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CONTRIBUTION TO THE CHARACTERISATION OF THE PHYSICO CHEMICAL QUALITY OF WATER OF SOME SPRINGS IN THE REGION OF TANGIER-TETOUAN (MOROCCO)

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ABSTRACT

Our study, based on the grid water quality World Health Organization (WHO, 2004), targeted the evaluation of the physico-chemistry and heavy metals of water springs of the Tangier- Tetouan region (North-western Morocco). The analyses have involved eleven springs with tap water treated for three companies. According to Rodier (1978, 2009), the samples were taken from March/2013 to June/2013. The results for physico-chemical analysis have shown that the region has generally good quality of water, with the exception of a single spring (Agla), which itself shows a high contamination of iron and manganese. As for the heavy metals, it was found that all springs have very low concentrations or no trace elements. So general, the evaluation of the results of physico-chemical analysis presented in this work can be considered eligible and have no impact on the quality of the water, these results are consistent with those obtained by Belghiti et al. (2013).

Keywords: Quality, spring water, physico-chemical, and heavy metals.

RESUME

Notre étude a ciblé l'évaluation de la qualité physico-chimie et métaux lourds des eaux de sources de la région Tanger-Tétouan (Nord-ouest du Maroc) en se basant sur la grille de la qualité des eaux selon l'Organisation Mondiale de la Santé (OMS). Des analyses ont concernés onze sources avec l'eau de robinet traité pour trois compagnes. Les prélèvements ont été effectués du Mars/2013 au Juin/2013 selon Rodier (1978 et 2009). Les résultats relatifs aux analyses physico-chimiques ont permis de montrer que la région présente une eau de bonne qualité, à l'exception d'une seule source (Agla) qui, elle, révèle une forte contamination en fer et en manganèse. Quant aux métaux lourds, il s'est avéré que toutes les sources ont des concentrations en éléments traces très faibles ou nulles. De façon générale, l'évaluation des résultats des analyses physico-chimiques présentés dans ce travail peuvent être considérés admissibles sauf (Agla) et ne présentent aucune incidence sur la qualité de la nappe, ces résultats sont en accord avec ceux obtenus par Belghiti et al. (2013).

Mots clés : Qualité, Eaux de source, Physico-Chimie, et Métaux lourds.

INTRODUCTION

The stakes of water on the water form a set of pressures that make the water vulnerable (Hugonin, 2011). Indeed, springs water having a natural water quality, are very vulnerable to any type of pollution caused by human actions and the influence of climate variability on the quantity and quality of surface run off feeding groundwater. (Saad et al., 2011). Water springs are a vital resource for the economy of the region. They are crucial water resources for drinking water supply for much of the rural population and for irrigation of agricultural land (Guergazi et Achour, 2005).

This work studies the physico-chemical quality of water springs in the Tangier-Tetouan (Northwestern Morocco) region, used by the local population.

MATERIAL AND METHODS

Sampling

The sources have been selected have a representation on the spaced Tingitane peninsula. We conducted a total of thirty three samples for physico-chemical analysis and toxic elements sources and distributed as follows: Eleven samples during the period of March 2013, eleven samples during the period April 2013 and eleven during May 2013.

Study area

The region of Tangier-Tetouan, being the capital city of Tangier, covers an area of 11,570 km², representing 1.6% of the total area of the Kingdom. It is bordered by the Mediterranean Sea to the north, the Atlantic Ocean to the west, the region of Taza-Al Hoceima-Taounate to the east and the Gharb-Chrarda-Beni Hssen South.

From the geographical point of view, the Tingitane peninsula is characterized by a structural entity that is the Rif area according to (APDN, 2007).

Indeed, and outside the coastal plains areas geomorphology steep or heavily corrugated cover more than 80% of the region.

- Tangiers, located in the Straits of Gibraltar between the Mediterranean Sea and the Atlantic Ocean, approximately coincides with the basin of the river M'harhar and presents an alternation of valleys, covered mainly Quaternary alluvium, marl and sandstone hills.
- Lower Basin Loukkos constituting the countryside the most developed in the region, thanks to good soils and abundant water and covering the clay alluvial plains and the sandy plateau of Larache.

Tangier Peninsula is characterized by a dense hydrographic network as wadis low flow and unsteady (DAKKI A., 2004).

By their position in the extreme north-west of the country and printed their raised by the many mountains of the Rif Mountains and the coastal plains variability basins Loukkos of Tangiers and the Mediterranean coast are subject to varying weather conditions.

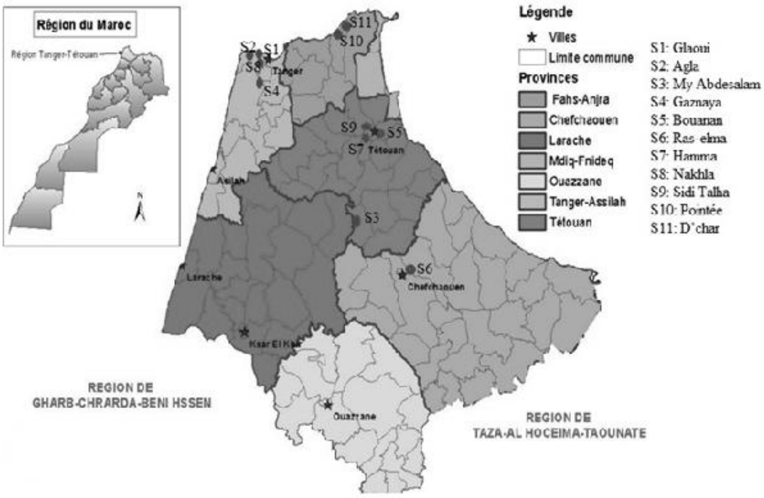

Figure 1: Map of the Tangiers-Tetouan Region
(source: 1/50000 topographic map)

Physico-chemical parameters analyzed

The study was conducted on water samples from common sources in the region of Tangier-Tetouan during the period from March 2013 to June 2013. Three water samples were taken in each source. Samples collected for physico-chemical analysis were placed in plastic bottles and transported to the laboratory for analysis. A total of 31 samples of water were collected. Temperature (T°), the potential of hydrogen (pH) and conductivity (Cs) were measured by immersing a thermometer, a pH meter, turbidity and conductivity of all types EUTECH in 50 ml of water taken from each sample. After 4 minutes of immersion, each of these devices has been removed for reading the results. For other physicochemical parameters: volume is the method used for the determination of bicarbonates, chlorides, dissolved solids, oxidizability, calcium and magnesium, total hardness; the molecular absorption spectrophotometry for sulfates, nitrates, nitrites, ammonium and silicate ions (Rodier, 2009, Abouzaid and Duchesne, 1984). The determination of trace elements (Cd, Zn, Pb, Cu, Fe) is performed using emission spectroscopy inductively coupled plasma (ICP-AES) at the national center for studies and research on water and energy (CNEREE) in faculty of sciences and technology-Marrakech (Morocco). The water samples collected and stored in plastic bottles are returned to the laboratory in a cooler, then stored in a refrigerator at 4°C. Analyzes had been performed until 24 hours after collection.

RESULTS AND DISCUSSION

Physico-chemical water quality

Temperature

Temperature is a fundamental physical factor in surface aquatic and terrestrial environments. It controls the evolution and transformation in aquatic many chemical factors including dissolved oxygen (Ait Boughrous, 2007). It also affects the pH by its effect on the dissociation of acids and solubility of CO_2. This effect is not marked because, in general, an increase in temperature of 20°C lowers the pH of only 0.1 units. The temperature of the water springs studied is relatively stable (Figure 2), with a slight variation inter monthly between 15 ° C in the S4 source and 20 ° C in the source S8. Usually, these values exist in the range of Moroccan standard drinking water (5 ° C <T <25 ° C).

Figure2: Spatial variation of the average values of the temperature.

pH

pH indicates the acidic or basic character of the water. In groundwater, it is determined, in part, by the geological nature of the drainage basin. It is also influenced by acid precipitation, biological activity and some industrial discharges (Ait Boughrous, 2007). pH changes in groundwater follow those of surface waters, with values that are always lower. All sources have explored the pH near neutrality (Figure. 3). Values recorded during the study period revealed low pH variation. They range between 6.55 and 7.8 for sources, these resources are generally in the range of water intended for human consumption, 6.5<pH <8.5.

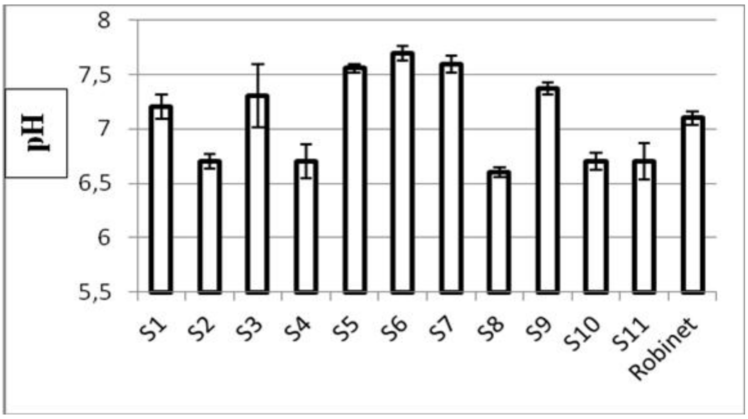

Figure 3: Spatial variation of the mean values of pH

Electrical conductivity (µs/cm)

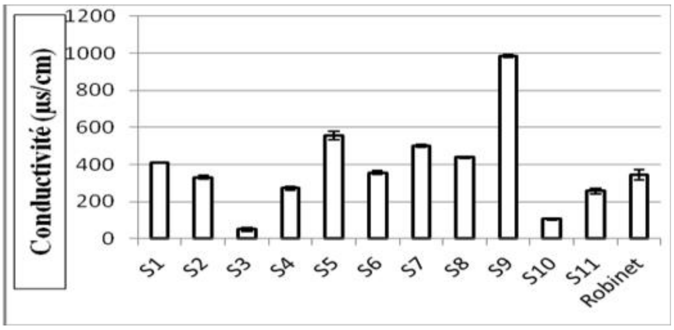

Figure 4: Spatial variation of the mean values of electrical conductivity

Electric conductivity revolves around the degree of mineralization of the water that is in part influenced by the seasonal cycle of the river. But according to (Ait Boughrous, 2007), the conductivity should not be considered only when the unknown aquifer study. The analyzed water sources has generally low conductivity values (Figure 4) between 49 microseconds / cm in the source S3 and 105 microseconds /cm S10 in the month of March. These values correspond to a very low mineralization (Rodier, 2009). However, a large value of about 1000 microseconds /cm is recorded in the S9 source, which corresponds to a significant mineralization of the water.

Turbidity (NTU)

Turbidity of water is due to the presence of suspended particles, including colloidal: clays, silts, grains of silica, organic matter, etc. The assessment of the abundance of these particles measures its turbidity (Rodier, 2009). Turbidity sources ranges between 0.38 NTU to 4.78 NTU source S6 and S4 source (Figure 5), but all values are generally lower than the permissible maximum value dictated by the standard quality of water supply: VMA <5.

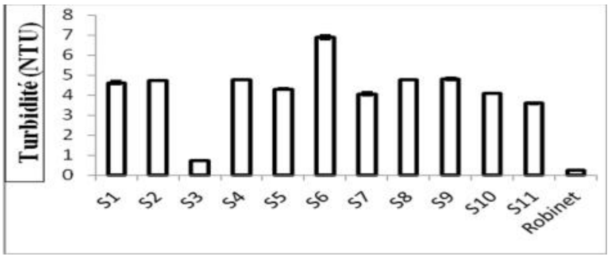

Figure 5: Spatial variation of the mean values of turbidity

Dissolved oxygen

In groundwater, the dissolved oxygen levels are relatively low compared to that of surface water due to the absence of photosynthetic plants, low water contacting atmosphere, and the lack of water turbulence (Ait Boughrous, 2007). Oxygen levels observed in the sources studied (Figure 6), undergo a significant spatio-temporal fluctuation, whose critical situations are observed from time to time close to pollution. The lowest concentrations recorded for S1 (4 mg/l) and S8 (4.4 mg / l). On the contrary, other sources are more or less well oxygenated, and meet the standards of water quality for human consumption 5 < O_2 <8.

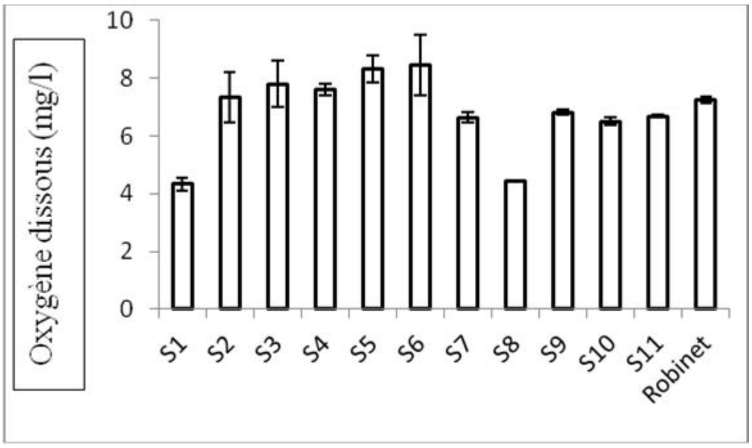

Figure 6: Spatial variation of the mean values of oxygen dissolved

Dry residue at 110 ° C

The determination of the residue on unfiltered water used to assess the dissolved solids and non-volatile suspended; measurement after filtration corresponds to dissolved solids. The analytical results are influenced by the temperature and duration of drying. The values used to assess the mineralization of the water: for less than 600 mg /l, the consumer acceptability values is good, above 1200 g /l, the water becomes unpleasant (Rodier , 2009).

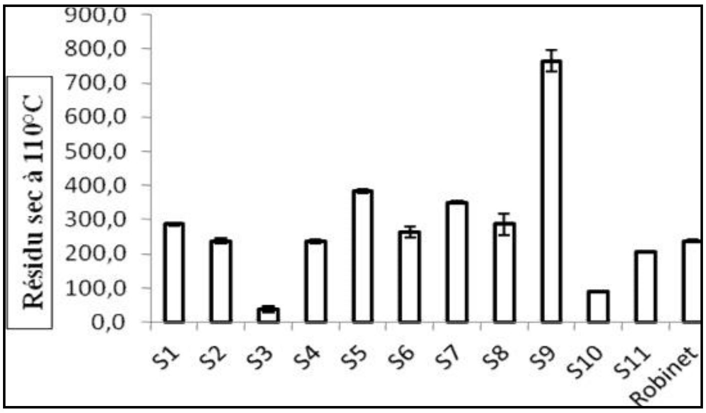

Figure 7: Spatial variation of the mean values of dry residue

Oxidizability to $KMnO_4$ (mg/l)

Excessive organic matter content assessed by oxidizability may be caused by contamination releases or seepage of dirty water. The contents of the permanganate oxidizability in prospected sources is about 0.3 mg/l for S10 and upper 1mg/l for other stations with the maximum value (1.37 mg/l) was recorded in S1 and S3 (figure8). Generally all sources surveyed meet the standard (less than 5mg/l) of water for human consumption.

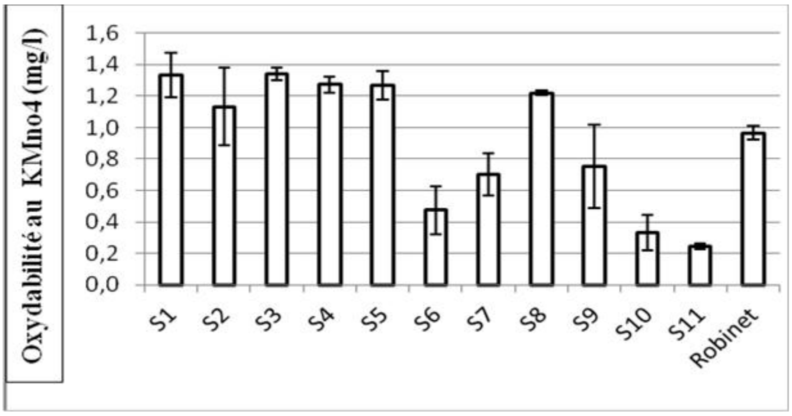

Figure 8: Spatial variation of the mean values of Oxidizability.

Total hardness

The total hardness where a gauging water corresponds to the sum of the concentrations of metal cation other than alkali metal and hydrogen ions. In most cases, the hardness is caused by calcium and magnesium ions (Rodier, 2009). The total hardness of the water sources studied is low (Figure 9), this is due to the seed nature of the geological soils crossed by water; S9 source presents the highest total hardness: 11meq/l.

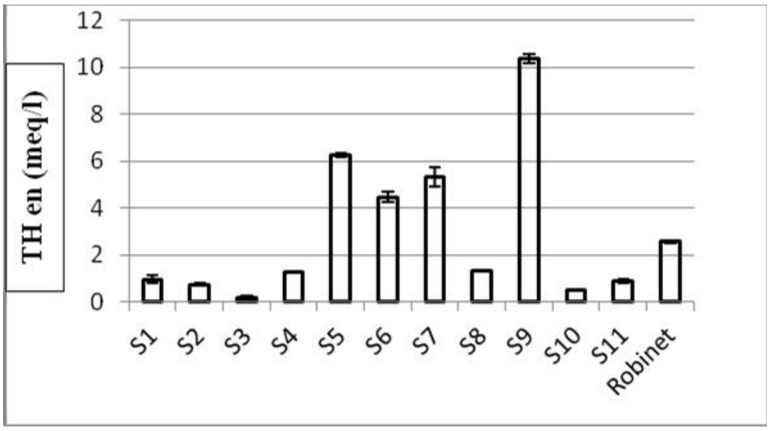

Figure 9: Spatial variation of the mean values of total hardness

Calcium Hardness

The calcium ions are resulting of the attack of water containing carbon limestone or simple dissolution of sulfates such as gypsum dioxide. In all sources studied (Figure 10), the calcium ions are weak and closely follow that of the total hardness. They vary from one source to another; the highest values were obtained in March, with a content of S9 6.8 meq/l.

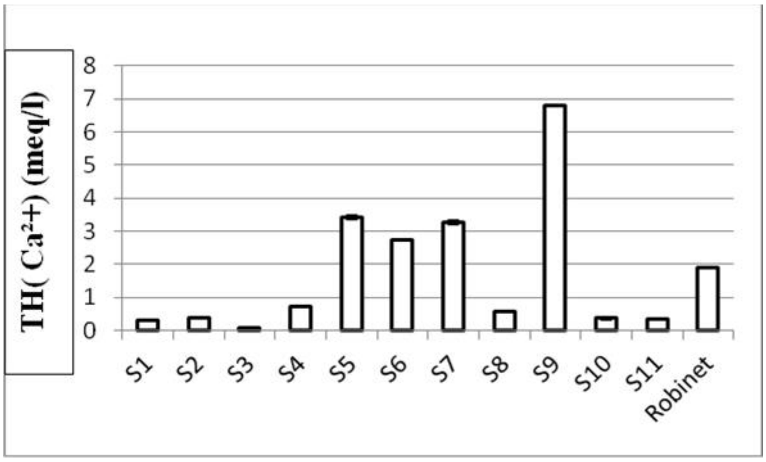

Figure 10: Spatial variation of mean values of calcium hardness

Magnesium hardness

The Mg^{2+} content is very variable and small in the majority of water sources (Figure 11). They are between 0.47 meq/l and 3.65 meq/l.

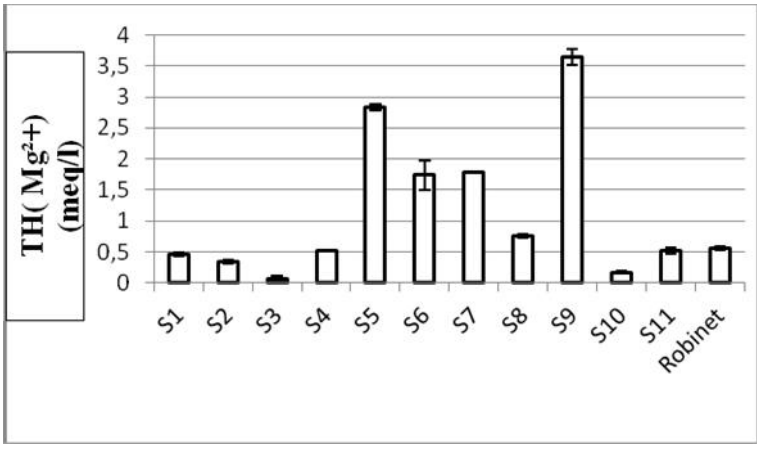

Figure 11: Spatial variation of mean values of magnesium hardness

Bicarbonates

The alkalimetric total title corresponds to water content in free alkaline, carbonates and hydrogen carbonates which originally comes from the limestone bedrock of the watershed that gives water its kind bicarbonate. Bicarbonate exists in the sources surveyed with varying levels (Figure 12) and quite large; close to 0.3 meq/l in S1, S2, S3, S4 and S8, and 4 meq/l in S6 and S7, the maximum value (6.3 meq/l) is obtained in S5 and S9.

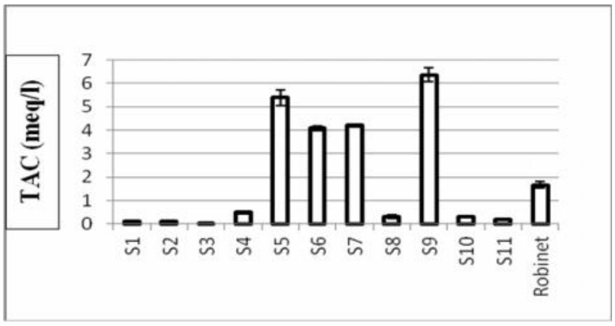

Figure 12: Spatial variation of the mean values of Bicarbonates

Chlorides

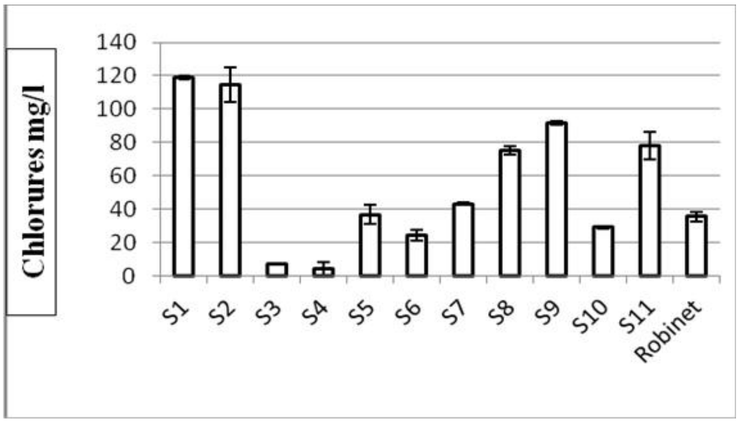

Figure 13: Spatial variation of the mean values of Chlorides

The presence of chlorides in water may be linked to several origins: natural (sea salt intrusion or land), human (urinary discharges) or industrial (potash, oil and food industry) (Gaujous, 1995). The contents of Cl^- ions vary slightly from one source to another (Figure13), but are generally of low levels (< 110 mg/l) except for the source S1; whose value Cl^- is approximately 120 mg/l because of its position in a geological formation saline. But these levels remain below the guideline value of human consumption is 750 mg/l.

Sulfates

Sulphates may have a dual origin in aquatic environments: natural, which originates from the dissolution of gypsum, leaching of pyrifères land; or oxidation of sulfates (Ait Boughrous, 2007) or anthropogenic in relation to industrial and urban pollution (Bakalowicz, 1974). The sulphate contents are generally (Figure. 14) below 150mg/l, except that the source S9 is selenitic which the sulphate content is of the order of 330 mg/l. All sources surveyed meet the Moroccan quality standards for water intended for consumption which require maximum allowable value 'of 400 mg/l sulfate.

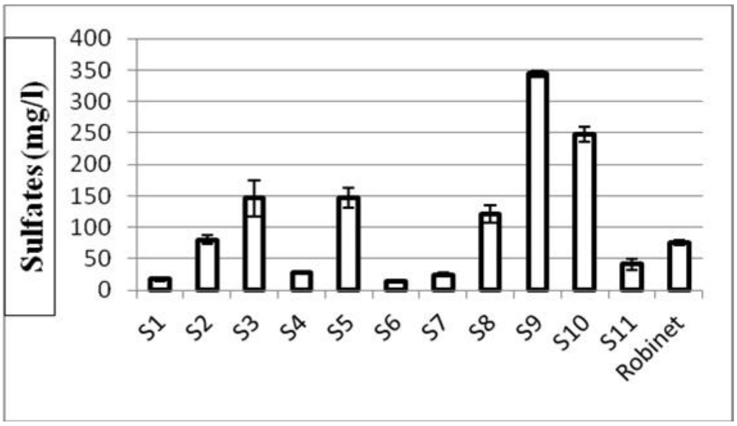

Figure 14: Spatial variation of the mean values of Sulfates

Nitrates

In unpolluted natural waters, the nitrate level is very variable depending on the season and origin of waters; it can vary from 1 to 15 mg /L and a concentration of 2 or 3 mg /l can be considered normal (BANAS D et al, 2006). WHO recommends for water intended for human consumption limit value of 50 mg/l (NO_3^-) and specifies that we must also take into consideration the concentration of nitrites in the same way as the ratio sum of concentration (nitrates and nitrites) in relation to their respective guide which should be inferior to 1. With the exception of the source S9 (Figure. 15), the concentration nitrate ions are very low particularly during the month of March. In May, the values are more or less important with a maximum level of about 20 mg/l in the S9 source. But these levels are generally lower than the “maximum value admissible 50 mg/l’’ for human consumption.

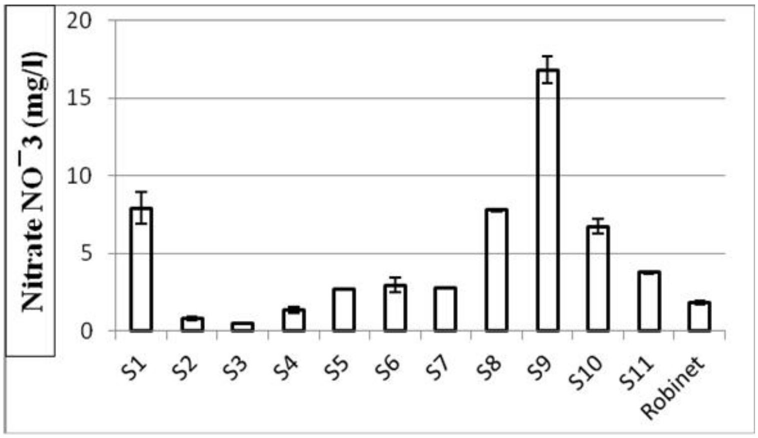

Figure 15: Spatial variation of mean values of nitrates

Note that the values of concentrations of nitrite NO_2^- were zero for all sources studied.

Ammonium ions NH+4

The presence of ammonium ion in the water is often a sign of incomplete degradation of organic material in connection with the lack of available oxygen. It shows a contamination of human or industrial origin (Rodier, 2009, Boulanouar, 1986). All springs have very low to zero concentrations (Figure 16) which do not exceed the guide value for the human consumption (0.5 mg/l).

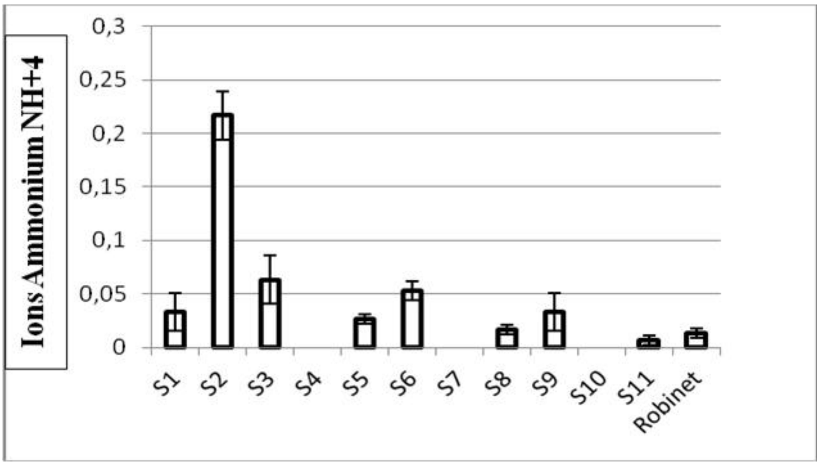

Figure 16: Spatial variation of the mean values of Ammonium Ions

Silicate SiO3

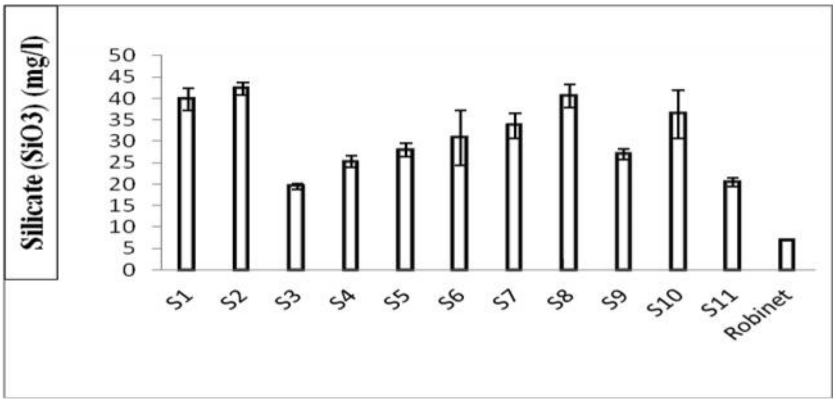

Figure 17: Spatial variation of the mean values of Silicate

Guidelines of the Council of the European Communities related to the quality of water intended for human consumption do not give indication of the maximum permissible concentration level guide. Drinkable water of high quality does not contain more than 55 mg/l silicate (Rodier, 2009). The found values do not exceed 45mg/l (Figure 17), and are lower than the recommended value for a high quality water 55mg/l.

Total iron

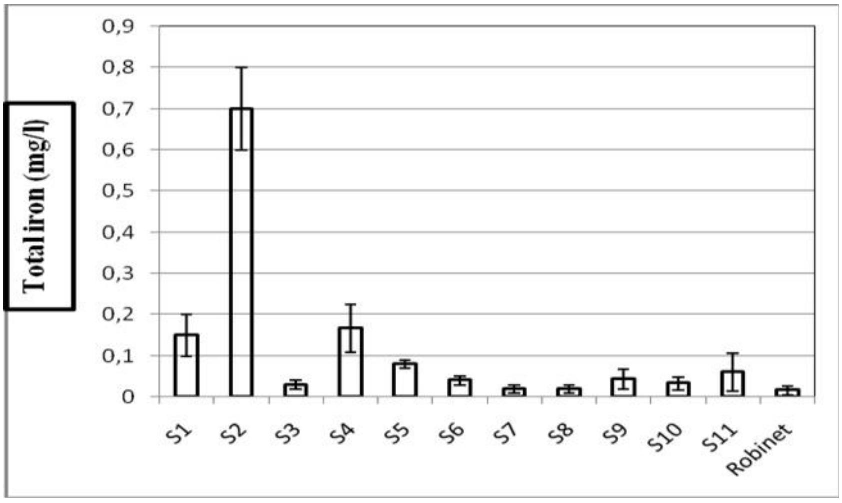

Figure 18: Spatial variation of the mean values of Iron

For water intended for human consumption, due to risk of stains on fixtures, WHO recommends a guideline value of 0.3mg/l. With the exception of the source S2 (0.7 mg/l), all the other prospected sources have very low concentrations (Figure 18). But usually they meet the maximum allowable 0.3 mg/l according to Moroccan standards of food waters.

Manganese

For water intended for human consumption, WHO indicates a provisional guideline value of 0.5mg/l. However, due to risk of stains on fixtures, it recommends a limit of 0.1 mg/l. From the values obtained it is only the source S2 which has an average value of 0.23mg/l, the other sources have very low to zero concentrations (Figure 19). All values are generally lower than the Moroccan standard feed water 0.5mg/l.

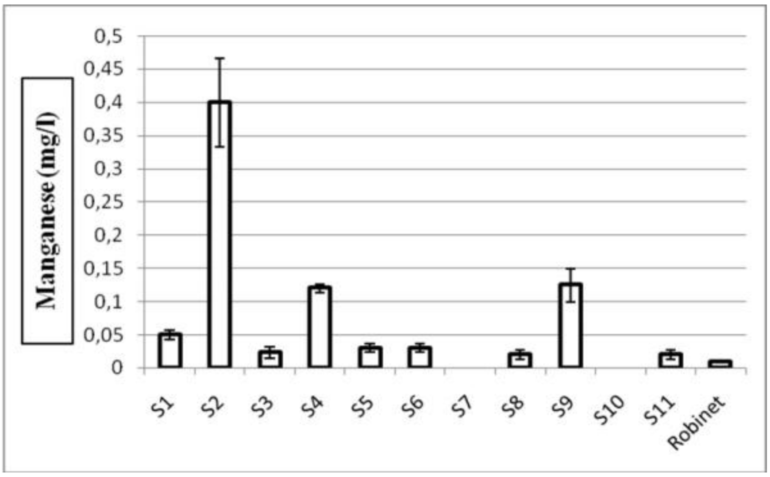

Figure 19: Spatial variation of the mean values of Manganese

Assessment of contamination by heavy metals

The major and trace elements are defined in relation to their natural abundance in the earth's crust. Conventionally, trace elements are 68 minerals of the earth's crust, the concentration is each less than 0.1%. Together, they represent only 0.6% of the total, while 12 major components account for 99.4% (Baize, 1997). The dosage results of the elements metallic traces (Cu, Zn, Pb, Cd,) most searched by different monitoring networks of terrestrial and ocean waters within the sources are listed in the tables below.

Table 1: Average concentrations of trace metals during the period March 2013/ June 2013 in the sources studied.

Sources Métal (mg/l)	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Robinet
Cu	0,11	0,2	0,01	0,13	0,1	0,03	0,08	0,1	0,12	0,05	0,05	0,06
Zn	0,8	0,8	0,01	0,009	0	0,01	0	0,9	0,03	0,05	0,09	0,02
Pb	0,002	0	0,001	0	0	0	0	0,001	0	0	0	0
Cd	0	0	0	0	0	0	0	0	0	0	0	0

The analysis of heavy metals of all stations surveyed, shows that Cu, Zn, Pb and Cd (Table 1) are less than the guideline value of consumption of Moroccan and international standards. These results indicate that the study area is free of any natural source of metal pollution (mineral deposit) or anthropogenic (mining activity) that can affect the water resources.

CONCLUSION AND RECOMMENDATIONS

The results for physico-chemical analyzes showed that the region of Tangier-Tetouan generally has a good quality within the parameters examined during the period of study, since the results obtained comply with the limits of quality (Standard Morocco: Quality of water for human consumption).

To avoid the possibility of any sanitary risk, it is recommended to:

- Contribute to the awareness of the local population vis-à-vis the importance of protecting water quality to establish strategies exploiting their natural water resources.

- Local authorities should establish a protection perimeter for sources with good quality.
- View labeled mentioning all data on protected sources.
-Proceed to treatment with either disinfection or removal of iron for sources with high concentrations in order to improve the quality of these waters.

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