J. Mater. Environ. Sci. 7 (2) (2016) 519-524
ISSN : 2028-2508
CODEN: JMESC

Assessment of the physicochemical quality of Hassar stream after installing Mediouna wastewater treatment plant (Casablanca, Morocco)

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Abstract
Morocco has a limited water potential. Further, it may decrease because of the drought that affects many area of the country. Since this situation, Casablanca has been characterized by a semi-arid climate where annual rainfall does not exceed 400 mm.The local water resources remain weak and limited to a few small flows during low water (El Mellah, Bouskoura, Hassar, Merzeg …) and to overused and poor quality groundwater's (Berrechid and coastal Chaouia). In this situation, the protection and rational management of existing water resources as well as the search for non-conventional water resources will become a strategic necessity to ensure sustainable development of the region. Thus, the wastewater in the regions of Morocco begins to be treated to protect receiving environment, to produce together reusable treated water for agricultural irrigation and other urban activities, such as watering and washing. This research focuses on assessing the physicochemical quality of Hassar stream after installing the WWTP Mediouna. The findings of our study show that there is an improvement of this quality with dissolved oxygen concentrations up to 8.26 mg/l, BOD_5 maximum of 14 mg/l, COD less than 80 mg/l, TSS maximum contents of 30 mg/l. At the same time, the nitrogen ammonia fluctuates between 0.9 to 7.8 mg/l, orthophosphate between 0,48 to 11.62 and nitrates between 4.7 to 25.3 mg/l. These results show that the majority of the stations of Hassar stream have an average to good quality.

Keywords: Casablanca, Hassar stream, diagnosis, quality, wastewater treatment plants.

Introduction
In the recent decades, Morocco has experienced a remarkable development with an acceleration of various anthropogenic activities in several cities and rural areas [1]. The emergence of new urban centres and other suburban localities has contributed to increase production of wastewater that is generally dumped directly into receiving environment without any treatment [2, 3,4, 5].
In fact, the protection of natural habitats including streams has become a necessity to preserve the ecological equilibrium of the receiving environment, but also a strategic choice for sustainable development [6]. So, the treatment of wastewater produced particularly in suburban localities and industrial zones seems to be an effective solution to protect some receiving environment and enable resilience for others.
Hassar stream, one of the tributaries of Mellah riverin South-East of Casablanca, had been receiving wastewater from Mediouna in the rough until the end of 2012. This situation causes a deterioration of ecological condition of this environment and various effects on the local population [1]. After installing of Mediouna WWTP, in early 2013, Mediouna wastewaters are treated through a biological process combined with membrane filtration [7]. Thus, this WWTP can contribute to protect the aquatic ecosystem of Hassar stream and subjacent groundwater and produce non-conventional water resources reusable for agricultural irrigation [8, 9].
This research aims to diagnose the water quality evolution of this stream through a spatio-temporal monitoring of physicochemical parameters of water quality.

2. Materials and methods

2.1. The study area and sampling stations

Hassar stream is a low-flow watercourse and a tributary of Mellahriver, crossing itself, the vast region of Mohammedia- Benslimane [10]. This suburban stream drains a part of water from the Berrechid groundwater and starts at a main source, now dried up, located3 Km North East of the Mediouna locality. At this point, Hassarstream receives treated waters from Mediouna WWPT and throughout passingto the Mellahriver, other sources feed it usually with brackish water. Considering this point of Mediouna treated water discharge, morphology, the nature of the stream bed and the substrate, the proximity of rural localities (e.g. villages and Douars) and the ability to access, seven (7) sampling stations were established for this study (see Figure 1 and Table 1).

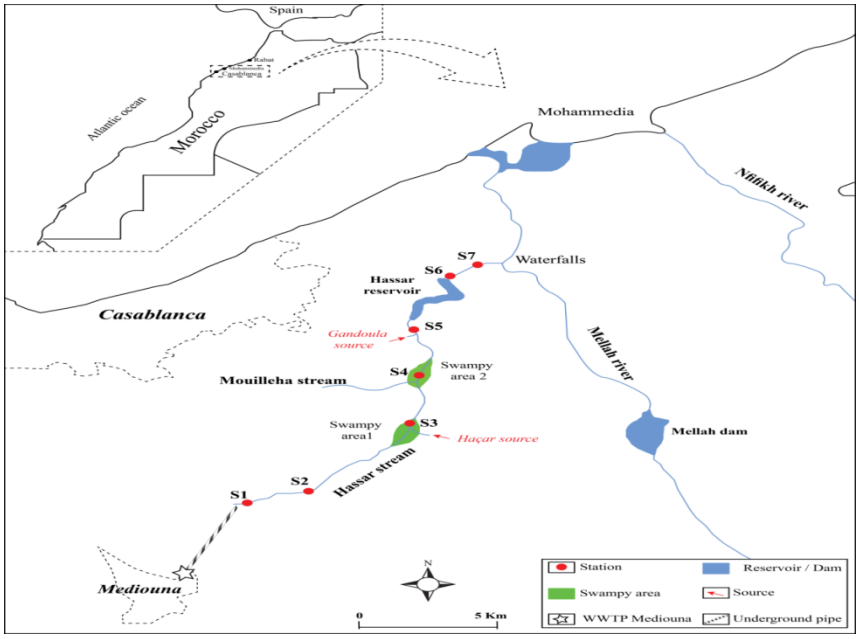

Figure 1: Location of the study area and sampling stations

Table 1: Location and characteristics of the sampling stations

Station	GPS coordinates	Distance from the main source (Km)	Region	Substratum
S1	33 ° 28'59.0 "N 7 ° 29'00.9" W	0.290	Douar Sidi Brahim	Mud
S2	33 ° 28'55.16 "N 7 ° 28'45.36" W	1	Douar Sidi Brahim	Mud and pebble
S3	33 ° 31'07.0 "N 7 ° 26'34.1" W	8	Sidi Moumene	Mud
S4	33 ° 31'29.1 "N 7 ° 25'45.9" W	9.3	Psychiatric hospital Tit Mellil	Mud and pebble
S5	33 ° 32'31.7 "N 7 ° 25'31.2" W	11.6	Village Sidi Hajjaj	sandy silt
S6	33 ° 35'22.8 "N 7 ° 26'06.7" W	18.7	Ouled Sidi Abdennabi	Sandy silt and pebble
S7	33 ° 36'11.9 "N 7 ° 25'46.9" W	21	Ouled Sidi Abdennabi	sandy silt

2.2. Sampling and analysis techniques

During our sampling out in realized between November 2013 and April 2014, water samples were taken in two replicas in 500 ml polyethylene flasks and transported to the laboratory in a cooler at 4°C. At the same time, in situ measurements of temperature, pH, Electrical Conductivity (EC), dissolved oxygen and turbidity were measured respectively by an ordinary mercury Thermometer, a pH meter WTW 3310 SET 2 (10^{-3}), a Conductivity meter LF90 (10^{-2}), a Oximeter WTW Oxi 3310 (10^{-3}) and a Turbidity meter EUTCH TN-100.
The chemical analyses of water are performed directly in the laboratory according to AFNOR standards [11] or those approved by Rodier [12] (Table 2).

Table 2: References of the methods used for water analysis

Parameter	Unit	Standard	Method
BOD_5	mg O 2/l	NF EN 1899 - 1998	OxiTop Method (VELP Scientifica)
COD	mg O 2/l	NF T 90-101	Oxidation by potassium dichromate
TSS	mg/l	NF EN 872	Filtration Method: GFC filter (0.45µm)
Nitrates	mg/l	Rodier, 2009	Sodium salicylate Method
Nitrites	mg/l	NF T 90-013	N-1 naphthylethylenediamine Method
Nitrogen ammonia	mg/l	NF T 90-015	Blue indophenol Method
Total phosphorus	mg/l	NF T 90-023	Dosage after peroxodisulfateoxidation
Orthophosphates	mg/l	NF T 90-023	Ammonium molybdate Method
Sulphates	mg/l	NF T 90-040	Nephelometric Method
Chlorides	mg/l	NF T 90-014	Mohr volumetric Method

3. Results and discussion

The results obtained during our monthly sampling were transformed into averages calculated for each station and presented in charts (see figure 2).

3.1. Temperature (° c) and pH

Water temperatures (T) in the different stations fluctuate between minima and maxima of 11.2 to 27.6°C. Maximum temperatures are recorded in station S1, which could be explained by the different temperatures of Mediouna treated water which are typically hot. Referring to the Moroccan standards of the superficially water [13], these temperatures show that Hassar waters are of good to excellent quality.
As for pH, the values of different stations fluctuate between 5.72 and 9.6 indicating an excellent quality. Furthermore, the slightly alkaline nature of Hassar stream can be explained by a strong photosynthetic activity which is due to the growth of algae and aquatic plants [14].

3.2. TSS and Turbidity

The average levels of TSS in the Hassar stream vary between 1 and 82 mg/l with an average of 22.94 mg/l while the turbidity varies between 4.8 NTU at S1 and 32.62 NTU at S7. At the same time, the TSS and turbidity vary in pairs with an increasing evolution in the upstream to downstream that reach peaks at stations S2 and S7 related to release of grey waters from riparian rural villages. As TSS load, Hassar stream is qualified in an excellent quality [13].

3.3. Mineralization

The average values of EC fluctuate between 3320 and 5570 µs/cm with an average of 4550 µs/cm, so they qualified Hassar water to be in a very poor quality [13]. More, the maximum values of EC are measured in stationsS3, S4, S6 and S7. The variation of EC average values generally follows an increasing gradient from upstream to downstream probably due to the influence of the underlying bedrock. According to the Moroccan standards [13], the EC values classify Hassar stream in a very poor quality.

The results that are found of average chlorides(Cl^-) contents go in pair with the EC evolution and show an increasing evolution from the upstream (773.34 mg / l) to downstream (1116.78 mg / l) with a peak at the station S5.
Concerning sulphates (SO_4^{2-}), concentrations vary between 54.8 and 373.3 mg/l with an average of 222.7mg/l. The maximum values are registered in stations S1 (256.21 mg/l) and S5 (248.78 mg/l).
These results of the EC, chlorides and sulphates show strong mineralization of Hassar stream linked especially to a salt layers (Permo-Triassic and Quaternary saltier) traversed by waters source [1,15, 16, 17].

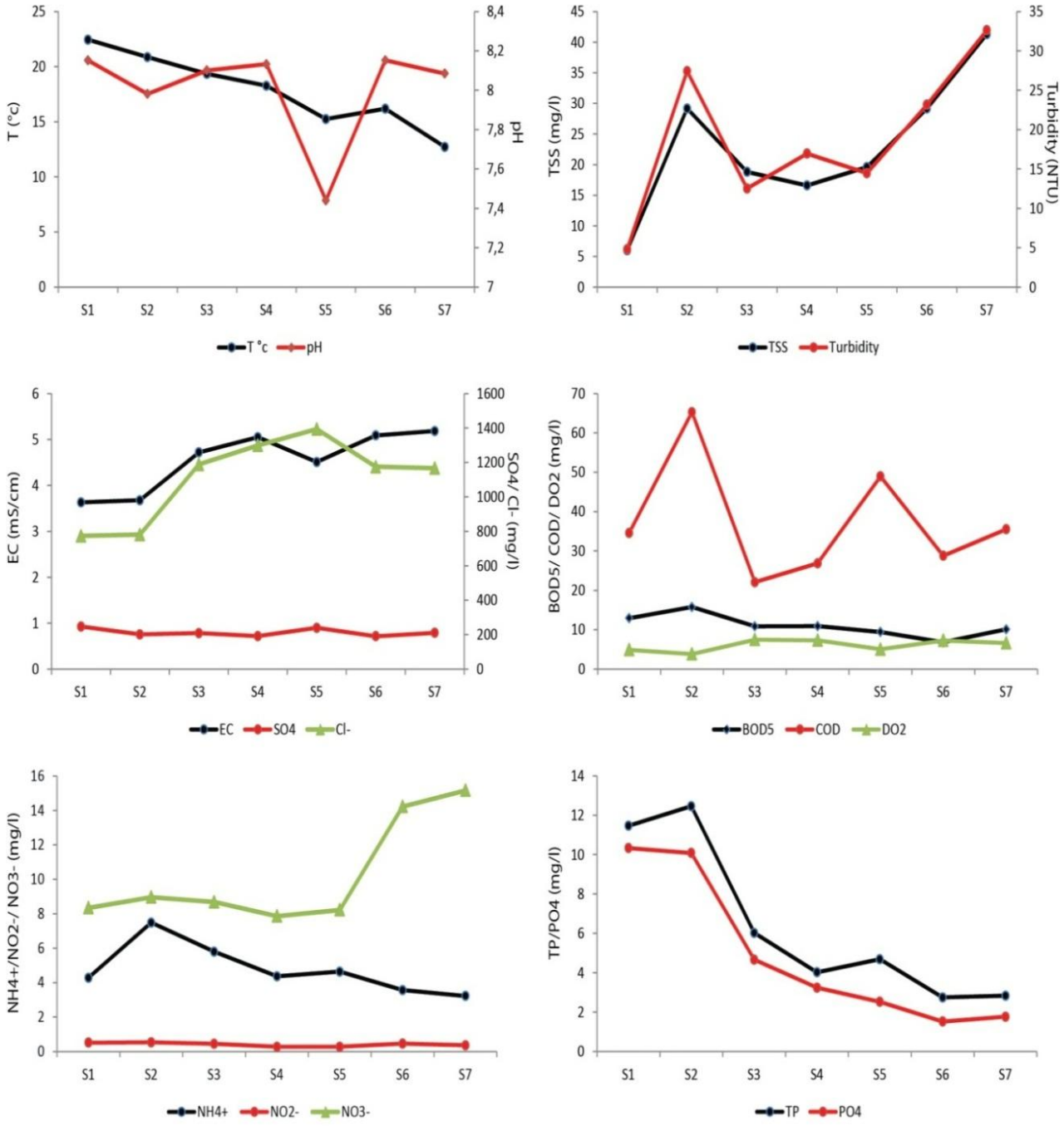

Figure 2: The average values of measured physicochemical parameters

3.4. Dissolved oxygen, BOD_5 and COD

The values of dissolved oxygen (DO_2) vary between 1.98 and 10 mg/l. These values characterize the Hassar water quality in general from good to excellent except stationsS1, S2 and S5, which have low dissolved oxygen values. At downstream, water's quality has improved at the station S6. This proves that the Hassar stream dam have an important rolein the self-purification of water.

BOD_5 values decrease from upstream to downstream with an exception of S2 and S7 stations. The values of BOD_5 decrease from 15.85 mg/l (S2) to 6.82 mg/l (S6) after Hassar dam. So, water quality is improving from upstream to downstream with a poor quality at the stations S1, S2 and S6 to average quality at downstream (6.81 mg/l) [13].

COD values which are paired with BOD_5 values, generally vary between and 9.6 mg/l and 76.8 mg/l with an average of 39 mg/l. These values show a decreasing gradient from upstream to downstream linked to the self-purification ability of the Hassar stream against the organic pollution. So, the Moroccan standards grid classifies Hassar stream waters to good quality water at S1, S3, S4, S6 and S7 and poor quality at S2 and S5 [13].

3.5. Total phosphorus (TP) and orthophosphates (PO_4)

The concentrations of phosphorus elements of Hassar stream follow a decreasing gradient from upstream to downstream. Phosphorus concentrations vary between a minimum value of 2,74 mg/lin S6 and a maximum value of 12.46 mg/l shown in S2. At the same time, the values of orthophosphates follow the same trend and fluctuate between 1.74 and 10.33 mg/l respectively noted in S7 and S1. These concentrations of phosphorus elements classify different water stations from poor to very poor quality [13].

3.6. Nitrogen Ammonia (NH_4^+), Nitrites (NO_2^-) and Nitrates (NO_3^-)

The average concentration of Nitrogen Ammonia in water varies between 0.8 and 13 mg/l. This load follows a decreasing trend from upstream to downstream with an exception in station S2, where the content increase from 4.3 mg/l to 7.5 mg/l before undergoing a continual fall to reach 3.22 mg/l in the S7 station.

Nitrites concentration follows a decreasing trend from upstream (0.51 mg/l at S1) to downstream (0.36 mg/l at S7). The high concentrations are registered in stations S2 (0.53 mg/l) and S5 (0.46 mg/l), which indicating a high degree of nitrogen pollution linked to dumping of local liquid effluents.

Unlike nitrites, the nitrates load evolution follows an increasing gradient from upstream (8.34 mg/l at S1) to downstream (15.16 mg / l at S7). Maximum values are recorded downstream of the Hassar reservoir at stations S6 (14.22 mg/l) and S7 (15.22 mg/l). This increase of water nitrates concentrations is linked to the nitration process promoted by the transition and stagnation of waters in Hassar reservoir [18].

Conclusion

Based on these results, the physicochemical water quality of the Hassar stream knows an improvement over its previous state before the installation of the Mediouna treatment plant. The installation of this WWTP permitted the reduction of the pollution load in terms of organic and inorganic oxidizable materials. This also permitted the physicochemical resilience of Hassar waters which led to an increase of dissolved O_2 rate and a reduction in COD and BOD_5 values. The result rank Hassar waters from average to good quality according to the Moroccan standards of superficial waters. However, the Hassar stream waters carry a large load of nitrogen and phosphorus elements probably due to the effects of treated waters of Mediouna WWTP since their load decreases from upstream to downstream which is linked to the self-purification ability of Hassar stream. This process is limited by the effect of some local Douars who dumped wastewaters directly in the stream that will limit the resilience process of Hassar stream.

In the future, our research will focus on studying Hassar stream hydrobiology and this reservoir to determine its bio-ecological resilience condition.

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