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Research Article

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Study of the Influence of the Hamma Outita Thermal Spring on the Quality of Oued Hamma, Sidi Slimane, Morocco

Aitsi Salah*, El Kharrim Khadija and Belghyti Driss

Laboratory of Agro-Physiology, Biotechnology, Environment and Quality, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco

ABSTRACT

The river Hamma near the city Sidi Slimane, tributary of the river R'dom . It is fed by a set of freshwater sources upstream in the Outita pre-Riparian ride. presents non-permanent flows during the three months February, March and April of the year 2017. The descriptive analysis showed that the waters of the Oued are subjected to physicochemical variations important after mixing with those of the source: enrichment with mineral salts (chlorides and sulfates) and the increase of temperature, conductivity and total hardness of water.

Keywords: Source moulay yacoub hamma; Water; Oued hamma; Physico-chemical; Mineral; Sidi slimane; Morocco

INTRODUCTION

The Hamma river near the Sidi Slimane city (18 km) is a non-permanent watercourse. It is supplied by a set of upstream freshwater sources.

The discharge of thermal waters from the Ain Hamma My Yacoub sidi slimane spring into the wadi could modify the quality of the latter's water. The physico-chemical characteristics of thermal water are related to its underground course, its depth for temperature and the mineral composition of the rocks. At depth, water can also be enriched with gas (CO_2, H_2S) depending on the nature of the rock. Thermal waters have been the subject of several scientific studies, including those of Hakam et al Duriez (Greece), Lkhdar et al., (Moulay yacoub), Zerouale et al (Eastern Morocco) and Fekraoui (Algeria). They have particular physico-chemical characteristics that may undoubtedly modify the quality of the receiving environment [1-8].

In this context, our study of the water quality of the Hamma wadi discharged by the Ain Hamma My Yacoub sidi slimane spring is part of this study. A monitoring of physico-chemical parameters has been started at three water points on the wadi and at the water level of these three sources. The main objective is on the one hand to study the water quality of these three sources and on the other hand to evaluate the changes in the physico-chemical quality of the wadi waters that can be attributed to direct discharges of thermal waters into the wadi waters [7].

MATERIALS AND METHODS

Présentation Du Milieu D'étude

The city of Sidi Slimane is located on the Gharb plain, in north-west Morocco, and belongs to the Rabat-Salé-Kénitra region.

The rivier El Hamma-Outita emerges on the outskirts of the pre-rifain mountain range, 12 km from the town of Sidi Slimane, on the road that leads to Meknes, and is very close to the marabout of Sidi Moulay Yacoub, at the bottom of the N-S cluse of Oued El Hamma, and its coordinates are Lambert, X=459,60, Y=392,7 and Z=120m, with a scale of 1/50000 from the map of El Kansera.

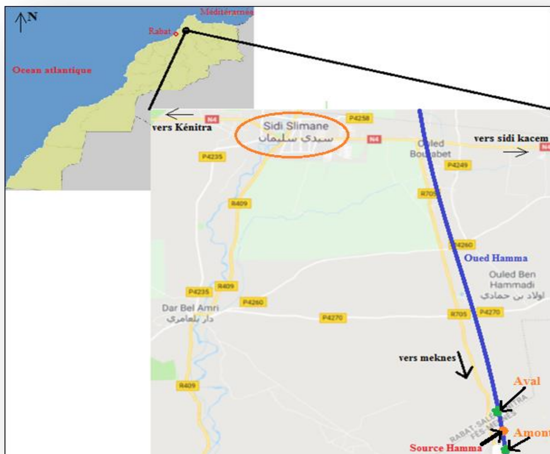

Figure 1. Geographic location of the study area

Sampling Sites

To assess the water quality of the wadi in the vicinity of the source, we chose two sampling sites on Hamma wadi: one site (O-amont) before 3 km from the confluence zone with the spring water and another site (O-aval) downstream from this zone. A third site (Source) was chosen at the water level of the Ain Hamma Outita spring.

Sampling and Analysis

The water sampling was carried out during the period February, March and April 2017, corresponding to the period of significant wadi flow each year.

Some parameters are measured directly in situ by portable devices: the conductivity and salinity of the water (by a portable conductivity meter of the Consort K912 type), the temperature (by a thermometer), and the hydrogen potential (by a portable pH meter of the Hanna Hi 8519N type). The water samples are transported, in a cooler at a low temperature ± 4°C, to the laboratory to analyze other major elements: Sulfates, Chlorides, TAC, Total Hardness, Calcium, Magnesium, Potassium, Sodium, Nitrates, and Dry Residue. These elements are measured in the laboratory according to approved protocols [9-16].

RESULTS AND DISCUSSION

Results Achieved

The different results of the physico-chemical analyses are represented in the following Table 1.

Table 1. Results of analysis physicochemical

	Amont	**Source thermale**	**Aval**
T°©	20,5	42	30
PH	7,415	6,945	6,91
Conductivité (µS /cm)	1675	8985	6156,5
Résidu sec à 180°C	-	663,45	583
(mg /l)			
Dureté (°F)	37,95	57,05	42,62
Tac (°F)	38	36,3	26,5
TA	0	0	0
Sulfates	10,82	655,88	11,3
(mg/l)			
Nitrates	0,69	0,8	0,19
(mg/l)			
Chlorures	81	1120,23	154,4
(mg/l)			
Calcium	128,2	150	135,4
(mg/l)			
Magnésium	6,43	49,34	13,55
(mg/l)			
Sodium	43,28	713,02	167,4
(mg/l)			
Potassium	26,71	39,31	30,13
(mg/l)			

Descriptive Analysis of Results

The variation in the contents of different physico-chemical parameters of the water at three sites is represented in the form of histograms, to facilitate comparison between these three sites and also to monitor the evolution of each parameter at these three sites (Figure 1).

Temperature

The temperature values recorded in the downstream wadi are higher than those measured in the upstream wadi. This difference could be explained by the direct discharge of water from the source (whose average temperature is around 42°C) into the downstream site (Figure 2).

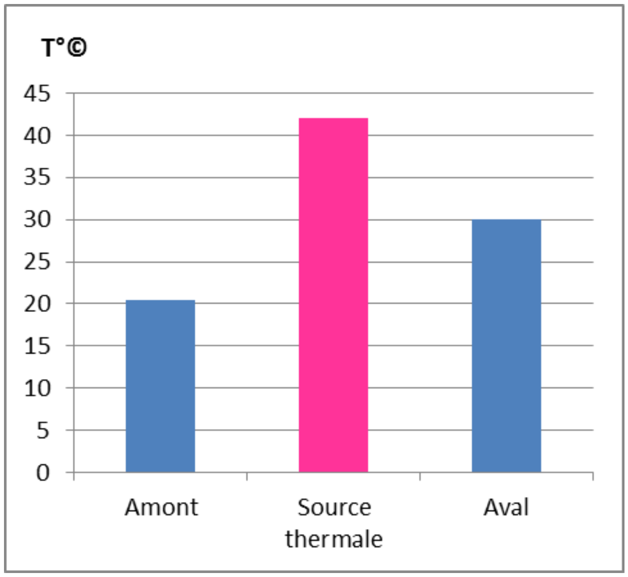

Figure 2. Results of analysis physicochemical

Hydrogen potential

The pH measured during the study period does not show significant variations between stations.

Although this parameter is related to almost all water quality parameters and some authors have mentioned the existence of seasonal fluctuations and/or spatial variations in pH values in streams [8,12]. The average values recorded are almost the same and close to neutrality: 7.42 (upstream), 6.91 (source) and 6.94 (downstream) (Figure 3).

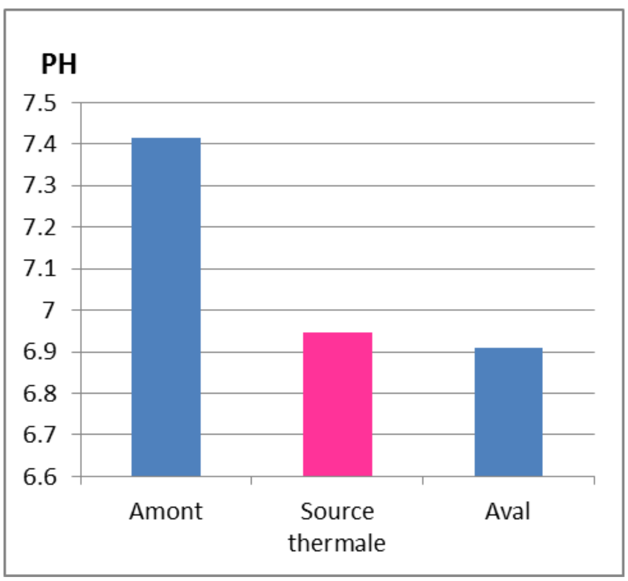

Figure 3. Hydrogen potential

Electrical conductivity

The conductivity values recorded in the downstream wadi waters are very high compared to those measured in the upstream. These results could be explained on the one hand by the direct discharges from the highly mineralized Hamma Outita source (whose electrical conductivity is between 8730 and 9240 µs/cm) which increase the conductivity of the water at the downstream site, and on the other hand, during the winter period, by the dilution of the water due to the return of the significant flow of the wadi [13] (Figure 4).

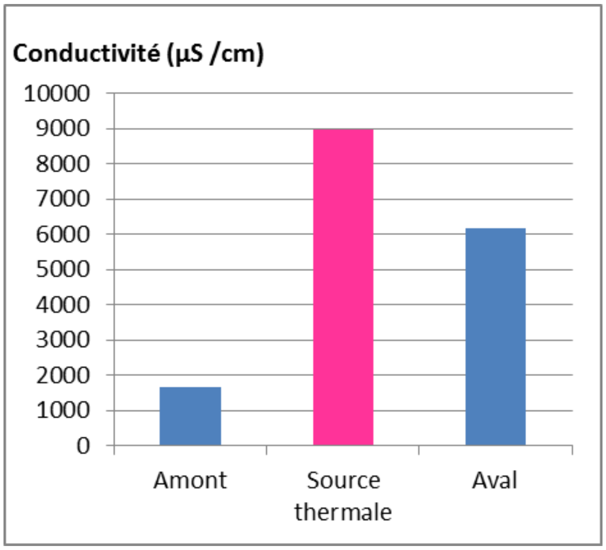

Figure 4. Electrical conductivity

The total hardness

The total hardness of the downstream wadi waters is high compared to the upstream, and influenced by direct discharge from the thermal spring, which has a significant value of the total hardness, (- upstream: 37.95 /- source: 57.05 /- downstream: 42.62). The hardness of groundwater is generally related to the nature of the sedimentary rocks crossed and is mainly due to the presence of Calcium and Magnesium, soluble constituents of carbonate rocks, especially limestone [14] (Figure 5).

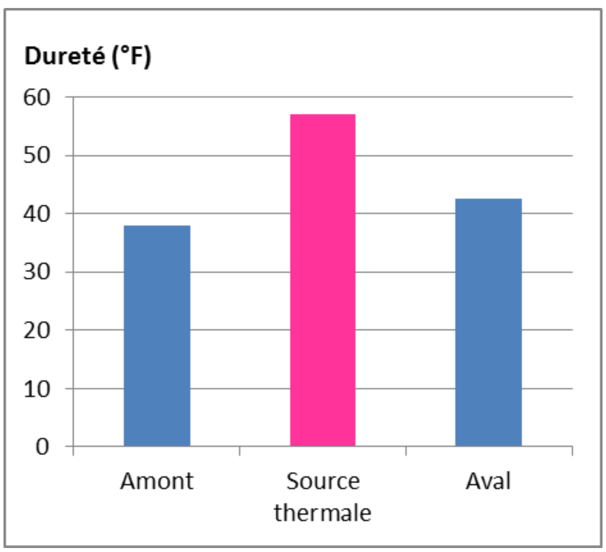

Figure 5. The total hardness

Sulphates

For sulphates, the waters of the O-aval site are more charged with these elements than the headwaters. The spring water (more sulphate-laden) discharged into the wadi could explain this difference between upstream and downstream. The average values recorded are in the order of 311.83 mg/l for O-amount waters, 933.39 mg/l for O-aval and 1130.62 mg/l for Source waters, reflecting the regional geological nature [10] (Figure 6).

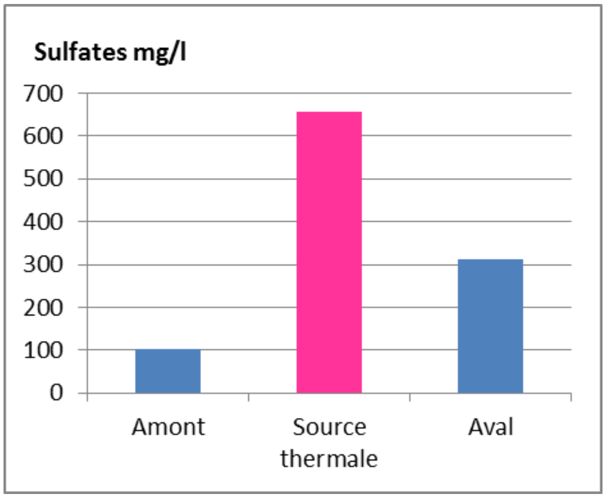

Figure 6. Sulphates

Chlorides

The waters of the wadi are more charged with chlorides and are influenced by the spring waters and by variations in the flow rate of the wadi. The averages recorded for O-amount, Source and O-aval are 254.36, 523.11 and 356.77 mg cl - /l ions respectively. The evolution of chlorides over the study period is similar in appearance to that of conductivity. This could be due to the regional geological nature [12] and the nature of the saline rocks at the source [13].

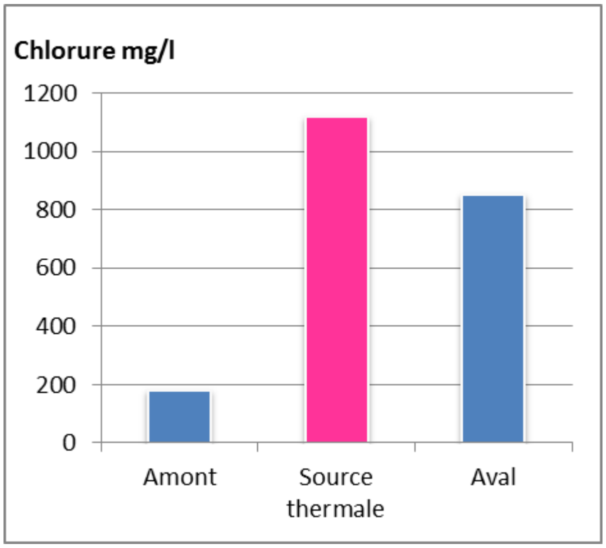

Figure 7. Chloride

Calcium

The concentration obtained (Figure 7) upstream of the thermal spring is on average 128.2 mg/l, while the concentration obtained from the thermal spring and its downstream are slightly higher (150 and 135.4 mg/l) (Figure 8).

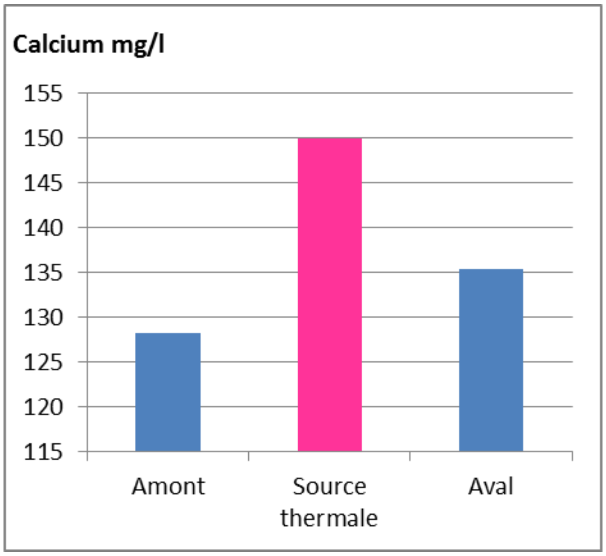

Figure 8. Calcium

Magnesium

The concentrations of magnesium obtained in the upstream and downstream sites are low compared to that of the thermal spring:

- The two upstream and downstream sites have successive values of 6.34 mg/l and 13.55 mg/l.
- Thermal Spring has a high value of 49.34mg/l (Figure 9).

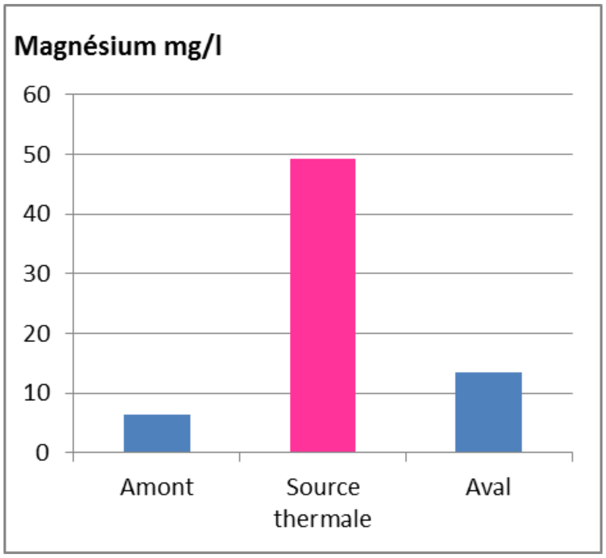

Figure 9. Magnesium

Sodium

The sodium value recorded at the upstream site is low and does not exceed 43.28 mg/l, whereas at the downstream site where Ain Hamma is discharged, the value reached is high at 167.4mg/l, due to the high mineralization of this source with a high sodium concentration of 713.02 mg/l (Figure 10).

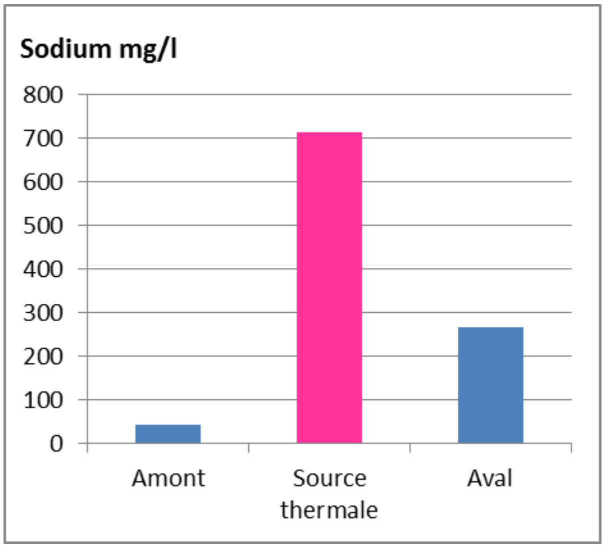

Figure 10. Sodium

Potassium

From the graph obtained, it can be seen that the Hamma Outita thermal spring has an influence on the potassium load of oued by its discharges, because it has a high concentration downstream (26.71 mg/l) and upstream (30.13mg/l), just after its mixing with the source which has a high value in this element (39.13mg/l) (Figure 11).

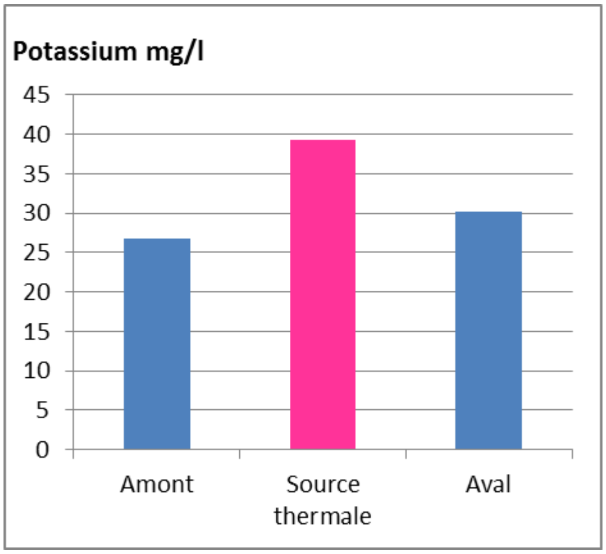

Figure 11. Potassium

CONCLUSION

The results obtained during our study made it possible to meet the objectives set out in the introduction and to draw up a portrait of the physico-chemical and bacteriological quality of the waters of the Ain Hamma Moulay Idriss spring and those of the section of the Khumane wadi located near the spring.

The waters of the thermal spring are highly mineralized and have very particular physico-chemical characteristics. These waters enrich the waters of the Khumane wadi with minerals and modify the physico-chemical quality of the latter, which could have an effect on this aquatic ecosystem downstream.

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