, 2008) and pass them in the ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy) according to the NF standard in ISO 11885. For mercury, we took samples in flasks of 250 ml containing 0,5 ml each of the solution of nitric acid - potassium dichromate, and did not filter them.

Metals have the advantage to be resistant, rigid and insensitive to the changes in temperature. Samples are always preserved at 4°C inside the prescribed extension of preservation; hence, this extension varies from 1 month for mercury to 2 months for dissolved metals or extractible metals (Rodier *et al*., 1996) ; (90 days for arsenic).

The dosage of metals was operated by ICP-AES: Inductively Coupled Plasma-Atomic Emission Spectrometry (Table 1) Mark: Activa Horiba Jobin Yvon. It is an analytical method which is based on the plasma as being a major source generated by inductive coupling.

Table 1: Analytical Conditions

Plasmagenic flow	Power	Flow of the gaz of spray	Speed of the pump	Pressure
12 litres/minute	100 watts	0.6 litres/minute	15 turns/min	3 bars

This method does not detect concentrations of mercury lower than 0.01mg/L; yet for this element, the Moroccan national quality standards of waters intended for the irrigation (Ministère de l'équipement et ministère chargé de l'aménagement du territoire de l'urbanisme, de l'habitat et de l'environnement [ME-MATUE], 2002a) as well as the quality of superficial

waters used for the production of the drinking water (ME-MATUE, 2002b), stipulates that the content of mercury in these waters should be lower than 0,001 mg/L. For this cause, we resorted to the method of determination of mercury by atomic absorption with the generation of cold vapor. Therefore, the limit of detection of mercury by this method is 0,1 µg/L.

Results and Discussions

Most of the measures of metallic trace elements revealed values below the threshold of analytical detection (Table 2 & 3). For such values, every real value would be included between a minimal value which is equal to zero and a possible maximal value equal to the thresholds of detection. We refer to the average by default as the average calculated on the basis of the minimal values which are considered as being equal to zero. Also, the average by excess is the average calculated on the basis of the possible maximal values which is considered as being equal to the thresholds of detection.

Table 2: Metallic dosage of urban wastewater receptacles of effluents hospital

Element mg/L	Hg µg/L	Cd	Co	Cr	Cu	Fe	Pb	Zn	Ni	Mn	As	Al
Average by default	---	00	00	0,051	00	---	0,027	0,051	0,02	0,04	00	< 0,05
Average by excess	---	0,0073	< 0,01	0,055	< 0.01	---	0,033	0,056	0,03	0,05	0,01	< 0,05
Average	0, 1	---	---	---	---	0,452	---	---	---	---	---	< 0,05

For every metallic trace element which has at least a single value below the limit of detection, the real average value is included between the average by default and the average by excess.

Urban waste water, of Aïn Choubbik, used for the irrigation of diverse cultures has a content in these toxic elements below the standards of the Food and Agriculture Organization of the United Nations which governs the quality of purified wastewater intended for irrigation (Organisation des nations unies pour l'alimentation et l'agriculture, 2003). Therefore, these results permit the urban wastewater receptacles of the hospital effluents to have no evident impacts, at least, on the health of the consumers. It is valid exclusively for the metallic pollution.

Table 3: Metallic dosage of the hospital effluents

Element mg/L	Hg µg/L	Cd	Co	Cr	Cu	Fe	Pb	Zn	Ni	Mn	As	Al
Average by default	---	00	00	0,045	0,005	---	0,015	---	0,02	---	00	< 0,05
Average by excess	---	0,007	<0,01	0,048	0,012	---	0,021	---	0,03	---	0,01	< 0,05
Average	0,3	---	---	---	---	0,34	---	0,14	---	0,04	---	< 0,05

On the other hand, except for mercury and copper, the content of the hospital effluents in these toxic elements is low compared to the urban effluents. These results suit those of certain previous research works: According to the US EPA (United States Environmental Protection Agency [US EPA], 1989), the wastewater proceeding from hospitals are essentially domestic. Given that hospitals use and reject an important volume of water, diverse identified pollutants, among others metals, dilute and meet in often nearby concentrations of those of the domestic effluents. Besides, Mansotte (2000) underlines that the global physico-chemical characteristics of the hospital effluents are completely similar to the average of those of the urban residual waters, with the exception of cleaners which present a concentration to be significantly higher. However, Leprat (1999) shows that the degree of global pollution of the hospital effluents is lower compared to the domestic effluents. According to Hartemann *et al.* 2005), analysis and measures of the pollution by the global physico-chemical parameters reveals generally a level of pollution lower than that of the classic urban effluents.

Also, according to Kümmerer (2001), the concentrations in heavy metals would be as high as in the domestic effluents except for platinum, mercury and gadolinium which would be in a more important concentration in the hospital effluents.

The results of the works mentioned above do not consider either the volume rejected or the toxic constituent of effluents. An establishment of 1000 beds would pollute as much as a city of 10, 000 inhabitants (Hartemann *et al.* 2005). So Hartemann *et al.* (2005) concluded that it is necessary to be rather interested in the eliminated molecules and not in the global physico-chemical parameters. In this sense, US EPA (1989) realized a campaign of physico-chemical characterization of the effluents of four hospitals and, on 400 analyzed parameters, and published a list of 15 priority pollutants which characterizes the hospital effluents. Seven metals appear among these 15 pollutants: chromium, copper, lead, mercury, nickel, silver and zinc. This analysis has been updated; so Boillot (2008) conducted a synthesis of the

main available data concerning the physico-chimical characterization of hospital effluents.

The Moroccan standards are completely in accordance with the international standards quoted above. As for mercury situated in the Moroccan standards, its concentration in the urban effluents of Aïn Choubbik, used for irrigation, is always lower than the Moroccan quality standards of waters intended for irrigation. Therefore, this shows that it does not have yet any harmful impacts on the health of the consumer; nevertheless, the content of the hospital effluents in mercury is widely superior (three times superior) to that of the urban effluents. These results are in accordance with those of researches quoted above and could let us foresee impacts of mercury of the hospital effluents which is likely to happen in the future on the urban effluents and finally on consumers' health.

Metallic trace elements can be found in low concentrations compared to the Moroccan standards governing the limit concentrations recommended in trace elements in superficial waters used for the production of the drinking water. Thus, this shows that so far, there are no metallic impacts of the hospital effluents nor the urban effluents of Aïn Choubbik on the superficial aquatic environment; and also, the superficial waters of the oued Bourouh receptacles of these urban effluents, during pluvial period, remain always susceptible to be used as a resource for drinkable waters supply.

Conclusion

It emerges from this study that toxic metallic trace elements measured, are present in the effluents of the Mohamed V hospital as well as in the urban residual waters of Aïn Choubbik receptacles of these effluents.

As for contamination of grounds and farm produces, urban residual waters which are well sought for the irrigation of the cereal, truck farming and tree-dwelling farm, contains metallic trace elements; but in low quantities compared to the various international and national standards governing the quality of waters intended for the irrigation. This means that they still have no apparent metallic impacts either on the environment or on the health of the consumers.

As for the contamination of superficial waters, residual waters of Aïn Choubbik mix in superficial waters of the Bourouh river during pluvial period; the concentration of metallic trace elements in these urban effluents as well as in the hospital effluents are always below the national limits recommended in trace elements in superficial waters used for the production of the drinking water. Consequently, we do not notice any apparent metallic impacts on superficial waters. In it is added the effect of the dilution of metallic trace elements upon their arrival at the level of the Bourouh river, and the dilution which would limit any possible metallic impact.

For the impacts of the hospital effluents on the environment, we noted that their content in metallic trace elements was always lower compared to that of the urban effluents with the exception of mercury. Therefore, we can conclude that the effluents of the Mohamed V hospital have no fatal metallic impacts on the urban sewer system receptacle.

The content of the hospital effluent in mercury exceeds that of the urban effluent, but it always stays below the standards. However, this relatively important content incites to watch closely the evolution of the concentration of mercury in the hospital effluents to plan the impacts that this toxic metal could have on the environment and the human health.

Nevertheless, the inauguration of the wastewater-treatment plant of the city of Meknes is imperative today more than ever. Therefore, in addition to that, it is necessary to plan the foundation of a pretreatment station of the Mohamed V hospital liquid waste.

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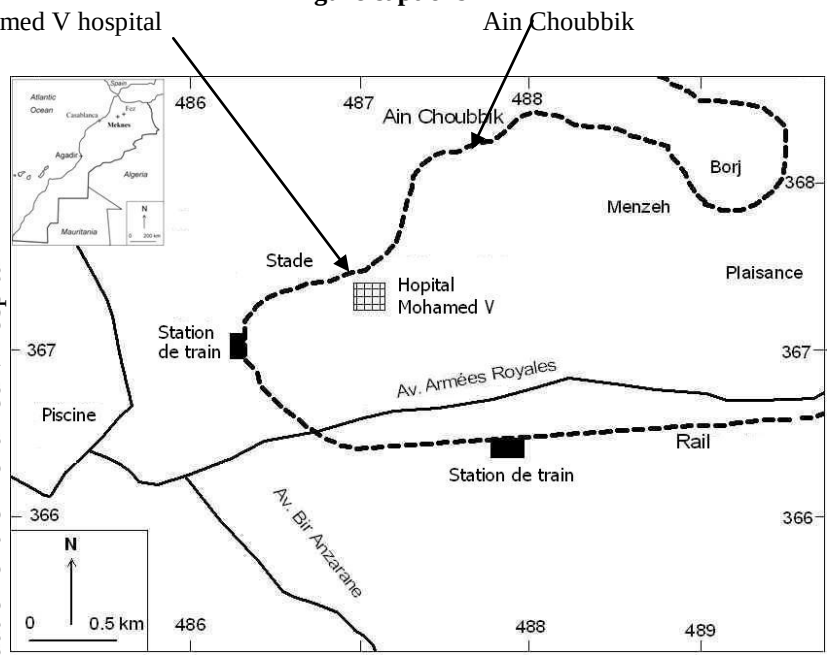
Figure captions



1 Map representing a part of the city of Meknes: situation of the Mohamed V hospital