Journal of Materials and Environmental Sciences
ISSN : 2028-2508
CODEN : JMESCN

J. Mater. Environ. Sci., 2018, Volume 9, Issue 2, Page 631-640

https://doi.org/10.26872/jmes.2018.9.2.70

http://www.jmaterenvironsci.com

Diagnostic of the environmental situation of the west coast of Tangier

Elkhalil CHERIF [1], Farida SALMOUN [1]

[1]*Laboratoryof of Physical Chemistry of Materials, Natural Substances and Environment, Abde Elmalek Essadi University, ancienne route de l'aéroport, km 10 Ziaten. BP : 416. Tanger, Maroc.*

Received 03 May 2017,
Revised 27 Sep 2017,
Accepted 30 Sep 2017

Keywords
- ✓ *west coast,*
- ✓ *diagnostic,*
- ✓ *bacteriological analysis,*
- ✓ *industrial activity,*
- ✓ *beaches.*

bakkalicherif@gmail.com ;
Phone: +212 654136839;
+212 644028554;

Abstract

To have an idea about the impact of wastewater treatment station Boukhalef installed in *west coast* of Tangier a *diagnostic* study and *bacteriological analysis* have been done along this *coast* between Achekar *beach* and the Diplomatic Forest *beach*. The preparation of the inventory of environmental aspects shows that the *west coast* of Tangier is a zone of intense *industrial activity* represented by the two industrial zones; Tangier Free Zone and Industrial Zone Gzenaya (TFZ and IZG) and the surface temperature of bathing water remains stable at 16-18 ° C, contrariwise it reaches 22°C in Jbila and Sidi Kacem. Consequently, the *bacteriological analysis* shows that the concentrations of Escherichia Coli and Intestinal Enterococci germs are high in the last two *beaches*.

1. Introduction

Since the late twentieth century enjoying leisure time on the coast throughout the year has increased in popularity. This requires minimum standards of quality in the coastal areas and it's bathing waters to ensure the health of the users [1]. For this reason the Monitoring of the quality of bathing water is more important and we give an idea of coastal pollution types and their gravity [2].

Monitoring the quality of coastal waters is carried out mainly in accordance with the European Directive on bathing waters, measuring the concentration of Escherichia coli and intestinal Enterococci. These bacteria indicate the bacteriological quality of waters [3]. Water quality indicators including physical, chemical, and biological properties are traditionally determined by collecting samples from the field and then analysing the samples in the laboratory [4]. But today studies on pollution of coastal waters have followed new technologies, such as remote sensing, Remote sensing techniques make it possible to monitor and identify large scale regions and waterbodies that suffer from qualitative problems in a more effective and efficient manner [5-7].

The West Atlantic coast of Tangier plays a socio-economic role of great importance. Firstly, this Moroccan coast has the advantage of being among the richest in the world with a wide diversity of ecosystems [8]. On the other hand, it is a privileged place for the installation of numerous agglomerations and industrial units, [9].

Along the coast of Cape Achekar to the beach of the Diplomatic Forest, there are several human activities, including unidentified urban and tourist areas, generating a large volume of wastewater, as well as the presence of a strong industrial activity represented by the two Large zones; Tangier Free Zone (TFZ) and Industrial ZONE Gzenaya (IZG) presenting a large source of waste water that can cause an imbalance of the ecosystem in the west coast of Tangier.

The installation of wastewater treatment station Boukhalef, one of the state's solutions to solve the pollution problem in this coast, is part of the national coastal pollution control program.

The objective of this work is to carry out an inventory of the environmental aspects and to make a qualitative assessment of the bathing waters with the aim of evaluating the state of contamination by bacteriological germs (Escherichia Coli, Intestinal Enterococci) and the use of the landsat_8 thermal bands for the evaluation of the temperature along the west coast of Tangier.

2. Study zone

Our study area is located in northwestern Morocco and occupies 150 km from Sol beach to the diplomatic forest beach between 35 ° N 40 'and 35 ° N 46' North latitude and W 5 ° 56 'and W 5 ° 57' west longitude (Figure 1). It belongs to the Rifain domain; [9]. The site is actually a Bukhalef watershed, whose river meets near the coast to form the mouth of the Boukhalef river with the Atlantic coastline.

The coast line, oriented from the south-west to the northeast, is open. However, it corresponds to a low and swampy alluvial plain characterized by the extent of Dayas and Merjas which occupy a large part of the coastal zone between Tangier and Asilah [10].

This zone has 6 beaches, human activities and consequently the environmental effects on the region are well observable. Two industrial zones, urban areas and a series of seaside tourists and hotels are concentrated on the coast; (Figure 1).

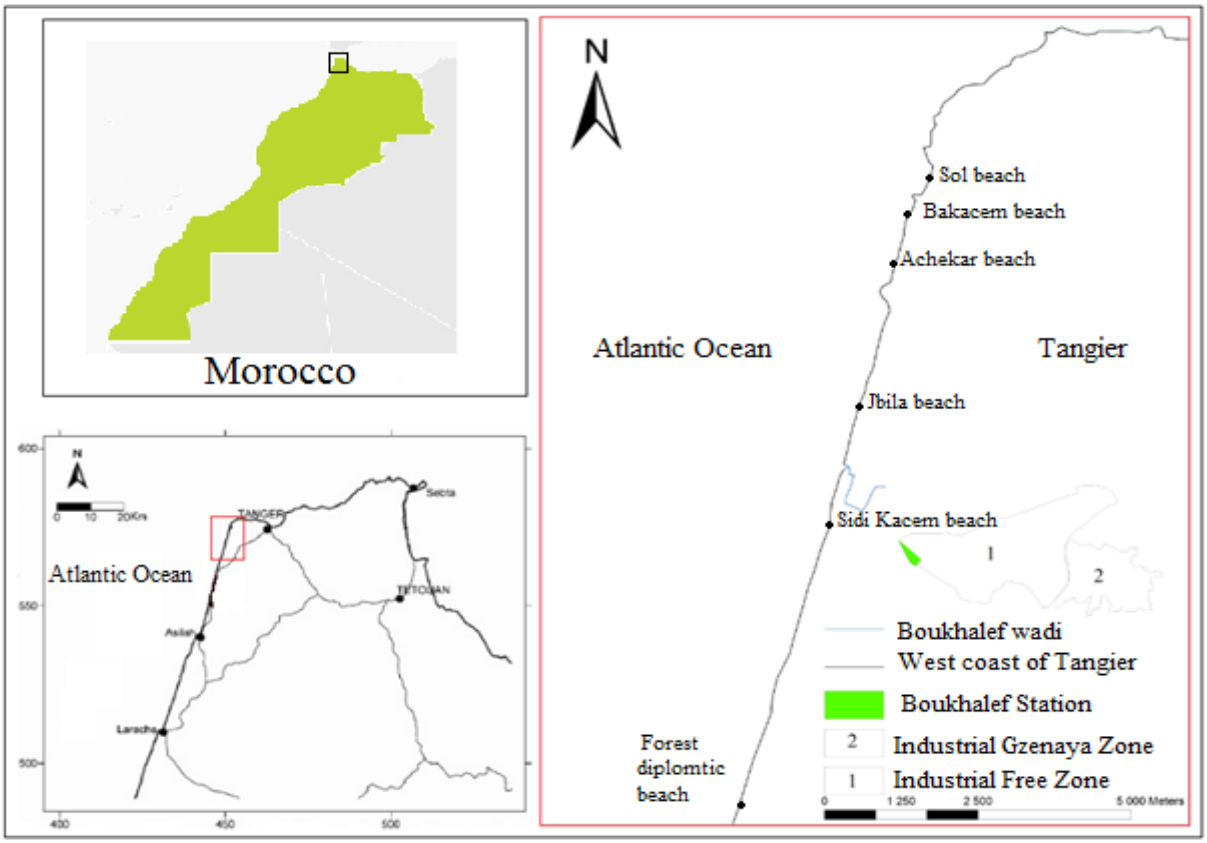

Figure 1 : The geographic location of the study zone.

We divided our study area (the west coast of Tangier) into 4 regions of coast according to the distance between the beaches and their characteristics in common.

The following table shows the selected regions of coast: (Figure 1).

Table1: The 4 regions of coast

Region	Beachs
region 1	-Sol -BA Kacem -Achakar
region 2	-Jbila
region 3	-Sidi Kacem
region4	-Plage foret diplomatique

3. Material and Methods

Our work is divided into two main axes: the inventories of environmental aspects (Diagnostic) and bacteriological analysis.

The inventories of environmental aspects that consist of collecting, organizing, processing and manipulating data on the coast using (ArcGis) software for cartography [11] and (ENVI) software for thermal treatment from the landsat_8 data for better analyze the vulnerablty of the cost west to pollution [11]. Thus, two images (with resolution of 30 meter) of the thermal infrared sensor (TIRS) and the operational land imager (OLI) sensor were acquired covering the west coastal of Tangier: 05/2016, 06/2016, the same date where done the bacteriological analysis. These images were then projected into the Lambert compliant conical Moroccan projection system (WGS84) and converted the pixels of two bands thermal of landsat_8 (band 10 and 11) into units of absolute radiance, then from the top of atmosphere (TOA) radiance to the temperature using the thermal constants provided in the metadata file [12].

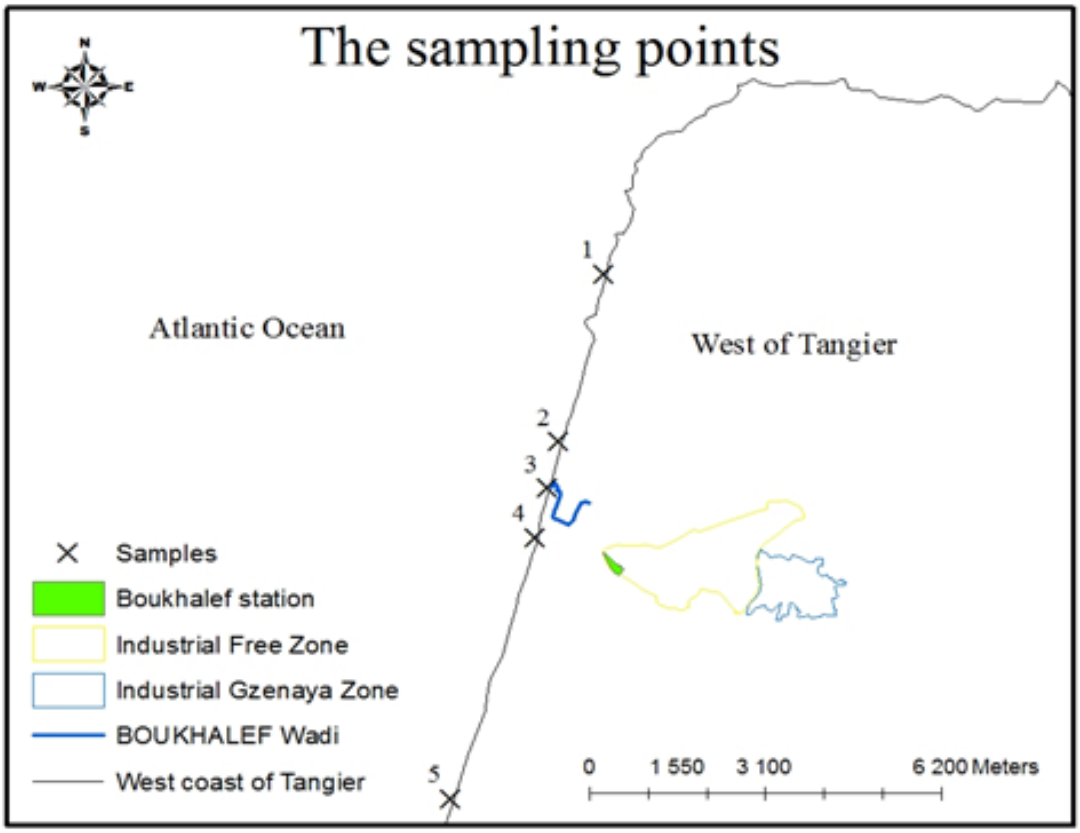

Figure 2 : The sampling points.

For the bacteriological analyses; 5 samples were collected in the 4 region (Figure 2)(Table 2) using sterile Pyrex glass bottles (120°/20) fitted with screw caps: the submerged bottle filled and then closed before being returned. The samples were immediately placed in an insulated cooler where the temperature is kept between 2°C and 8°C [13]; they are sent to the laboratory, they were performed following the standard methods; Escherchia Coli according to the Moroccan standard (NM 9308-1, 2014) and Intestinal Enterococci according to the Moroccan standard (NM 7899-2, 2007) and classify according to (NM 03.7.200, 1998).

Table2: Number of samples.

Regions	Beachs	Number of Samples
region 1	-Sol -BA Kacem -Achakar	1
region 2	-Jbila	2
region 3	-Sidi Kacem	1
region4	-Plage foret diplomatique	1

4. Results and discussion

1. Diagnostic

1.1. Region 1:

The first region of our study zone is located at the extreme part of the west coast of Tangier and extends over 6.6 km. It counts three beaches: Sol beach, Ba Kacem beach and Achekar beach, inserted between the Cap Spartel and Hercules Caves (Figure 1) that experience showed a daily frequentation of 24,000 people during the summer season, knowing that the Sol and Bakecem beaches are lacking sanitation and drinking water, the hygiene services are poor in view of the system and mechanism are done in a manual and mechanical way. They have five monitoring stations, the first at Sol beach, the second at Bakacem beach and the third at Achekar beach.

This stretch of beach is distinguished by: (figure 3)

- A hotel presence located on the plateau facing the sea: Mirage hotel, Bungalow Achekar, Capspartel Tanger villa, Casablanca villa and Arous Albahr.
- Five cafes restaurants frequented by a multitude of customers permanently
- The housing buildings characterizing this region are in an increased way, although dispersed, thus allowing agricultural activity on both sides.

At the same time, the studies carried out by the authorities concerned, showed that the quality of bathing water in these three beaches is generally of good quality (A)(Table 3), as indicated in the table below:

Table 3: The quality of the bathing waters of the beaches of Sol, Ba Kacem and Achekar from 2012 to 2016 Examined by the Ministry of the Environment and Ministry of Equipment, Transport and logistics;

Beaches/years	2012/2013	2013/2014	2014/2015	2015/2016
Sol	A	A	A	A
Ba Kacem	A	A	A	A
Achekar	A	A	A	A

Figure 3 : The first part of our study zone ; Sol, Ba Kacem and Achekar beaches and its components

1.2. Region 2:

The second region of our study zone is Jbila beach, along the coast for 3 km. and is frequented bay 4000 persons every day during the summer season. The absence of sanitation and drinking water is a handicap in this region, which has a negative impact on the local environment. The presence of the industrial and the urbanization units on this site are dealing with a permanent control of four monitoring station. To emphasize that, the discharge from the Boukhalef wadi and the waste water that are treated by the Boukhalef Station, reach the waters of this beach. The local urbanization is composed of two residential palaces, an industrial unit and coffee restaurants (Figure 4)

Figure 4 : The second part of our study zone ; Jbila beach and it components

The report of the studies, done at this level, concluded that the quality of bathing water in this beach is generally momentarily polluted (C)(Table 4), as indicated in the table below:

Table 4: quality of the bathing waters of the beache of Jbila from 2012 to 2016 Examined by the Ministry of the Environment and Ministry of Equipment, Transport and logistics;

Beaches/years	2012/2013	2013/2014	2014/2015	2015/2016
Jbila	C	C	C	C

1.3. Region 3:

Extended coastal area over 3 km, it is part of the rural commune Gzenaya, frequented by 4000 persons every day during the summer season.

It is connected to the sanitation and drinking water network, it receives the water of Boukhalef wadi, and the waters are treated by the Boukhalef wastewater treatment which come from the Gzenaya industrial zone, Free zone and tow large urban areas Hajriyin and Hassani.

Figure 5 : The thirth part of our study zone ; SidiKacem beach and it components

The report of the studies concluded that the quality of bathing water in this beach is generally of good quality to medium quality in recent years (A-B)(Table 5), as indicated in the table below:

Table 5: The quality of the bathing waters of the beache of Sidi Kacem from 2012 to 2016.

Beaches/years	2012/2013	2013/2014	2014/2015	2015/2016
Sidi Kacem	A	A	B	B

We can clearly observed here in region 3 of our study area the evolution of bathing waters quality from A to B, that is explained by the rapid growth and development of industrial and residential activities near this region of the coast, (Figure 7).
With reference to the study carried out with mentioned components we conclude the following:

1.3.1. The two industrial zones
Free zone:
The free zone (Figure 6) extends over an area of 345 Ha to 8 km of the city center of Tangier and 15 km of the south of Europe, entered operation in 1999. In terms of activities, it is the most important center of activities in the region: Engineering, computers, automobiles industries, aeronautics, carpentry, aluminum, textiles and mechanics.
This area contains 400 companies of which 257 are active, the diagram below represents the percentages of the categories of industries in the Free Zone (Figure 7).
Gzenaya Zone:

The Gzenaya industrial zone (Figure 6) extends over an area of 345 Ha to 8 km of the city center of Tangier, and in the immediate vicinity of the town of Gzenaya.
It includes 315 companies of which 215 are active, the diagram below represents the percentages of the industrial categories in the Gzenaya Industrial Zone (Figure 7)

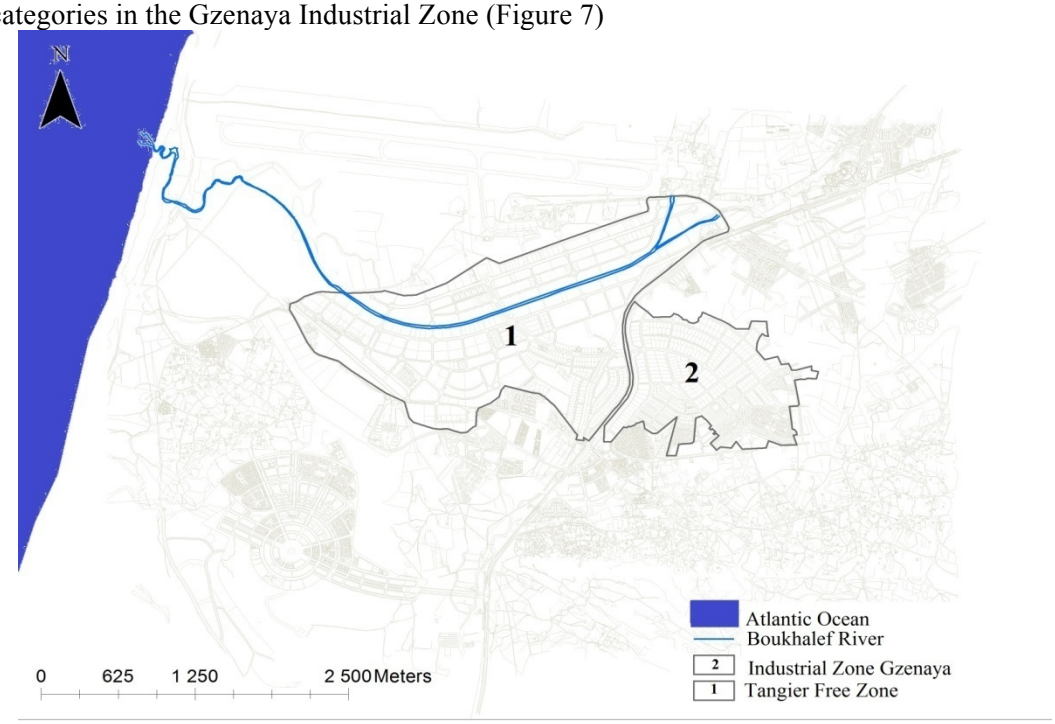

Figure 6: The two industrial zones; Free Zone and Gzenaya Industrial Zone.

If we compare the results of the TFZ and IZG with those of 2008,(Figure 7). We find that 2% increase for the Agri-Food Industries (AFI), an increase of 6% for the Chemical and Para-chemical Industries (CPI), also a strong increase in the Mechanical, Metallurgical, Electronics Industries (MMEI), Textile and Leather Industries (TLI) and a 6% increase for the Textile and Leather Industries (TLI).

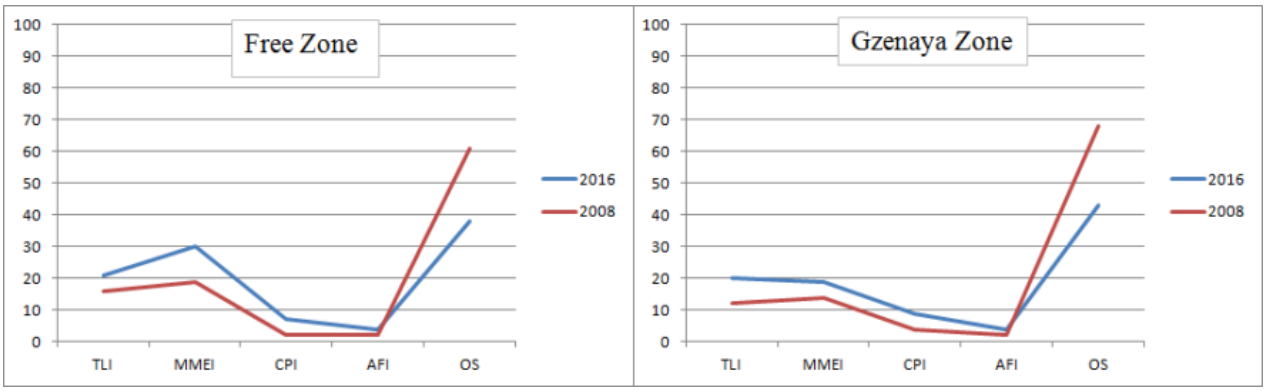

Figure 7: Percentages of the categories of industries in the Free and Gzenaya Zones.

Note: TLI -Textile and Leather Industries, MMEI- Mechanical, Metallurgical and Electronics Industries, CPI-Chemical and Para-chemical Industries, AFI-Agri-Food Industries, OS-Others/Services

The diagram of water consumption during a year shows that the consumption of industries in the Free zone and the Gzenaya zone increases during the spring season until the end of summer (Figure 8). This can cause a supersaturation of wastewater treatment station Boukhalef, and explains the increase of the polluting load in the treated water. The increase in these industries and the change in the mode of activity and production contribute greatly to the production of a large quantity of waste and polluted waste water, which exceeds the capacity of the station and consequently becomes difficult to process the total effluent.

1.3.2. wastewater treatment station Boukhalef:

The site of the station BOUKHALEF is located in the south west of the city of Tangier. It treats the waste water coming from the free zone of exploitation as well as those of the industrial zone Gzenaya. It is a station that has

several stages of treatment so that the wastewater would be in compliance with the standards of releases towards the natural environment. It is part of the coastal pollution control program, from Cap Malabata to Assilah (65 km). The station treats the urban and industrial discharges of: The Free zone, the industrial zone Gzenaya, Gzenaya, Boukhalef, Elhassani and Station elhajriene. This wastewater treatment plant is most often located at the end of a collection system, where the water is treated before being discharged into the natural environment. The table below shows the flows of the purification of the STEP BOUKHALEF.

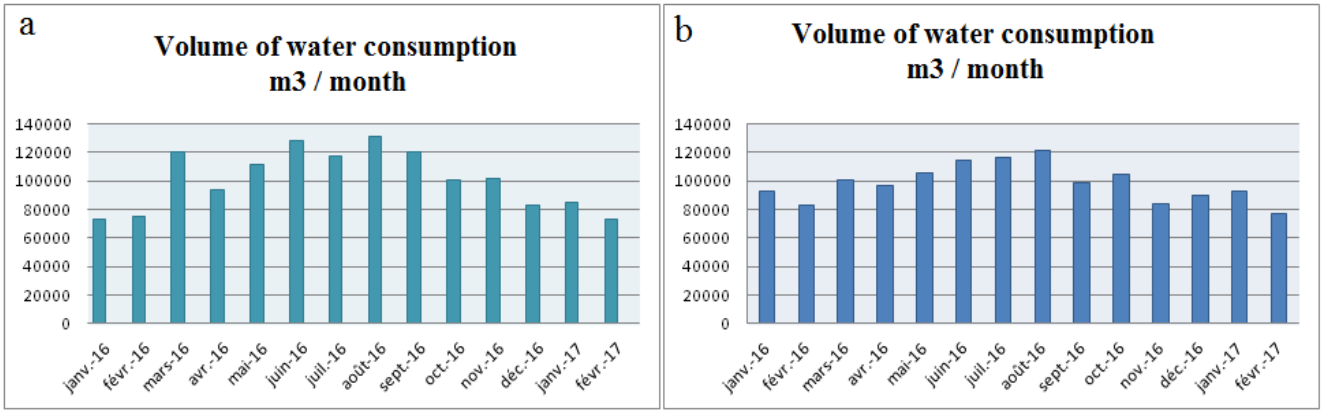

Figure 8: Volume of water consumption in the Free Zone and Gzenaya Zone in m3 / month. (Amendis, 2016/2017)
a: the volume of consumption in the free zone, b: the consumption volume in the Gzenaya industrial zone.

Table 6: Flows from the purification of wastewater treatment station Boukhalef.(Amendis, 2017)

Hydraulic load	1st tranche	saturation
Daily medium debit	2970	10700 m^3/j
Hourly medium debit	124	446 m^3/j
Hourly maximun debit	309	1115 m^3/j

The change in the volume of water flows has increased since February 2016 until the end of 2016, the change in the treatment volume of the STEP Boukhalef varies according to the consumption of the two Industrial Zones (TFZ and ZIG) and the Urban areas in the place. This variation results in polluted water, which have a negative impact on the receptive coastal waters. (Figure 9). This information correlates with the volume of water consumed by the two industrial zones.

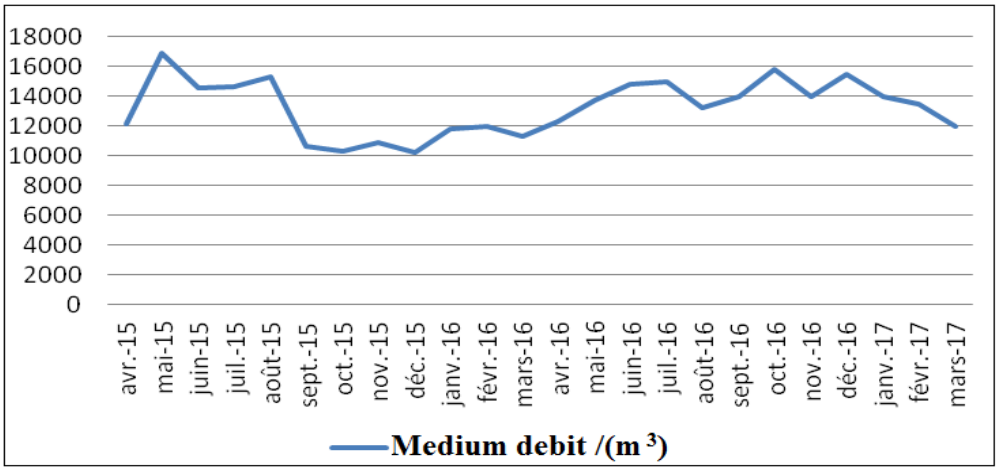

Figure 9: medium debit / month of wastewater treated by the wastewater treatment station Boukhalef. (Amendis, 2016/2017)

1.4. Region 4:

The beach of the Diplomatic Forest is a part of west coast of Tangier of 5 km long. It receives a daily attendance of 5000 people during the summer season, and is not linked to the network of sanitation and drinking water.
It is a beach that has three monitoring stations and its cleaning is done manually. This region is characterized by a large forest is the Diplomatic Forest and residences under construction.

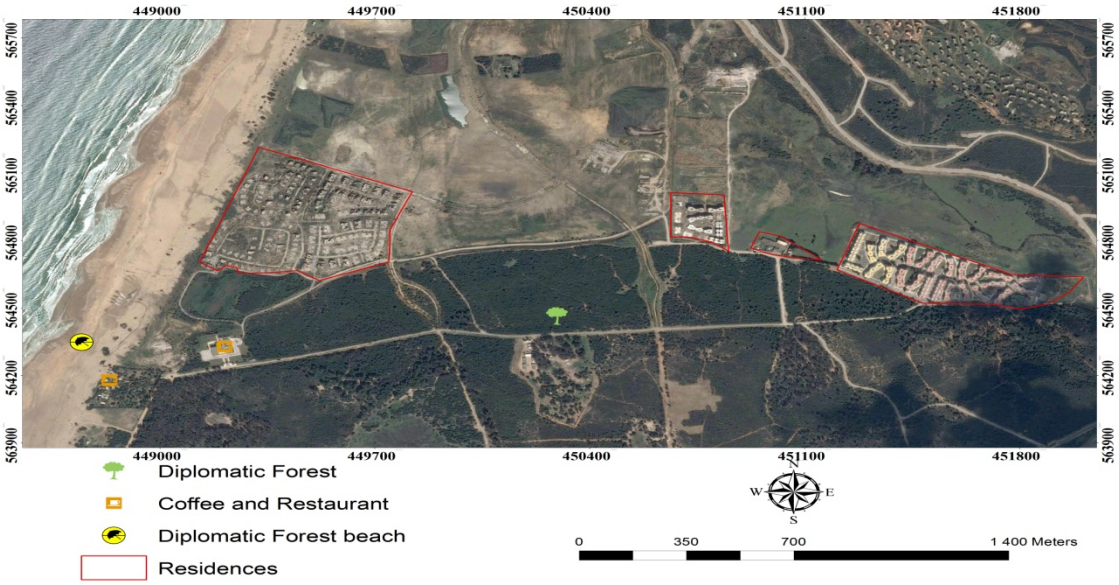

Figure 10: The fourth part of our study area, beach diplomatic forest and it composants.

The analytical reports for this area have shown that the quality of bathing water is generally good (A)(Table 7), as stated in the table below:

Table 7: The quality of the bathing waters of the beache of Foret diplomatique from 2012 to 2016 Examined by the Ministry of the Environment and Ministry of Equipment, Transport and Logistics.

Beaches/years	2012/2013	2013/2014	2014/2015	2015/2016
Diplomatic forest	A	A	A	A

1.5. Thermal treatment of the satellite image:

The surface temperature of bathing water remains stable at 16-18 ° C, contrariwise it reaches 22°C in part 2 and 3 where we have Jbila and Sidi Kacem(Figure 11). In relation with the presence of liquid and solid effluents from industrial units and urban areas, affecting consequently the quality of bathing water. This result coincides with the inventory and bacteriological analysis carried out in this coast, (Table8), especially in region 2 and 3.

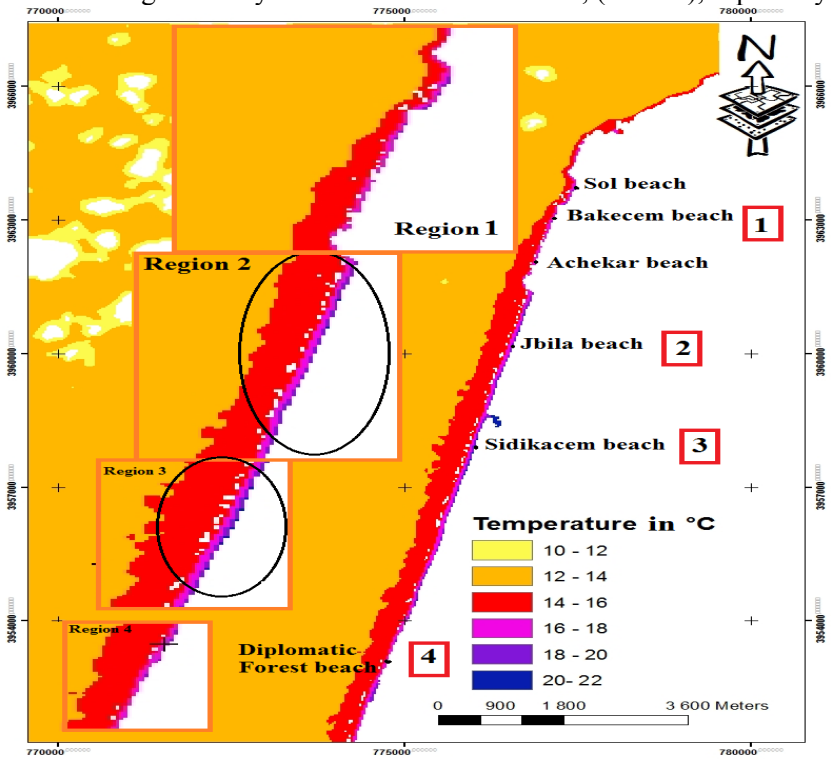

Figure 12: Surface water temperature in the four region of the west coast of Tangier

2. Bacteriological analyzes:

The results of bacteriological analyzes of bathing waters show that the quality of the bathing waters of region 2 is medium to temporarily polluted (B-C), and medium in region 3 (B). This is demonstrated by the presence of zones of Industrial activities, tourist activities and an important demographic dynamic. On the other hand, the quality of the bathing waters in region 1 and 4 is of good quality (A). This is demonstrated by the absence of industrial zones and the very dense tourist and human activities in these two regions(Table 8).

Table 8: Results of bacteriological analyzes.

Regions	Quality class
1	A
2	C-B
3	B
4	A

The bacteriological analysis of bathing water in this zone are in accordance with the values set by the standards applied to the monitoring of the quality of bathing water.

The quality classes of bathing water are: (NM 03.7.200, 1998).

CLASS A: Water of good quality

CLASS B: Medium quality water

CLASS C: Waters temporarily polluted

CLASS D: Poor quality water

Conclusion

All activities, including industrial, touristic and human activities, show to have an adverse impact on the quality of bathing waters on the west coast of Tangier, especially in Part 2 and 3 of west coast where we have; JBILA and Sidi Kacem beaches.

Therefore, the control and continuous monitoring by various tools have become vital to minimize the human impact on the natural environment, and thus to protect and preserve our environment. Thus, the thermal treatment of the bands 10 and 11 of the landsat_8 image presents seem to be an excellent indicator tools for the evaluation of quality of bathing water.

References

1. A. Palazón, I. López, L. Aragonés, Y. Villacampa, F. Navarro-González, *J. Science of the Total Environment,* 593–594 (2017) 173–181
2. C. Gantzer, A. Maul, J. Audic, L. Schwartzbrod, *Appl Environ Microbial,* 64 (11) (1998) 4307–4312.
3. K.M. Callahan, D.J. Taylor, M.D. Sobsey, *Water Sci. Technol,* 31 (5–6) (1995) 189–193.
4. M. Gholizadeh, M. Melesse Assefa , R. Lakshmi , *Sensors (Basel),* 16(8) (2016) 1298.
5. E. Alparslan, C. Aydöner, V. Tufekci, H. Tüfekci, *Environ. Monit. Assess*, 135 (2007) 391–398.
6. D. Anding, R. Kauth, *Remote Sens. Environ*. 1 (1970) 217–220
7. V.E. Brando, A.G. Dekker, *IEEE Trans. Geosci. Remote Sens,* 41 (2003) 1378–1387.
8. H. Sabri, O.Cherifi, A.Maarouf, M. Cheggour, M. Bertrand, L. Mandi, *J. Mater. Environ. Sci*, 8 (3) (2017) 857-862
9. A. Chaouay, L. Bazzi, M. Hilali, A. Ait Alla, K. El Mouaden, J. *Mater. Environ. Sci,* 5 (S2) (2014) 2472-2477
10. M. Achab, *Travaux de l'Institut Scientifique, Rabat*, (2012) 1–12.
11. H. Cherkaoui Dekkaki, M. Ben Ali, A. Ait Taleb, H. Myzy, M. Hassani Zerrouk, A. Mesmoudi, *J. Mater. Environ*. Sci., 9 (1) (2018)107-112
12. G. Faour, A. Shaban, J. Jaquet, *Télédétection,* 4 n° 2, (41 22) 917-8029 (2004) 197–209.
13. A. Laghzal, F. Salmoun, B. Boudinar, M. Khaddor, S. Cherroud, M. Fihri, C. Mammad, *J. Mater. Environ. Sci*, 7 (2) (2016) 456-462