Contribution of remote sensing and bacteriological analysis for the quality of bathing waters on the west coast of Tangier

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Abstract:
To have an idea about the impact of wastewater treatment station 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 Sidikacem. Consequently, the bacteriological analysis shows that the concentrations of Escherichia Coli and Intestinal Enterococci germs are high in the two last beaches.

Keywords: Diagnostic, Industrial zone, Environment, Pollution, Wastewater treatment plant, Remote sensing.

1. Introduction
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. Moreover, it is a privileged place for the installation of numerous agglomerations and industrial units, (CHAOUAY et al., 2014). 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 polluted water, 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. In these two zones (TFZ and IZG) industrial activity increased from 2% for Agri-Food Industries (AFI), 6% for the Chemical and Para-chemical Industries (CPI) and the Textile and Leather Industries (TLI), a strong increase in the Mechanical, Metallurgical, Electronics Industries (MMEI), to more than 20 % for other services in period from 2008 to 2016. The objective of this work is to carry out an inventory of the environmental aspects and to make a qualitative

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assessments of the bathing waters with the aim of evaluating the effects of seasonal variation on 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). The site is actually a Boukhalef watershed, whose river meets near the coast to form the mouth of the river Boukhalef with the Atlantic coastline.

3. Methodology
Our work is divided into two main sections: the inventories of environmental aspects (Diagnostic) and bacteriological analysis. The inventories of environmental aspects consist of collecting, organizing, processing and manipulating data on the coast using (ArcGis) software for cartography and (ENVI) software for thermal treatment from the landsat_8 data. Two images 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. These images were then projected into the Lambert compliant conical Moroccan projection system (WGS84) and the pixels of two thermal bands of landsat_8 (10 and 11) converted 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 (FAOUR et al., 2004). The bacteriological analysis was performed following the standard methods; Escherichia Coli according to the Moroccan standard (NM 9308-1, 2014) and Intestinal Enterococci according to the Moroccan standard (NM 7899-2, 2007) and classified according to (NM 03.7.200, 1998).

4. Results

4.1 Diagnostic
The surface temperature of bathing water remains stable at 16-18 °C, contrariwise it reaches 22°C in Jbila and Sidikacem. In relation with the presence of liquid and solid effluents from industrial units and urban areas, affecting consequently the quality of bathing water, see after figure 2.

4.2 Bacteriological analyzes
The bacteriological analysis and analytical reports of the Ministry of the Environment (MINISTERE, 2013; 2014; 2015; 2016) shows that in recent years, the quality of bathing waters is generally of good quality in Sol, Bakacem, Achekar and Diplomatic Forest beaches (A); is momentarily polluted in Jbila beach (C); and in Sidikacem beach it is generally of good quality to medium quality (A-B), see after table 1.

<table>
<thead>
<tr>
<th>Beach</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sol</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Bakacem</td>
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<td>A</td>
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<td>A</td>
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<tr>
<td>Achekar</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Jbila</td>
<td>C</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Sidi Kacem</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
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<tr>
<td>Diplomatic Forest</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

Note: CLASS A: Water of good quality; CLASS B: Medium quality water; CLASS C: Water temporarily polluted; CLASS D: Poor quality water.

The results of bacteriological analysis of bathing waters show that the similar qualities in 2016 except for Sidikacem beach were water quality decrease (C). This is demonstrated by the presence of two zones Industrial activities, see table 1.
5. Conclusion
All activities, including industrial, touristic and human activities, prove to have an adverse impact on the quality of bathing waters on the west coast of Tangier, especially in Jbila and Sidikacem 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.

6. Références bibliographiques


Mediterranean rocky coasts: 
Features, processes, evolution and problems