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Impact of Anthropic actions on the quality of surface water (Case of the Tiflet Wadi)

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ABSTRACT

The quality of surface waters of the city of Tiflet, represented by the wadi of Tiflet, depends mainly on various anthropic impacts, including liquid discharges from industrial and domestic sources without prior treatment. With the ultimate goal of ensuring the means of protection of water resources and sustainable development, the study of the physico-chemical and bacteriological quality of the wadi of Tiflet starts from upstream to downstream from three sampling stations. The results are processed by ArcGis and presented by evolutionary maps. The bacteriological characterization of the wadi waters shows that they are not acceptable for agricultural use, which means that the treatment of wadi waters is an essential step before any agricultural use in order to reduce pollution. However, the physico-chemical parameters show that the water of Tiflet Wadi must undergo a physico-chemical treatment and disinfection before any human consumption.

***Key words** : Quality, Surface water, Chemical analysis, Wadi of Tiflet*

Introduction

Water is defined as a vital substance for all living beings. Once it is polluted or contaminated by different organic or mineral substances, it becomes a source of propagation of several diseases such as gastroenteritis, viral hepatitis, typhoid, leptospirosis. Millions of infants and children die each year from diarrheal diseases due to contamination of food or drinking water (Louis *et al.*, 1991).

Morocco has very important water resources: groundwater, rivers and two 3500 km long ocean fronts; a wealth of plant, animal and fish species that could provide the country with a solid foundation for a real economic take-off and a sustainable and harmonious human development. However, the demographic growth and the rhythm of urbanization have had a negative impact on these aquatic ecosystems.

In addition, the unreasonable management of these natural resources, the dumping of solid waste and liquid discharges into the natural environment without any treatment, the illegal dumping and the lack of basic notions of environmental protection among citizens, endanger the environmental stability of the country. The city of Tiflet in this case, is part of the Moroccan cities that have neither a wastewater treatment plant nor controlled landfill, participating a priori in the deterioration of aquatic ecosystems constituting a receiving environment of the majority of wastewater generated by the city without prior treatment, including the Tiflet Wadi constituting the only watercourse of the city (WHO: Guidelines for Drinking-water Quality, 1994; Nimri *et al.*, 2004)

The objective of this work is to highlight the bacteriological and physico-chemical quality of the waters of the Tiflet Wadi through three stations located from upstream to downstream of the Oued. The processing of data geographically, were carried out by the use of ArcGIS, which allows the display and overlay of different layers of geographical information in the form of maps for a visualization of the spatialized evolution under the effect of anthropic impacts of different parameters of the quality of the wadi.

Materials and Methods

The study area

The city of Tiflet (Fig. 1) is a Moroccan city, located 56 km east of the capital Rabat, depending on the province of Khemisset in the region of Rabat-Salé-Kenitra.

The population of Tiflet is 86709 inhabitants and spreads over an area that tends to 12 km ^{2}. The city is affiliated with two watersheds, Sebou and Bouregreg. It has two water resources, the Tiflet Wadi and the aquifer of Maamora are used in agriculture which is defined as the first economic activity of the city with a UAA of 67 ha, livestock comes second with that of the sheep estimated 97.2%. (Water Basin Agency, 2019)

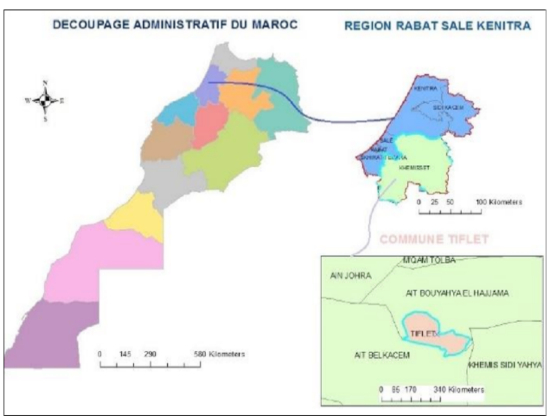

Fig. 1. Geographical location of the town of Tiflet

Our study area is geologically part of the Khemisset-Tiflet region which is included between the meseta that was structured during the Hercynian phase. It extends over the geological provinces of the Sehoul block in its western part (Tiflet region) while its major part is located south of the Pre-Ribbentine wrinkles (Michard *et al.*, 1976 ; Faqihia *et al.*, 2015)

Moreover, it belongs to a domain with the same litho-stratigraphic facies as the neighboring hydrogeological units (North of Maâmora and Northwest, Rharb in the Northeast and Meknes basin in the East) (Master Plan for Integrated Water Resources, 2011).

However, from a hydrological point of view, The Tiflet Wadi has an altitude of 7 meters and extends over a length of approximately 7.6 km, from the city of Tiflet upstream to the city of Sidi Yahia El Gharb east of the forest Labracha downstream viathe town of Sidi Boukhelkhal (Water Basin Agency, 2019).

In this study, we were interested in the study of the quality of the surface water, Wadi of Tiflet, limiting ourselves to the area of the city of Tiflet. For this purpose, we carried out water sampling at three different stations of this Wadi (Table 1), going from upstream to downstream, S1, S2 and S3. (Fig.3)

Fig. 2. Geographic location of the Tiflet Wadi

Study Method

In order to determine the quality of the surface water of Wadi Tiflet, we have carried out physico-chemical and bacteriological analyses.

The pH and temperature were determined by a 206 Lutron pH meter equipped with a temperature probe.

Table 1. Coordinates of sampling stations

Sampling station	X	Y
S1	417199.06	364644.10
S2	416751.19	366937.31
S3	415709.17	370152.71

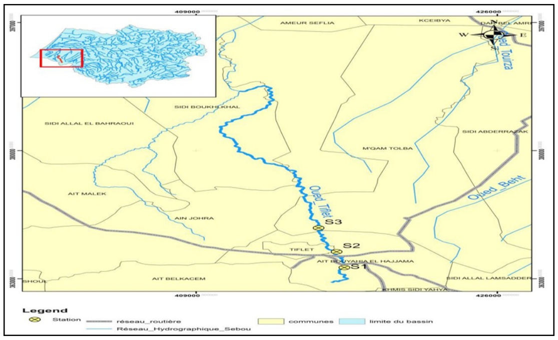

Fig. 3. Geographical location of the water sampling stations of Wadi of Tiflet

Electrical conductivity was measured with a WTW LF90 conductivity meter. Turbidity was determined by a 2100p portable turbidimeter.

Suspended solids (SS) are measured by a filtration process on a 125 µm diameter filter already dried for 2 hours in an oven at 105 °C, the weight of the filter is measured after filtration of the sample and drying in an oven at 105 °C.

The ratio of the mass difference to the filtered volume gives the concentration of suspended solids in the sample.

The measurement of total solids and organic matter consists of drying the sample at different temperatures, 105 ° C for ST and 550 ° C for MO, in porcelain capsules the mass of the hollows containing the sample in the initial state and after each drying is measured (Rodier *et al.*, 2016).

Water hardness was determined by complexometry by volumetrically dosing 100 ml of the sample with a complexing titrant, EDTA in the presence of a buffer solution and the color indicator NET. The TAC (complete alkalinity titre) was determined from the volumetric determination of 100 ml of the sample with 0.02 mol.l^{-1} of acid in H_3O^+ ion in the presence of helianthine.

Nitrate NO3- is determined spectrophotometrically in the presence of sodium salicylate and read at a wavelength of 450 nm. Sulfates are measured by nephelometric method in hydrochloric medium in the state of barium sulfate and Tween solution and read at a wavelength of 650 nm.

Phosphates were calculated by the spectrophotometric method in the presence of ammonium molybdate reagent and read at a wavelength of 880 nm. (Rodier *et al.*, 2016).

Microbiological analyses were limited to the determination of fecal pollution indicators (fecal coliforms and fecal streptococci).

The method used is membrane filtration. Fecal coliforms are determined from Tergitol medium and incubation at 44 °C for 48 hours. While, Fecal streptococci are determined from Slanetz medium and incubated at 37 °C for 48 hours (Rodier *et al.*, 2016).

Results and Discussion

Physico-Chemical quality

The physicochemical analyses of the surface waters studied in the Wadi of Tiflet remain quite variable from one parameter to another. The water temperature is an ecological factor that has important ecological repercussions (Leynaud *et al.*, 1968). It acts on the density, viscosity, solubility of gases in water, dissociation of dissolved salts, as well as chemical and biochemical reactions, development and growth of organisms living in water and particularly microorganisms. (World Health Organization, 1987)

The average temperature of the waters of Wadi Tiflet is about 11.9 ° C for the study period. This value can be explained by the influence of the air temperature and the period of measurement (winter). Thus, the pH remains almost neutral. It varies between 6.76 and 7.65 (Fig. 4).

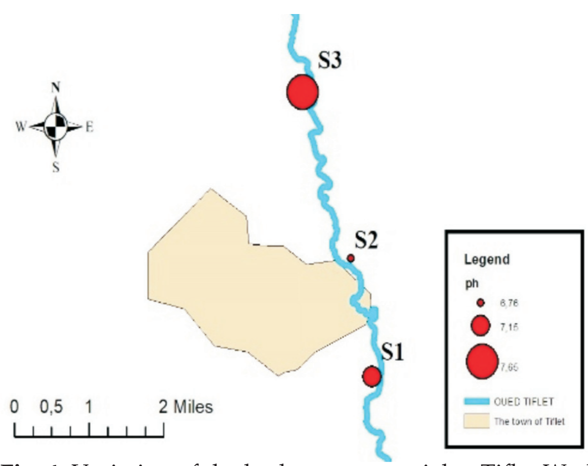

Fig. 4. Variation of the hydrogen potential at Tiflet Wadi

The pH of the water measures the concentration of H+ protons in the water. It summarizes the stability of the equilibrium established between the different forms of carbonic acid and is linked to the buffer system developed by the carbonates and bicarbonates. For comparison, we observe that the pH measured at the level of Wadi Beht 8.4 is higher than our result recorded in Wadi Tiflet (Ezzaouaq, 1991; EL Blidi *et al.*, 2003; Himmi *et al.*, 2003; Lakhili *et al.*, 2015).

These values are consistent with the standards of water intended for the production of drinking water on the one hand and on the other hand the standards of water intended for irrigation (Water quality grid, 2014; Quality standards for water intended for irrigation, 2002).

The recorded conductivity values vary from a minimum of 1291µS/cm measured at station 1 to a maximum of 2110 µS/cm measured at station 2. (Fig. 5).

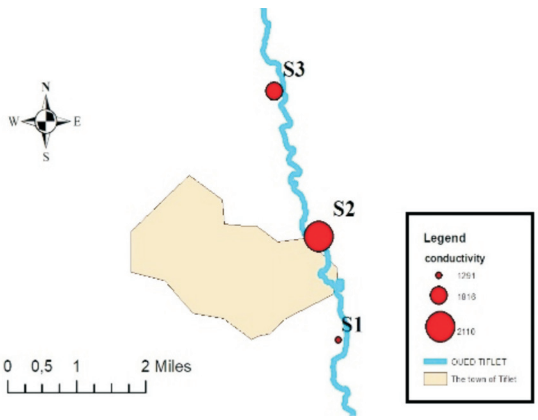

Fig. 5. Variation of conductivity in Tiflet Wadi

It is noted that the result obtained from the conductivity is higher than the value recorded in Oued Beht, 296 µS/cm (Lakhili *et al.,* 2015).

The conductivity of these waters increases at station 2, which is explained by the discharge of liquid waste from the textile industries located just before the location of this station, then we observe a decrease until station 3 (1816µS/cm), and this can be explained by the effect of self-purification which is based on a set of natural processes, physico-chemical and biological allow the Wadi to reduce pollution or eliminate it in a definitive way.

The waters of the Wadi of Tiflet studied show values of electrical conductivity exceed the standard set by the grid of quality of water intended for irrigation (Quality standards for water intended for irrigation, 2002).

According to the grid of quality of water intended for the production of drinking water, the results testify that the waters of Tiflet Wadi are undergone to the category A1 of which they need a simple physical treatment and disinfection in the sense of treatment of conductivity (Water quality grid, 2014).

The turbidity of Oued Tiflet water oscillates between 2.92 NTU recorded at station 1 and 342 NTU recorded at station 2. The value (38.9 NTU) recorded at station 3 located upstream of the wadi may be due to self-purification (Fig. 6).

The observed value of turbidity at the second station is always related to liquid discharges from textile factories and the discharge of domestic wastewater from the city of Tiflet discharged just in the vicinity of this station.

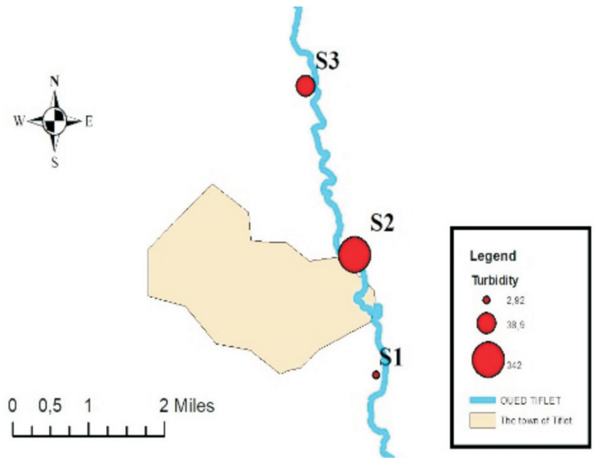

Fig. 6. Turbidity variation in Tiflet Wadi

The concentrations of sulphates measured in the waters of Tiflet Wadi increase from 25.94 mg/l (station 1) to 53.5 mg/l (station 2). The value of sulphates recorded at station 2 can be explained by the presence of industrial effluents.

These values are in accordance with the maximum values set by the standards of the quality of water intended for the production of drinking water and the quality standard of water intended for irrigation (Fig. 7).

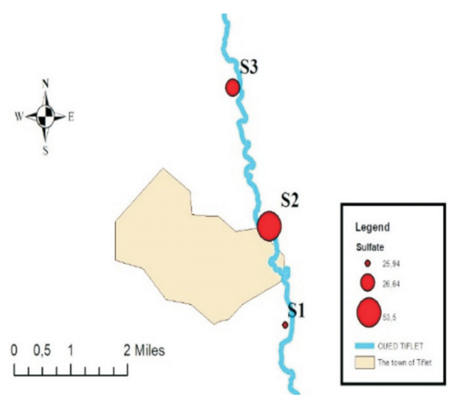

Fig. 7. Variation of sulfate in Tiflet Wadi

The biological oxygen demand (BOD_5), varies from 2.6 mgO2/l observed at station 1 and 240 mgO2/l observed at station 2 (Fig. 8), while the chemical oxygen demand (COD), varies between 28.8 mgO2/l noted at station 1 and 3552 mgO2/l noted at station 2 (Fig. 9).

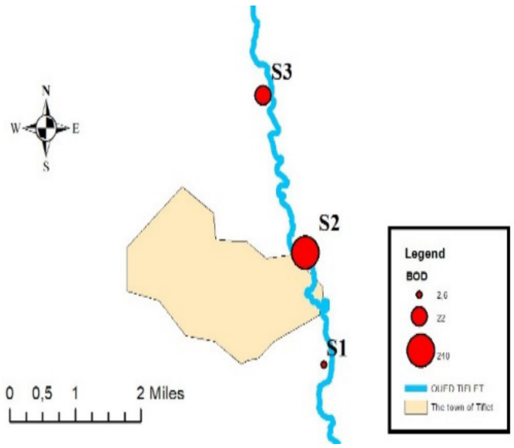

Fig. 8. Variation of BOD_5 in Tiflet Wadi

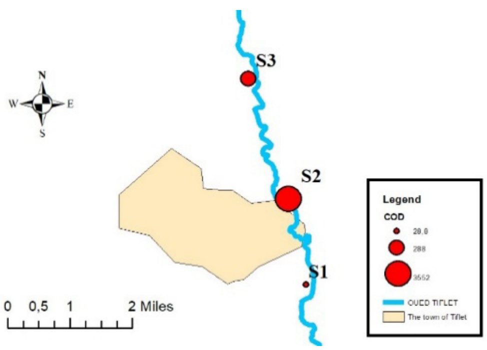

Fig. 9. Variation of COD in Tiflet Wadi

We note that the BOD_5 recorded in our study, especially at station 3, is higher than the average BOD_5 calculated at the surface waters of the Sebou basin 2.5 mgO_2/l. Other than the COD, measured at station 3, is considered higher than the average observed at the level of surface waters of the Sebou basin 22.67 mgO_2/l.

On the other hand, the results of BOD_5 and COD obtained at the first station are almost equal to the averages calculated at the Sebou basin. This is due to the discharge of wastewater and liquid pollutants throughout the Wadi. (Surface water quality, 2002)

The results show that the BOD_5 and COD of the surface waters of the city of Tiflet exceed the limit values of the quality of water intended for the production of drinking water and the quality standard of water intended for irrigation (Water quality grid, 2014; Quality standards for water intended for irrigation, 2002).

The ratio of biodegradability (COD/BOD_5) minimum at the studied stations of Tiflet Wadi is 11.08, which is higher than 4 and which shows that these waters are hardly biodegradable (Fig. 10) (Fekhaoui *et al.*, 1993).

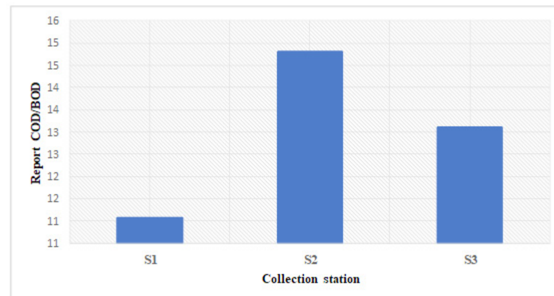

Fig. 10. Biodegradability ratio at the three sampling stations

Suspended matter represents all the mineral and organic particles contained in water. They are a function of the nature of the land crossed, of the season, of the rainfall, of the water flow regime, of the nature of the discharges, etc. (Rodier *et al.*, 2016). High levels of suspended solids can be considered as a form of pollution. Such an increase may also lead to a warming of the water, which will have a detrimental effect on cold water fauna (HÉBERT, S *et al.*, 2000).

The recorded suspended solids content varies from a minimum value of 3 mg/l at station 3 to a maximum value of 25 mg/l in station 1 (Fig. 11).

From a qualitative point of view and according to the quality grid for water intended for the production of drinking water, these waters do not exceed

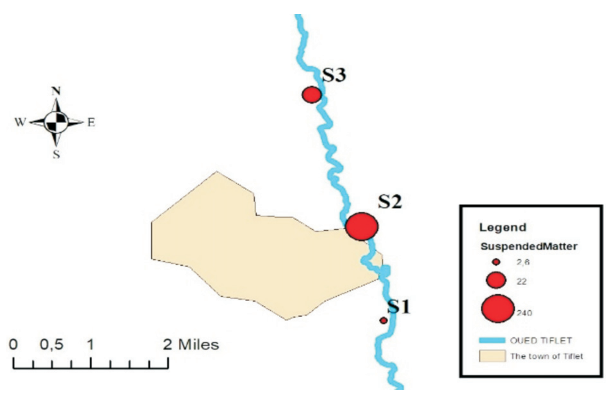

Fig. 11. Variation of suspended matter in Tiflet Wadi

50 mg/l, which says that they are classified to category A1 and can have a simple treatment and disinfection in terms of suspended matter (Water quality grid, 2014).

According to the quality standards of water for irrigation, these waters remain acceptable in irrigation (gravity and localized irrigation system). (Quality standards for water intended for irrigation, 2002)

The organic matter takes a bell shape with a maximum of about 56.9 mg/l observed at station 2. (Fig. 12).

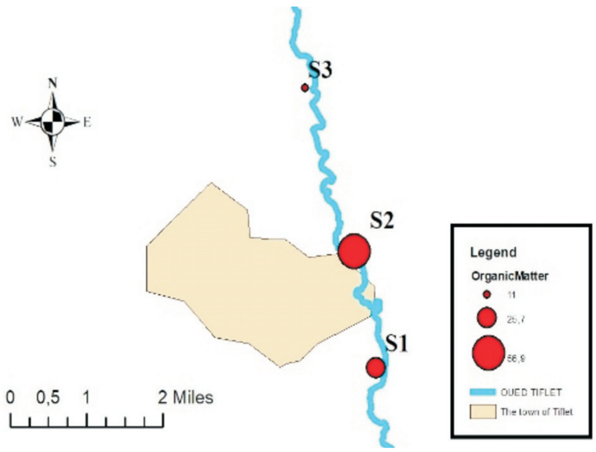

Fig. 12. Variation of organic matter in Tiflet Wadi

The hardness varies between 209°F and 83.5°F. According to these values, the waters of the Wadi of Tiflet are classified as very hard waters since they exceed 30°F. The rate of the (Ministry in charge of land use planning, 2003). (Fig. 13)

As for the mineral matter, the values recorded at the level of the studied waters vary from 902.1 mg/l calculated at the level of the station 1 to 32.3 mg/l

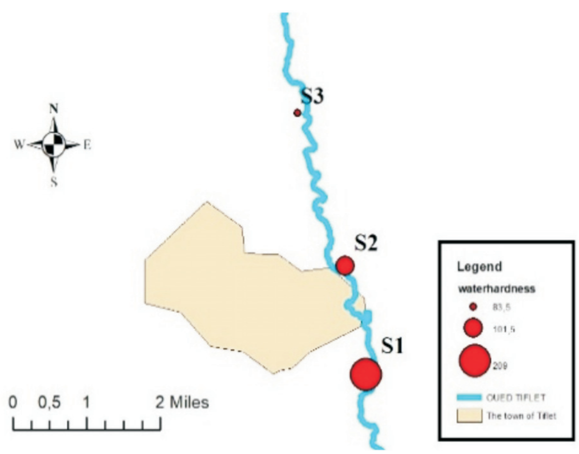

Fig. 13. Variation of the total hardness in Tiflet Wadi

at the level of the station 3. It is noted that the concentration of mineral matter shows a gradient decreasing the direction of flow of the Wadi from south to north (Fig. 14).

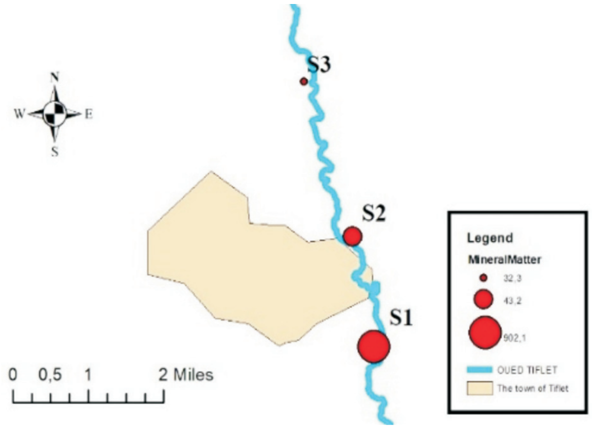

Fig. 14. Variation of mineral matter in Tiflet Wadi

The nitrate concentration fluctuates between 7.94 mg/l (station 1) and 28 mg/l (station 3). This result is much higher than the nitrate values recorded in Oued Beht and which vary between 0.009 mg/l and 0.9 mg/l (Lakhili *et al.*, 2015).

The concentration of nitrates in Oued Tiflet does not exceed the limit value of nitrate concentration set by the quality standard of water intended for drinking water production (50 mg/l) and the quality standard of water intended for irrigation (30 mg/l) (Fig. 15).

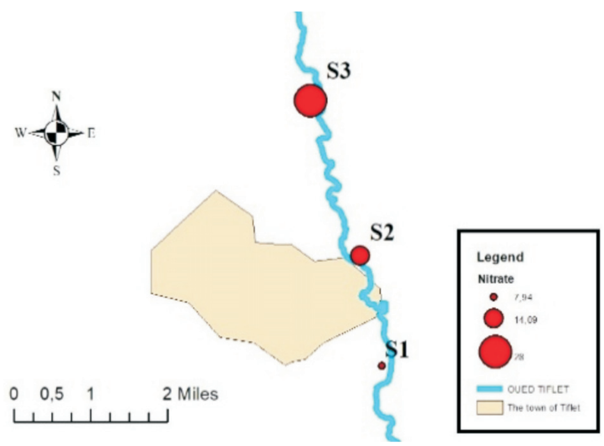

Fig. 15. Variation of nitrate in Tiflet Wadi

The concentration of phosphates in Tiflet Wadi evolves from 0.47 mg/l measured at station 1 to 8.77 mg/l measured at station 3. The increase in phosphate concentration is explained by the discharge of wastewater from the city of Tiflet along the Oued, whose phosphates would come from the urine (Fig. 16) (Rodier *et al.,* 1996) (Fig. 16).

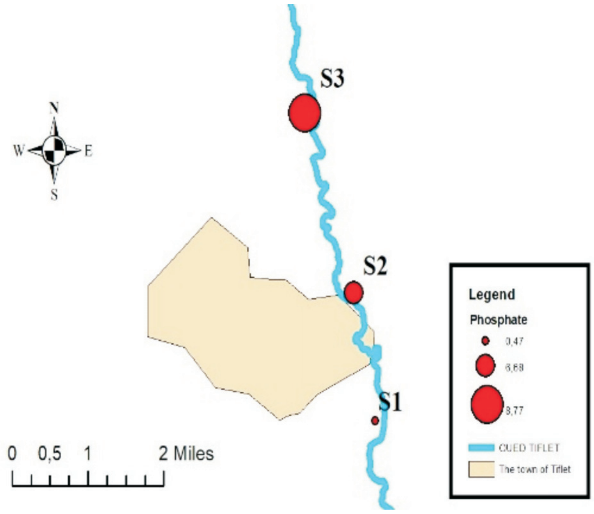

Fig. 16. Phosphate variation in Tiflet Wadi

According to the results obtained, by observing the maps of spatial variation of the studied characteristics, we notice that most of the physicochemical parameters are concentrated at the second sampling station and they have a bell shape such as electrical conductivity, turbidity, sulphates, BOD5, COD, TSS and OM.

This is always linked to the large volume of wastewater discharged to the Wadi at this station since almost the entire population of the city is connected to this station, other than the discharge of industrial wastewater from existing textile factories in the middle of the city, as well as the discharge of margines resulting from the process of extracting olive oil, and which are discharged at the level of the station 2 Other than the total hardness and mineral matter varies from upstream to downstream in a descending manner.

On the other hand, it is observed that nitrates and phosphates accumulate along the entire length of the wadi. These parameters show an increasing gradient from upstream to downstream of the wadi of Tiflet, this is mainly due to the agricultural activities that are located along the banks of the wadi mainly in the downstream part and also to the areas where the discharge of domestic and industrial wastewater is located.

Bacteriological quality

The concentrations of fecal coliforms, vary from 19.10^6 CF/100 ml (station 1) to 9.10^7 CF/100 ml (station 3), and from 16.10^6 SF/100 ml to 21.10^6 SF/100 ml (Fig. 17)

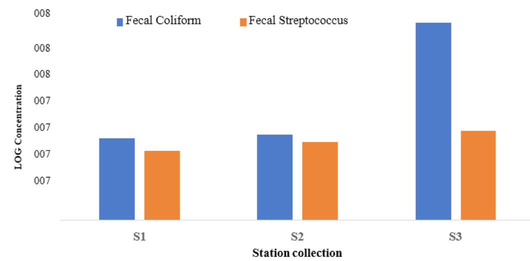

Fig. 17. Concentration of CF and FS at Tiflet Wadi

Fecalstreptococci concentrations varied very little. Station 3 has the highest concentration with a value of 21.10^6 SF/100 ml and the lowest concentration isobserved in station 1 with a value of 16.10^6 SF/100 ml.

From the qualitative point of view, the waters of Tiflet Wadi are of very poor quality, exceeding the standard set by the gridrelating to river waters 20000 CFU/100 ml and also exceeding the average calculated at the level of surface waters of the Sebou basin 16200 CFU/100 ml. Generally, the surface waters of the city of Tiflet are not drinkable as a whole and they must have a thorough physical chemical treatment, refining and disinfection according to the quality grid of waters intended for the production of drinking water.

On the other hand, thisbacteriologicalqualityis not acceptable for use in irrigation according to the qualitygrid for water intended for irrigation. (Water Basin Agency, 2019; Surface water quality, 2002)

The monitoring of the faecal coliform/faecal streptococcus ratio at the three stations studied show that the origin of the pollution at the first two stations is from a source of uncertain origin (CF/SF Station 1 = 1.38; CF/SF Station 2 = 1.05) and at the last station, from an exclusively human source (CF/SF Station 3 = 4.5). (Borrego *et al.,* 1982).

Conclusion

From this study, it is concluded that the physicochemical and bacteriological quality of Tiflet Wadi is generally variable from one parameter to another.

With the exception of pH which is almost neutral, the other physicochemical parameters follow a spatial distribution in the form of a bell such as electrical conductivity, turbidity, BOD_5 and COD, which was explained by the exposure of Tiflet Wadi at the level of the second station to a large quantity of wastewater discharged from domestic and industrial sources, in addition to the seasonal discharge of margine. However, the concentration of nitrates and phosphates follows an increasing gradient from upstream to downstream, this accumulation is due to wastewater discharges and agricultural activities along the banks of Tiflet Wadi.

From a bacteriological point of view, the surface waters of Tiflet are of poor quality with a fairly high concentration of indicators of fecal pollution and the source of this pollution remains human

Generally, the physicochemical and bacteriological quality of the surface waters of Tiflet Wadi highlighted the negative impact of anthropic actions. Similarly, the value of all the parameters exceeds the averages calculated at the level of the surface waters of the Sebou basin of which Tiflet Wadi is part.

Therefore, the use of Tiflet Wadi water requires a treatment before any use in agricultural activities, so the consumption of these waters by human beings is forbidden only after a disinfection.

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