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Monitoring the microbiological quality of the Sidi Ifni coastline (South-West Morocco): Domestic wastewater treatment plant impact

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Abstract
This work is a contribution to the monitoring of the physicochemical and microbiological quality of seawater on the coasts of Sidi Ifni. Its aim is the evaluation of the quality of coastal waters and the determinationof the degree of compliance with Moroccan standards.
The seawater samples were taken between January and June 2021 from three sampling sites (S1: BoumrsaL, S2: Goraizim and S3: Aglou), which were chosen according to several criteria, such as the presence of direct and indirect pollution points and the most frequented areas of swimmers and visitors to the beach.
The results of analysis of the physicochemical parameters (Temperature, pH, Salinity and Dissolved oxygen) and bacteriological indicators (Total coliforms, faecal coliforms and faecal streptococci) of seawater presented on the Sidi Ifni ratings show significant spatial and temporal variations with values that do not exceed the guide values of Moroccan standards. This allows the beaches of Sidi Ifni to be classified in category A (Good quality of bathing water).
The analysis of variance indicates the difference between the study sites, as well as the correlation test between environmental parameters and contamination indicators showed a significant correlation between faecal bacteria concentrations (TC, CF and FS) with abiotic parameters. While principal component analysis (PCA) confirmed that the site located near the pre-treated wastewater discharge point had significantly high levels of total coliforms, faecal coliforms, faecal streptococci and sites free of wastewater discharge.
In an environmental context and as part of the protection of the health of visitors to the beaches of Sidi Ifni, it is recommended to systematically monitor the parameters of faecal contamination and carry out additional studies to assess the effects of seawater pollution on health.

Keywords: bacteriological quality, faecal coliforms, faecal streptococci, microbiological, monotoring, morocco, pollution, physicochemical, seawater, sidi ifni, wastewater treatment

Introduction

Morocco has 3500 Km of coastline spread over the Mediterranean Sea and the Atlantic Ocean. The Moroccan coastline extends over 2934 Km of the Atlantic Coast which concentrates most of the national socio-economic activities, whether industry, fishing, tourism, port activity and navigation (Mansour, 2003; Sif *et al.*, 2012; Mansour *et al.*, 2020) [30, 44, 30].
In addition to tourism, the fisheries sector presents real opportunities for the province of Sidi Ifni (Bennafla, 2011) [10]. It is an activity that is part of the tradition of the coastal expanses of the region and considered the main activity at the level of the province of Sidi Ifni (Attrassi *et al.*, 1993) [8], moreover the province is home to the second fishing port in the region and characterised by significant ecological and environmental potentialities and has significant fishery wealth that extends over a coastline of 80 Km (El Bettioui *et al.*, 2020) [21].
In recent years, fisheries resources have been degraded due to various human activities such as industrial, agricultural and household discharges that are discharged into the sea without any prior treatment (Codjo *et al.*, 2020; Motib, 2020) [16, 34].
Based on the causes of marine pollution, three types can be distinguished: physical, chemical and biological. The type of pollution that interests us during this study is that of bacterial pollution. This contamination occurs directly by bathing or indirectly by discharges of waste water runoff, most of whichis land-based. In the marine environment, bacteria serve as food for many marine organisms, they promote the attachment of algae or larvae on certain substrates, but they can carry germs responsible for diseases (Aubert & Aubert, 2021) [9]. The best known bacteria are coliforms, streptococci and salmonella.
Among the main sources of bacterial contamination is wastewater from various sewage effluents (urban agglomerations, hospitals, slaughterhouses, factories,... etc.) (Desmos, 2021) [19], in the marine environment often without any prior treatment this causes contamination of thefood chain.This mixture can pose a danger to bathers when an infectious dose of pathogens colonises a site and leads to disease (El Attiffi El Ouadrassi, 2011) [20]. The incidence of diseases depends on several factors; extent of water pollution, type of exposure, immune status of users, and other factors (Al Safady, 2013) [5].
In the marine environment, the proliferation of bacteria is

promoted by environmental conditions and the presence of nutrient substrates and organic matter in wastewater entering the marine environment, even though it is an environment that does not support the life of most pathogens (Rubio, 2002) [42]. The activity of these bacteria is at the origin of a decrease in the oxygen content of the environment which can be fatal for the survival of oxygen-consuming species. In addition, some bacteria are pathogenic to humans when they multiply in an organism or when they secrete toxic or antigenic substances (Pergent, 1991) [38]. To cope with the presence of contaminants in this ecosystem and reduce the pollution of coastal waters, the preservation of the environment has therefore become one of the priorities of scientists and environmental managers. For this, the Sidi Ifni company was installed from a domestic wastewater treatment plant.

The beaches of Sidi Ifni are of socio-economic importance and are considered pleasant places for the population of the region. In recentyears, we have conducted studies onthe coastline concerning thephysicochemical aspect (Abbassi *et al.,* 2017) [1] the biochemical aspect (Abbassi *et al.,* 2015; Abbassi *et al.,* 2018) [2, 4] and chemical contamination (Abbassi *et al.,* 2021) [3]. The results of this work showed that recreational seawater was poorly contaminated along the Coast of Sidi Ifni.However, in the context ofmarineenvironmental preservation, the assessment of coastal areas is an important issue for the development of the region.

This work allows the evaluation of the microbiological andphysicochemical qualityof seawater of the beaches along the coast of Sidi Ifni. This can help to establish guidelines and assess any deviations from normal. In addition, this work will add new information on the impact of the domestic wastewater treatment plant on the bacteriological quality of Sidi Ifni's coastal waters, which could change our overall view of beach surveillance policies.

Materials and Methods

Study sites

The sites selected for this study are the beaches of Boumersal, Graizim and Aglou, located in the maritime district of Sidi Ifni. This area covers 60 km north of Sidi Ifni (Figure 1). The choice of these sites is based on the criteria: the exploitation of fishery resources and the risks of faecal contamination by the presence of potential sources of pollution.

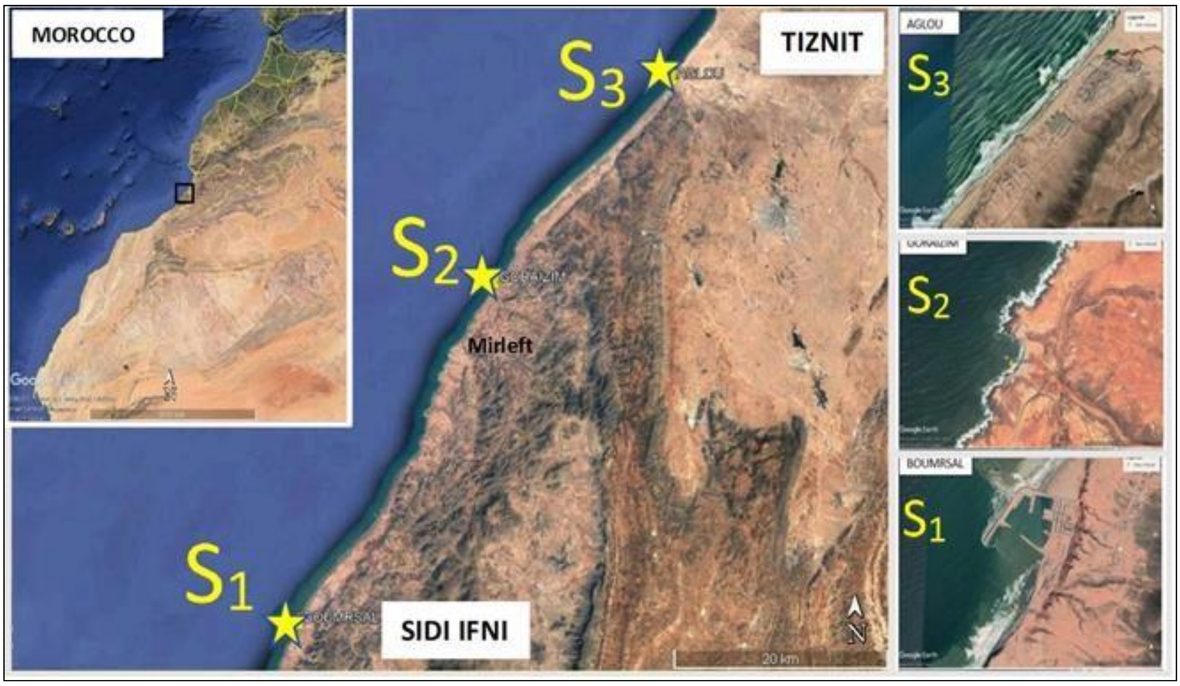

Fig 1: Geographic location of the studied sites Boumrsal(S1), Goraizim (S2) and Aglou (S3)

- Boumersal (S1) located near the fishing port of the city of Sidi Ifni (Latitude: 29°20'56.05"N and Longitude: 10°11'48.74"W). The beach is about 500 m long. It is a common pleasant destination for an average often visitors per day during the bathing season (June-August). This site receives treated wastewater from the wastewater treatment plant in the city of Sidi Ifni, which makes it appropriate to integrate it into our study. It is also characterised by artisanal fishing (nets, boats and rods).

- Goraizim (S2) (Latitude: 29°37'59.22"N and Longitude: 10° 0'31.95"W) located about 36 Km north of Boumersal (S1) and about 07 Km north of the centre of the municipality of Mirleft, and is far from any source ofpollution, but its beach is often visited by tourists because of its remarkable landscape. It corresponds to a pebble beach, with a low slope. It is associated with a rocky coast with mainly volcanic and volcano-sedimentary cliffs. In addition to fishing on foot and rod fishing, thisstation is home toa landing point, artisanal fishing canoes, under the delegation of maritime fisheries of Sidi Ifni.

-Aglou (S3) (latitude: 29°48'7.16"N and longitude: 9°50'23.06"W) located about 24 km north of Goraizim and about 17 km west of the city of Tiznit, it is considered the maritime extension of the latter. This beach is characterised by the existence of a cornice equipped with several catering and hotel units. It is also characterised by the existence of rod fishermen and mussel pickers.

Sampling

Monthly seawater sampling was conducted at the three study sites between January 2021 and June 2021. Seawater samples were taken at low tide using sterile vials. The latter remain closed until they are immersed in the water. Samples are taken about 25 cm below the surface of the water, immersing the vial by hand in the inverted vertical position, so as to avoid contamination due to the surface of the water. The cap is put back after throwing a little water so that it remains a little air in the bottle once closed. This volume of air is necessary to be able to homogenise the water taken during its bacteriological analysis in the laboratory. Subsequently, the samples were labelled and transported to the laboratory in a T≤6°C cooler.

Physicochemical and microbiological analysis

The physicochemical analyses were measured in situ, monthly, using aportable multiparameter Hanna Instruments® HI98194. Four physicochemical parameters were monitored between January 2021 and June 2021, namely: Temperature (T), pH, salinity (Sa) and dissolved oxygen (DO_2).

In the laboratory, bacteriological analyses were carried out on seawater samples taken from the various study sites. These analyses consisted of a count of the germs indicator of faecal contamination, namely total coliforms (TC), faecal coliforms (CF) and faecal streptococci (FS). The methods used to determine these parameters are based on membrane filtration (Rodier, 2009):

Afnor NF EN ISO 9308-1 standard (September 2000). Water quality – Detection and enumeration of Escherichia coli and coliform bacteria – Part 1: General membrane filtration method.

Afnor NF ISO 7899-2 standard (August 2000). Water quality – Investigation and enumeration of intestinal enterococci – Part 2: Membrane filtration method.

The results are expressed as a number of colony-forming units (CFUs).

To determine the origin of faecal contamination, we used the ratio (R) of Borrego and Romero (1982) [13], it is a ratio that related to the concentration of faecal coliforms to the concentration of faecal streptococci in the following relationship: R=FC/FS (Borrego & Romero, 1982) [13].

Statistical processing

The monthly variations of the different parameters studied are presented as averages ± standard deviations (SD).

Analysis of variance (ANOVA) and LSD (Least Significant Difference) post-hoc test were used to compare different parameters in time and space and determine significant differences between their means.

The study of the relationship between faecal bacteria and other environmental variables was tested using the "Pearson" correlation test.

In addition, principalcomponent analysis was applied to explain the relationships between the different variables studied and to access their structuring in order to be able to group them by zone.

The processing of statistical data was established using statistica 12 statSoft, Inc.

Results and Discussion

Physicochemical parameters

Figure 2 shows the temporal variations in physicochemical parameters of seawater collected from the three sites during the study period (January - juin 2021).

Seawater temperature shows a seasonal evolution in relation to atmospheric temperature variations with minimum values in winter and maximum values in spring. Indeed, thefigure shows a monthly profile similar to the three sites (Figure 2a), the highest values were recorded during the month of June at S1 and S2, respectively 20.7 °C and 21.8 °C, while the lower values were observed in January 2021 at S2 (14.9 °C). The average seawater temperature collected from the three sites S1, S2 and S3 are 18.43 °C ±1.85, 17.42 °C ±2.51 and 17.58 °C ±1.59 respectively.

At the level of S1 and S3, thetemporal variations in the pH of seawater (Figure 2b) show that the pH values recorded during the first three months (winter) are higher, while the situation is reversed during the last threemonths (spring). These values vary between 7.36 and 8.84 with an average of 8,243 ±0.26 in Boumrsal (S1) and 8.32 ±0.29 in Aglou (S3). At Goraizim (S2), pH values remain approximately stable.

The salinity of the seawater of the coasts of Sidi Ifni shows a significant temporal variation (Figure 2c). The highest values were detected in May (S2: 37.14 g/l) and April (S3: 35.59 g/l. However, the minimum values were recorded in February (S1 = 27.13 g/l). However, a significant decrease ($p<0.05$) was observed in the salinity values of Boumrsal seawater (S1: 29.61 ±2.22) compared to the results obtained at Goraizim (S2: 32.72 ±2.65) and Aglou (32.57 ±2.36).

During the study period, dissolvedoxygen measurement results showed a monthly dissimilar variation between study sites, with a minimum value in January (S2:7.52 ±0.35 mg/l) at GORAIZIM and a maximum value in June (S1: 8.74 ±0.15 mg/l) (Figure 2d). However, the average dissolved oxygenlevels recorded in seawater for each site have very similar values; (S2: 8.10 ±0.40 mg/l), (S3: 8.17 ±0.37 mg/l) and (S1: 8.29 ±0.35 mg/l).

Analyses of variance of physicochemical parameters indicate no significant difference ($p>0.05$) between the Goraizim and Aglou sites, with the exception of pH which showed a significant difference ($p<0.05$) between the mean of the values recorded during the study period. On the other hand; all physicochemical parameters differed significantly ($p<0.05$) compared to the averagevaluesrecorded at the Boumrsal station.

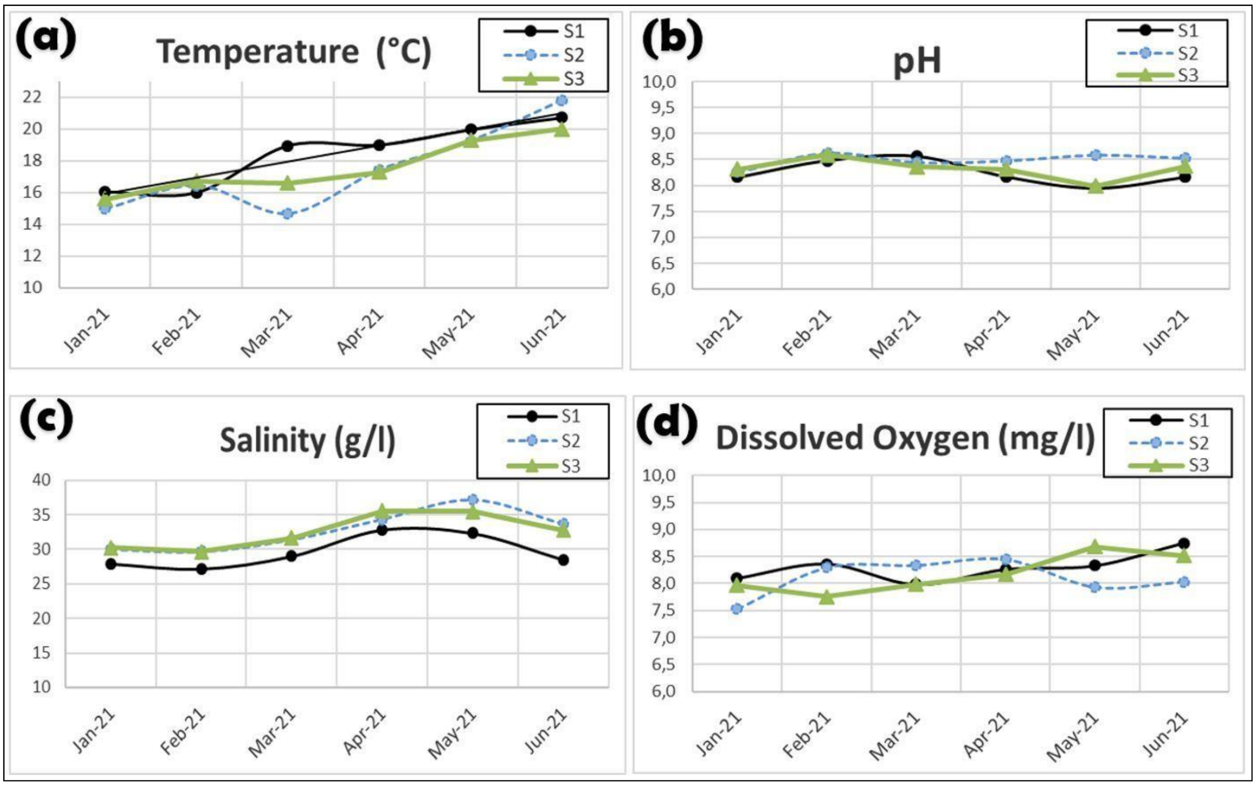

Fig 2: Monthly evolution of physicochemical parameters (T, pH, Sa and DO) during the sampling period of study area S1, S2 and S3

Bacteriological parameters

The results of the analysis of the microbiological parameters of the seawater collected from the study sites (S1, S2 and S3°), during the period from January to June 2021, are presented in Figure 3.

Figure (3a) shows that total coliform concentrations in seawater are higher at the first station (S1) than at other study sites S2 and S3. The highest concentration was recorded in May 2021 in Boumrsal (S1: 22.60 ±5.03 CFU/100 ml), while the low concentration was observed in March 2021 in Goraizim (S1: 1.80 ±0.78 CFU/100 ml) (Figure 3b).

Similarly, faecal coliforms at the study sites showedsignificant spatial variations ($P<0.05$) in favour of S1 (Figure 3c). Meanvalues of faecal coliform in seawater ranged from 0.80 ±0.63 to 12.30 ±3.02 CFU/100 ml respectively in March 2021 to S3 and May 2021 to S1 respectively (Figure 3d).

With regard to faecal streptococcal concentrations, it can be noted that they are relatively higher at BOUMRSAL (S1: 24.86 ±17.02 CFU/100 ml) rather than Goraizim (S2: 4.85 ±3.01 CFU/100 ml) and AGLOU (S3: 11.90 ±11.57 CFU/100 ml) (figure 3e). Figure (3f) shows that the high concentration was recorded in April 2021 in Boumrsal (S1: 51.90 ±6.60 CFU/100 ml), while the lowest concentration was observed in May 2021 in Aglou (S3: 0.90 ±0.73 CFU/100 ml).

In general, theresults obtained revealed spatiotemporal variations in the microbiological parameters of the quality of the seawater taken from the coast of Sidi Ifni during the study period.

However, the results indicate that significant spatial variations occurred between sites and temporal variations between months. Indeed, the analysis of variance for bacteriological parameters shows that the sampling site has a significant effect ($P>0.05$). Similarly, there is a very significant difference between months ($P<0.001$).

However, we note that the highest concentrations of total and faecal coliforms were observed during the warm season (April, May and June), while concentrations of faecal streptococci were found to be in disturbance during the study period.

Table 1 presents the results of faecal contamination at three sites studied. In general, the contamination of Sidi Ifni ratings during the study period is of animal origin ($R<0.7$). Except that, during the month of May, site S3 showed contamination of human origin ($R>4$) and during the month of April and May, site S2 marked a mixed contamination mainly animal ($2 \leq R \leq 4$).

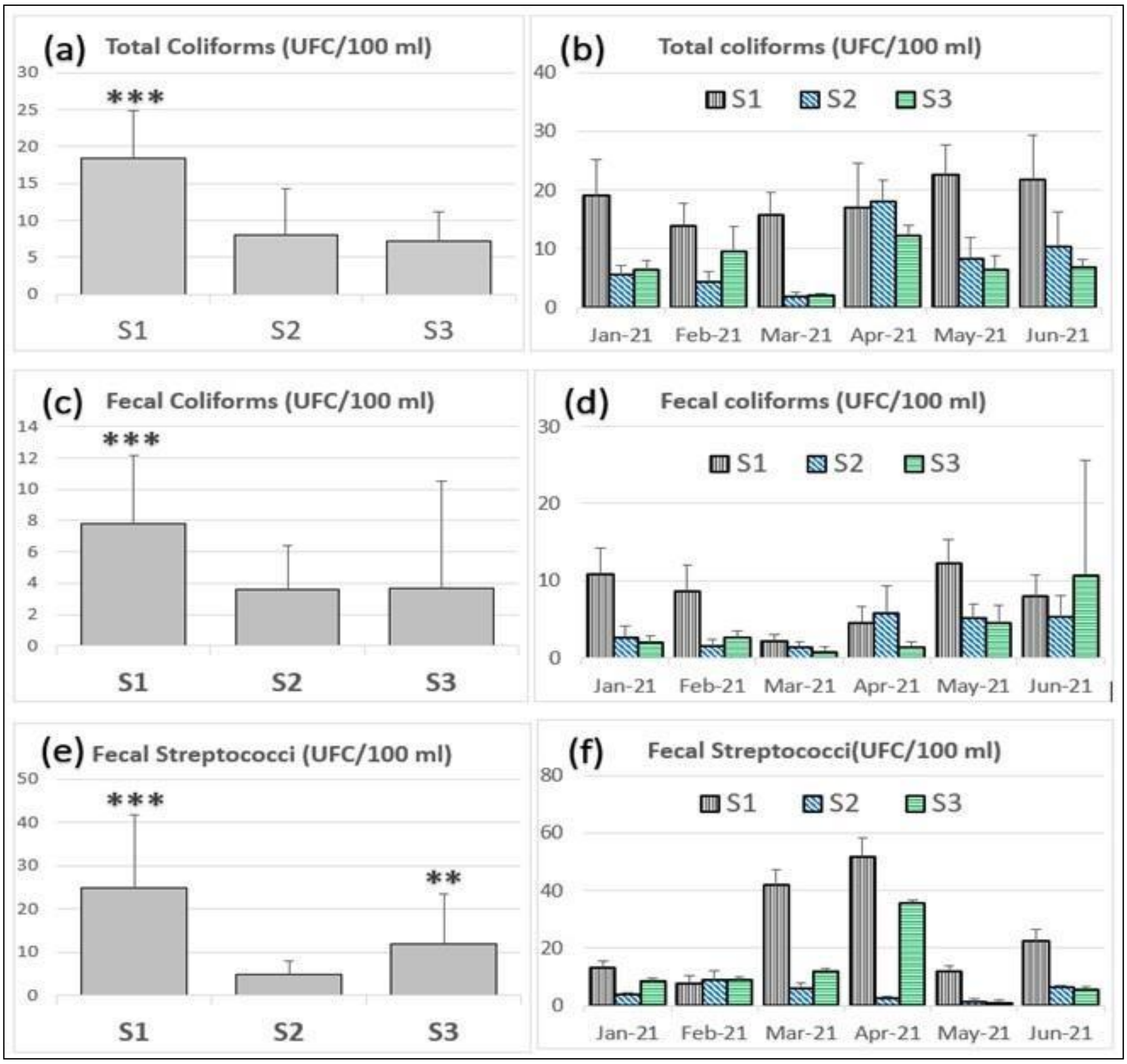

Fig 3: Spatiotemporal variations in bacteriological parameters of seawater collected at each of the three sites (S1: Boumrsal, S2: Goraizim and S3: Aglou) along the coast of Sidi Ifni during the study period. (The values presented are Mean ± SD (CFU/100 mL)

Table 1: Origin of faecal contamination by reports (R=FC/MSDS).

CF/SF	S1	S2	S3
January 2021	0.820	0.711	0.238
February 2021	1.115	0.169	0.295
March 2021	0.053	0.233	0.067
April 2021	0.089	2.148	0.039
May 2021	1.017	3.923	5.000
June 2021	0.359	0.828	1.911
FC (Means)/FS (Means)	0.313	0.749	0.308

Relationship between abiotic factors and faecal bacteria

Table 2 shows the relationships between abiotic variables (T, pH, Sa and DO_2) and faecal microorganisms in seawater collected from the coast of Sidi Ifni.

For the three sites studied, total coliform concentrations have significant correlations with all environmental parameters: temperature (r=0.3629, p=0.000), pH (r=-0.2165, p=0.004), Salinity (r=-0.1542, p=0.039) and dissolved oxygen (r=0.2288, p=0.002).

In contrast, pH and salinity were not substantially related to faecal coliform and faecal streptococcal coliform concentrations. The latter have a significantly positive association with temperature (r=0.1812; p=0.015). However, faecal coliform concentrations also have a significantly positive relationship with temperature (r=0.2877; p=0.000) and dissolved oxygen (r=0.2388; p=0.001).

Table 2: Relationship between faecal bacteria and environmental variables according to the Pearson correlation test (* p<0.05; ** <0.01)

	T	pH	Sa	DO
TC	0.3629** p = 0.000	- 0.2165** p = 0.004	- 0.1542* p = 0.039	0.2288** p = 0.002
FCFS	0.2877** p = 0.000	- 0.1328 p = 0.075	- 0.0907 p = 0.226	0.2388** p = 0.001
FS	0.1812* p = 0.015	- 0.0963 p = 0.198	- 0.0972 p = 0.194	- 0.0096 p = 0.898

The principal component analysis (PCA) was carried out on the seven physicochemical and bacteriological variablesmeasuredon samples of seawater collected at three sites on the coast of Sidi Ifni. Analysis of the variables shows that axis F1 expresses 30.03% of the variance and axis 2, less important with a variance of 19.18% (Figure 4a). With the first two axes (49.21% inertia) in a two-dimensional system of the seven measured parameters (temperature, pH, salinity, dissolved oxygen, total coliforms, faecal coliforms and faecal streptococci) seems reasonable. These considerations allowed us to obtain a graphical representation of the correlations between the different variables (Figure 4a) and the dispersion of the sampling sites (Figure 4b).

Axis 1 or permanent pollution axis is positively defined by temperature (T), salinity (Sa), dissolved oxygen (DO), total coliforms (TC), faecal coliforms (FC) and faecal streptococci (SF). On the negative side of the axis, we meet only the pH.

The arrangement of almost all the variables (Figure 4a) on the positive side makes it possible to highlight a relationship between the different variables, in particular the existence of a close relationship between the bacteriological data and the physicochemical variables. This approximation is underlined in Table 2 by positive correlations with temperature and dissolvedoxygen. In addition, negativecorrelationss with pH and salinity.

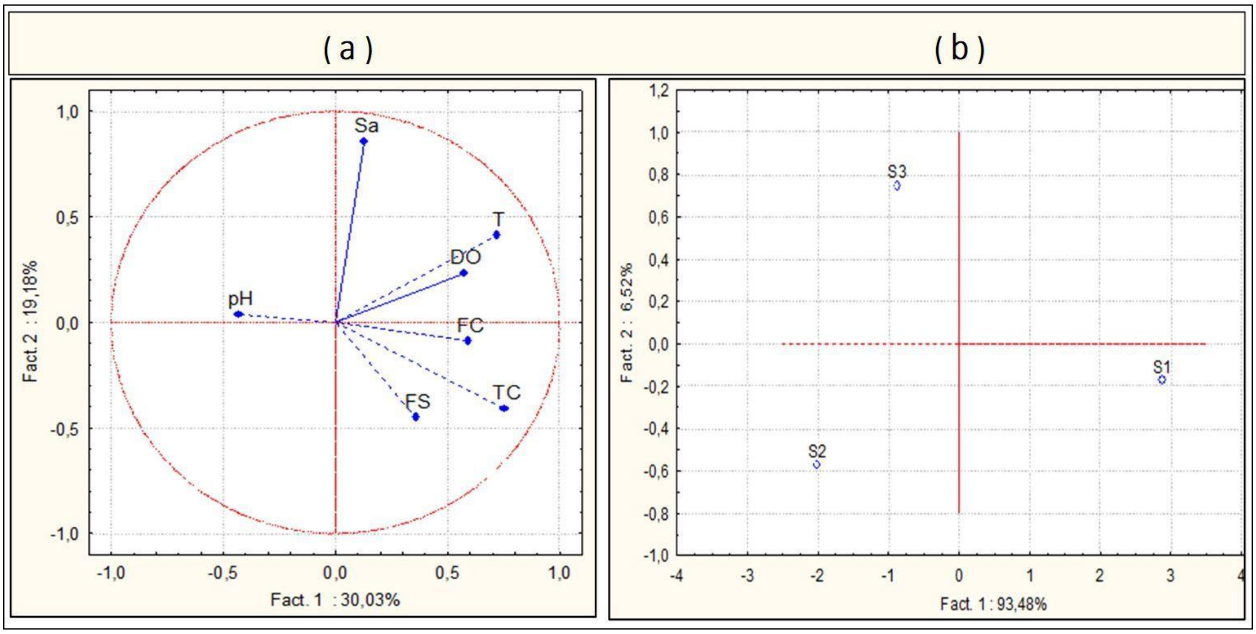

Fig 4: Principal component analysis (PCA), ofthephysicochemical and bacteriological parametric studied at the beaches of Sidi Ifni.**a:** Projection of variables on the factorial plane (1*2) (T:temperature; Sa: salinity, DO: dissolved oxygen; TC: Total coliforms, FC: faecal coliforms; FS: faecal streptococci) b: Projection of study sites on the factorial level (1*2) (S1: BOUMRSAL; S2: GORAIZIM; S3: AGLOU)

Fig 5: Location of sources of pollution in the first Boumrsal site (Fishing portandurban wastewater treatment plant in the city of Sidi Ifni)

Discussion

Numerous published studies have reported that abiotic factors have a great influence on various cell activities and undergo the action of many other external factors.

The results of the study of environmental parameters revealed similar variations in temperature at the three sites, whichcouldbe explained by the direct influence of the regionalclimate characterised by a warm season in spring and a cold season in winter. Thus, the pH of seawater remains more or less stable during the study period, which can be explained by the buffering power and chemical composition of seawater. Due to several factors such as atmospheric precipitation, drainage geology and evaporationprecipitation (Wetzel, 1983) [49].

In addition, salinity results show low values recorded in winter could be explained by dilution of seawater due to heavy rains during the winter season (Chaouay *et al.,* 2016) [14]. While the increase in salinity recorded in April and May coincides with the evaporation of seawater due to the increase in seawater temperature during this period (Regragui, 1991) [39]. This reflects the richness of marine waters by mineral salts ionised by salts dissolvedin water (Derwich *et al.,* 2010; Rodier, 2009) [18, 40].

With regard to dissolved oxygen,its concentration is related to temperature, it is higher in cold water compared to hot water (Hébert & Légaré, 2000) [23] and in disagreement with the results obtained by Chouya *et al.,* (2016) [14]. In addition, the high level of dissolved oxygen could be due to the movement and turbulence of water bodies during the rise in wave levels. The decrease in dissolved oxygen could be explained by its consumption by aerobic bacteria from discharges from the wastewater treatment plant in the vicinity of these beaches and by runoff discharges (Aminot & Kérouel, 2004; Chapman, 1996) [6, 15].

During our study, the monitoring of bacteriological contamination at three sites, on the coast of Sidi Ifni, shows values that comply with Moroccan bathing water standards. However, the analysis of variance of faecal bacteria concentrations indicated significant spatial variation. Numerous studies have shown that the detection of faecal pollution indicators can be influenced by precipitation (Boehm *et al.,* 2005; Eregno *et al.,* 2016; Howard *et al.,* 2003; Rose *et al.*, 2001; Zhang *et al.*, 2013) [11, 22, 24, 41, 51]. Moreover, the bacteriological analysis of the seawater taken from the coast of Sidi Ifni shows high concentrations of total coliforms, faecal coliforms and faecal streptococci at the first S1 site. This result can be explained by the effluents from the wastewater treatment plants in the city of Sidi Ifni (Nnane *et al.,* 2011) [35]. In addition (Meays *et al.,* 2006) [33] indicates that faecal pollution of seawater can come from wildlife, agricultural activities, human activities and watersheds.

The results of our work are consistent with those found by (Amorim *et al.,* 2014) [7]. Sampling from the Goraizim and Aglou beach shows a reduction in faecal contamination and shows good quality water during the study period (Amorim *et al.,* 2014) [7]. This change could be explained by the remoteness of S2 and S3 to all sources of pollution and the hydrodynamic variables of the ocean (Amorim *et al.,* 2014) [7].

In addition, many studies attribute the decrease in bacterial load in seawater to abiotic and biotic factors. The climatological conditions can also change and influence the load of faecal bacteria and seawater. Similarly, our work reports correlations between environmental parameters and faecal bacteria. For example, the action of temperature and solar irradiation on seawater can significantly decrease and eliminate faecal bacteria such as total coliforms, faecal coliforms and faecal streptococci (Curtis *et al.*, 1992; Noble *et al.,* 2004; Whitman *et al.*, 2004) [17, 36, 50]. In addition, the reduction in faecal coliform survival is influenced by baseline pH values (Kh & Assobhei, 2005; Mayo, 1995) [29, 32].

However, salinity is another abiotic factor that is responsible for decreasing the concentration of faecal bacteria. Indeed, high salinity can be a stressor of faecal bacteria in seawater (Hughes, 2003) [25] and cause a decrease in faecal coliform levels (Bordalo *et al.*, 2002) [12]. But a monitoring report in coastal waters found that total coliform and CF concentrations were inversely correlated (Karbasdehi et al., 2017) [28] with salinity, but it maintains that the density of indicator bacteria increases with decreased salinity (Karbasdehi *et al.,* 2017) [28].

Studies of the relationship between dissolved oxygen and bacterial load also show significantly negative correlations (Hughes, 2003; Peak *et al.*, 1983; Sinton *et al.*, 1994; Webb & Brown, 1979; Webb & Brown, 1976) [25, 37, 45, 48, 47].

Indeed, thecombination of UV wavelengths and oxygen allows the formation of highly reactivefree radicals causing the reduction of the bacteriumcharge (Vincent & Neale, 2000) [46].

In addition, some research on the relationship between bacteriological and physicochemical variables shows no significant correlation between faecal bacteria and seawater salinity, although it has found that faecal coliforms and faecal streptococci are positively related to temperature (Kalkan & Altuğ, 2015) [27]. They linked this pollution situation to domestic and industrial activities (Kalkan & Altuğ, 2015) [27]. Similar studies have found a negative correlation between CF and FS levels and abiotic factors (Kacar & Omuzbuken, 2017) [26].

In addition, fromthe ACP statistical analysis, it can be concluded that the distribution of the values of the parameters studied corresponds to a spatial distribution of the study sites (Figure 4b). Indeed, the BOUMRSAL sampling site (S1) represents thestation whose water quality is bacteriological charged.

In the present study, many interpretations could probably be attributed to faecal contamination of seawater, in the three sites studied, to human and animal origins. In general, human origin can be due to tourist activities, domestic and industrial activities. In our case, we find the fishing activity (port) and domestic activities (domestic wastewater treatment plant) on everything for site 1 (Boumrsal) (Figure 5). On the other hand, the animal origin may be due to wild animals living along the sea coast of Sidi Ifni. It should be noted that our results confirmand in agreement withthose of Abbassi *et al.* (2015) [2] on the coasts of Sidi Ifni and which found mainly human contamination due tothe discharges from the domestic wastewater treatment plant of the city of Sidi Ifni (Abbassi *et al.,* 2015, 2017) [2, 1].

Conclusion

This work is a contribution to the study of the microbiological quality of the coastal waters of Sidi Ifni. In this context, our work mainly aims to study the different physicochemical and microbiological parameters of seawater collected at three different stations located on the coast of Sidi Ifni: Boumrsal (S1), Goraizim (S2) and Aglou (S3).

The results of physicochemical (T, pH, Sa and DO) and microbiological (TC, CF and FS) analyses performed during the study period (January to June 2021) show similar monthly variations. However the inter-site comparison reveals a higher bacterial load (total and faecal coliforms) at site S1 compared to other sites. However, the principal component analysis confirms this result by the influence of abiotic parameters (T, pH, Sa and DO) on bacteria indicative of faecal contamination, which reflects the risks for people who frequent this region, especially during the summer. Even if, theresults of the bacteriological analysis show that the sea water in the areas studied complies with Moroccan standards and can be classified as a category A (good quality of bathing seawater).

Following the planning of the implementation of a tourist complex on this site, and in an environmental context, as part of the preservation of seawater quality, it is therefore necessary to accompany this development project with regular monitoring of water quality in order to control sources of pollution, thus ensuringa good biomonitoring of this ecosystem.

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