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Monitoring and Sanitary vigilance of bathing waters on Moroccan beaches from Mehdia to Skhirat.

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Abstract— The coastline today is a complex, very diversified space, with profound changes and perpetual transformations. With a coastline of approximately 3500 km, developing on two Atlantic and Mediterranean maritime facades, the Moroccan coastline occupies a privileged place at the level of the entire coastline of the African continent. The wealth, associated with the strategic space that represents the littoral, made of this last one a major space of development of the country in terms of urbanization, industrial zones and tourist equipments.

The quality of bathing water is a criterion increasingly demanded by the general public for the choice of its holiday resorts. The authorities watch over the Moroccan beaches and take all necessary measures to fight against their pollution. The direct and recognized consequence of this activity is the quality of the marine environment, which is the receptacle for all industrial, agricultural and urban nuisances.

The Main objective of our present study is to make a diagnosis of the state of health of the principal beaches of our region of Rabat-Sale and Kenitra. Our sampling focused on 8 beaches of Kenitra Mehdia, Nations, Rabat-Sale, Harhoura, Témara, Golden Sand, Val D'or and finally the beach of Skhirate Amphitrite. Bacteriological analyzes were conducted to identify the microorganisms that are indicative of faecal pollution including faecal coliforms and faecal streptococci and their enumeration by the filter membrane method on nutrient media Tergitol7 Agar, Litsky, Slanetz & Bartley.

In addition to microbiological sampling of water, the air temperature was measured "in situ" using a mercury thermometer, the temperature of the water using a pH meter, the pH of the water using a portable pH meter, the tide (high or low) and finally the estimate of the summer population.

The Main results obtained made it possible to classify the beaches in 3 categories according to the Moroccan standard for monitoring bathing water quality NM 03.7.200. The beaches of the Nations, Harhoura and Val D'or are classified A. The beaches of Mehdia, Temara, Golden Sand and Skhirat with medium quality waters are classified B. Only the beach of Rabat-Sale is very polluted and classified in category C.

Keywords— Coastline, Beaches, Swimming, Pollution, Microbiology, Coliforms, Streptococci, Morocco.

I. INTRODUCTION

The Moroccan coastline is obviously a heritage of great importance for the country. It represents a Mediterranean facade stretching about 460 km from Tangier to Saidia and an Atlantic facade of 2500 km from Tangier to Lagouira.

It is a strategic area with a wide variety of natural and biological resources, including beaches, dunes, lagoons and wetlands. It is under increasing demographic pressure from urban agglomerations and the influence of various industrial, port and tourist activities.

Morocco has a strong tendency to urbanization estimated at 4.4% per year, which is accompanied by a phenomenon of coastalisation of the population. The expanding coastal agglomerations provide the bulk of urban growth with more than 60% of the total urban population of the country [1].

The coastline is also the location of most industrial units; more than 80% of industries are located near coastal areas. The industries are highly concentrated along the Kenitra-Safi axis and especially in the Casablanca agglomeration. This axis concentrates nearly 62% of industrial units and nearly 70% of industrial employment [1].

In addition, through the marine facilities located along the coast, transiting 98% of trade with the outside of this fact Moroccan water are experiencing intense shipping. Thus, hundreds of boats run daily along the Moroccan coast, including tankers and tankers that pose a permanent threat to marine pollution. Similarly, the important fisheries resources consist of more than 7137 animal species providing a fishing potential estimated at 1000 000 annual tons [2].

In recent years, tourism policy has made seaside a priority option and this by the development of certain areas such as Tangier and Agadir which concentrate 70% of the hotel capacity approved. The surge in domestic demand on the seaside has also led to the proliferation of second home projects and the occupation of the public domain, which has led to the emergence of a real lack of health infrastructure and consequently a negative impact on several beaches.

Moreover, the quality of the beaches has become over the years a criterion increasingly used by the general public to choose its holiday beaches. This led the authorities to ensure the protection of beaches against pollution by wastewater and to establish a classification of beaches according to their quality.

The Main objective of our current research is to make a diagnosis of bathing water safety through physicochemical and microbiological monitoring.

II. MATERIAL AND METHOD

II.1. Study area

Our sampling focused on the 8 beaches of Kenitra Mehdiya, Nations, Sale, Harhoura, Temara, Sable D'or, Val D'or and finally Skhirat Amphitrite Beach (Table 1). The beaches that are the subject of our study are part of the Rabat-Salé-Kenitra region, which regrouped two Gharb Chrarda Beni Hssen regions (GCBH) and Rabat, Salé, Zemmour-Zaér according to the old administrative division of 1997. The region of the GCBH has 3 provinces Kenitra, Sidi Kacem and Sidi Slimane, 8 circles and 61 rural communes. Its total area is 8809 square kilometers. The region of Rabat, Sale, Zemmour-Zaér is divided into 3 prefectures: Rabat with an area of 118 km²; Salé with an area of 672 km² and Skhirat-Témara with an area of 485 km² [3]. The study area is part of the northern coastal Meseta area. It is bounded on the north by the Sebou river, on the south by Oued Cherrat, on the east by the Moghrebian dune cords and on the west by the Atlantic ocean [4].

The study area is located on the Atlantic coast, dominated by sandy beaches, rocky platWaters without cliffs, small and medium cliffs, large dunes at more or less advanced stages of fixations by the flora of the sub floor. The tidal sway zone is essentially composed of very fine sand with shell debris.

Coastal marine currents are mainly induced by winds. The influence of the tide is very weak and the general current of the Canaries, south direction, is not perceptible near the coast. The study area is located between the city of Mehdiya and the city of Skhirat, and extends for a distance of about 75 km. Swimming is the Main activity in summer. With the exception of the beaches of Rabat and Sale of the estuary of Bou Regreg, seaside activity is concentrated outside the urban agglomeration, either at the beaches of Harhoura, and Skhirat or Nations.

The study area is subject to considerable urban pressure and is therefore influenced by the various industrial, port and tourist activities. It receives inputs from the watersheds of Sebou, Bou Regreg and Ikem rivers and the continental alluvium they carry as well as the wastewater outfalls of coastal agglomerations.

II.1.1. Mehdia Beach

Mehdia Beach is 5 km long, located 8 km west of Kenitra. It is a small coastal town 30 km north-east of Rabat. The Mehdia beach receives the Sebou estuary.

II.1.2. Beach of Nations

The beach of Nations extends over 4 km. The line of the coast is straight and open to the ocean which allows a continuous renewal of the waters of the beach. The only source of point pollution comes from the rejections of the Hotel des Nations. The number of summer visitors varies from 4000 to 6000 per day and from 40000 to 50000 during Saturday-Sunday.

II.1.3. Rabat-Salé Beach

The beaches of the Oued Bouregreg estuary, Sale beach and Rabat beach are respectively 1 km and 1.2 km long. These beaches are located in the middle of the urban area and are very popular during the seaside season. These beaches are subject to the numerous discharges of domestic wastewater from the cities of Rabat and Sale, to which are added the contributions of the Bouregreg river considered as an important source of pollution. These beaches are almost closed by dikes.

II.1.4. Témara Beach

The beach of Témara extends about 0.4 km and receives the sewage of the emissaries of the Témara town and discharges from the houses installed directly on the borders of the beach.

II.1.5. Harhoura Beach

The beach of Harhoura extends about 0.95 km and receives the sewage of the emissaries of the Wilaya of Rabat-Sale and discharges from the houses installed directly on the borders of the beach.

II.1.6. Sable D'or and Val D'or Beaches

The beaches of Sable D'or and Val D'or are in the form of basins each extending about 1.5 km. Their waters are contaminated by Septic tanks often poorly Maintained some beach houses and bathers.

II.1.7. Skhirat Beach

Skhirat Beach is 1.5 km away. It is open to the ocean and is not exposed to any source of urban pollution. This beach, despite its remoteness from Rabat, has a sizeable stream of summer visitors estimated at 600 visitors per day and 1200 at the end of the week.

Table 1: Description of beaches between Kenitra and Skhirat [5].

Provinces	Communes	Beaches	Lenght in km	Daily Frequency of Estivants
Kenitra	Mehdia	Mehdia	5	100000
Sale	Bouknadel	Nations	1,2	2500 - 5000
	Sale Medina	Sale	1,5	9000
Skhirat Témara	Témara	Témara	0,4	1500
	Harhoura	Harhoura	0,5	1400
		Sable D'or	0,5	3000
		Val D'or	0,4	1000
	Skhirat	Skhirat Amphitrite	1,5	1500

III. Study method

III.1. Waters sampling

At each stage of the microbiological sampling, there is a risk of distorting the entire procedure, which is why sampling requires special care to avoid any contamination. Thus sterility and adequate temperature are of paramount importance in carrying out microbiological research. For optimal sampling, according to Moroccan standard NM03.07.006:

- * the sample must be representative;
- * errors introduced during sample collection and preparation are generally larger than errors from analytical determinations;
- * major difficulty to obtain a representative sample due to the lack of homogeneity in the time and space of the sampled water body;
- * There are no defined criteria for determining the number, distribution of sites, frequency and timing of sampling.

In our sampling we proceeded as follows:

- sampling points are based on the extent of the beach in areas with the highest density of bathers;
- sampling at the level of the upper layer of the body of water at a depth of 30 cm;
- sampling frequency is two samples per month during the summer season and one sample per month for the rest of the year;
- the sampling time is fixed between 12h and 13h;
- the storage conditions of the samples designated for bacteriological analysis include storage in an insulated box at a temperature between 0 and 4 °C.

In addition to the water sampling, the following parameters were measured "in situ":

- + the temperature of the air using a mercury thermometer;
- + the water temperature using a pH meter;
- + the pH of the water using portable pH meter Hanna type Instrument;
- + the tide (high or low);
- + estimate of the summer population.

III.2. Microbiological analysis methods

For the prospecting of the biological quality of bathing waters, it is necessary to carry out bacteriological analyzes to search for microorganisms which are indicators of faecal pollution, especially faecal coliforms and faecal streptococci.

III.2.1. Coliforms

The term "coliform" refers to the different species belonging to the gram negative Enterobacteriaceae family, aerobic or optionally anaerobic, non-sporogon and whose Main characteristic is the fermentation of lactose with gas production [6].

* Fecal coliforms (CF).

According to the World Health Organization [7], the faecal coliforms are Gram-, aerobic and facultative anaerobic, rod-shaped, non-sporulating bacteria that ferment lactose by producing gas, within 24 hours, at the same time they growth at 44°C on the medium Tergitol 7 Agar. Faecal coliforms have a highly significant positive correlation with faecal contamination caused by humans or warm-blooded animals, and are therefore a good indicator of the health quality of coastal waters [8]. This is based on the fact that *Escherichia coli* can't survive for a long time in the environment. Its survival time depends on several physicochemical factors, temperature is the essential factor that affects its concentration. Other work [9], show that the density of faecal coliforms and directly proportional to the biological oxygen demand (BOD₅). So their presence in the water always indicates a recent faecal contamination.

* Fecal Streptococci (SF).

Faecal Streptococci are slightly oval, Gram-positive, spherical cocci in the form of pairs or short chains during their growth on Slanetz and Bartely medium containing 2,3,5 triphenyl tetrazolium chloride (TTC).

The group of fecal streptococci normally comes from human intestines or warm-blooded animals and indicates faecal pollution when they are detected in seawater. Their mortality rate depends on salinity, temperature and solar radiation,...etc.

III.2.2. Enumeration of Fecal Coliforms

* Filter membrane method

The membrane filter method is the method used for the enumeration of fecal coliforms and fecal streptococci. This method is suitable for the enumeration of faecal coliforms and faecal streptococci in coastal bathing waters of temperate seas. It has been established for sanitary surveillance of beaches [10-13].

➤ Principle:

The method consists in filtering a volume of seawater sample taken under sterile conditions, according to the quantity of coliforms estimated in the water sample. The filtration membrane should have a pore diameter of 0.45 µm optimal for the total retention of bacteria. The membrane is placed on the surface of the culture medium poured into Petri dishes and cultured. After incubation the cultures are examined for bacterial colonies with specific characteristics and count to deduce the bacterial concentration per 100 ml of water (Figure 1).

➤ Interpretation:

Sodium heptadecyl sulfate (Tergitol 7) inhibits unwanted secondary flora. The degradation of lactose to acid is revealed by a yellow turn of the pH indicator, bromothymol blue, biphenyl chloride 2,3,5 tetrazolium (TTC) is reduced very rapidly by almost all coliforms except *Escherichia coli* and *Enterobacter aerogens* which give a red coloring.

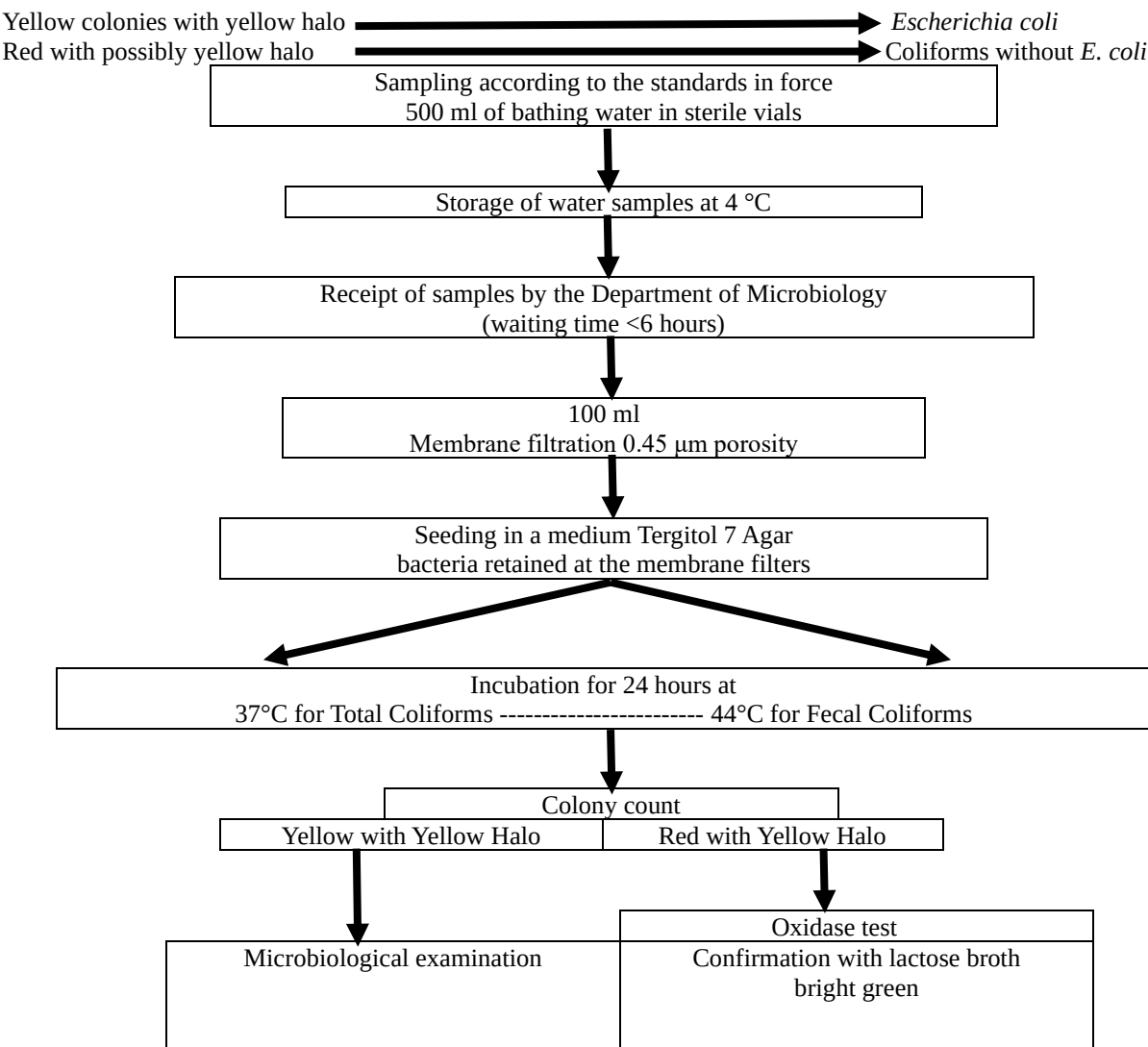


Figure 1: Protocol for the detection and enumeration of fecal coliforms.

- **Confirmatory test:**
Faecal coliform colonies presumed on Tergitol 7 Agar medium are confirmed on bright green bilious lactose medium at 37 ± 1 ° C for 24-48h.
- **Interpretation:**
Cloudy medium and presence of gas under the bell → Fermentation of lactose → Soliforms.

III.2.3. Enumeration of Fecal Streptococci

For Enterococci on membrane filters, selective Agar is used according to Slanetz and Bartley. This medium contains an abundant amount of nutrients to ensure good growth. On the other hand, all secondary flora is inhibited by azide (**Figure 2**).

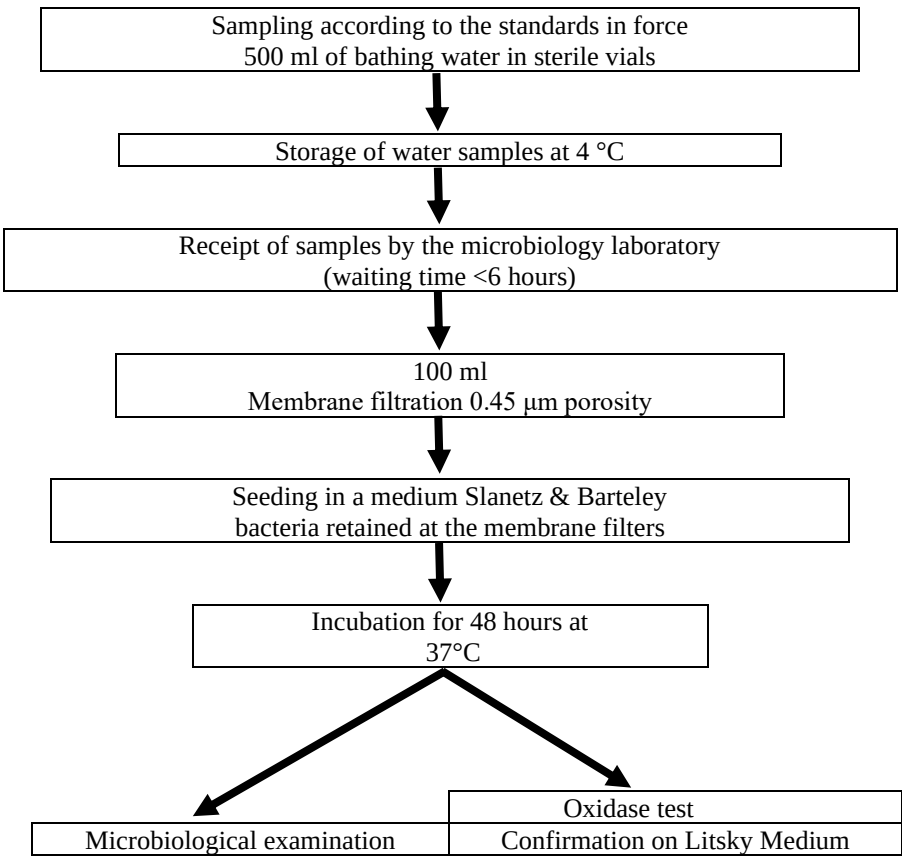


Figure 2: Protocol for detection and enumeration of Fecal Streptococci.

- **Interpretation:**
Enterococci colonies reduce TTC to red-colored formazan, which allows early identification of yellow Escherichia coli colonies.

Pink to brown colonies with a diameter of 0.5 to 2 mm are usually fecal streptococci.

➤ **Confirmatory test:**

Fecal Streptococci colonies presumed on Slanetz & Bartley medium are confirmed on Litskey medium at $37 \pm 1^\circ \text{C}$ for 24-48h. Tubes with a disorder are considered positive and taken into account for the enumeration of fecal streptococci.

III.3.Method of classification of bathing waters

For the classification of bathing waters four categories are distinguished namely: **A**, **B**, **C** and **D** on the basis of the overrun of the Moroccan standards [1] for monitoring the quality of bathing water (Table 2) and the international standards and guidelines for the sanitary monitoring of bathing waters [14-15].

Table 2: Guide values and imperative values set by the Moroccan standard NM 03.7.200 [1].

Parameters	Guide Value VG UFC/100mL	Imperative Value VI UFC/100mL
Fecal Coliforms	100	2000
Fecal Streptococci	100	400

* **Category A:** Good quality waters for swimming.

- At least 80% of *Escherichia coli* or faecal coliform results are less than or equal to the guideline value of 100 bacteria / 100mL;
- At least 95% of the results in *E. coli* or faecal coliforms are less than or equal to the mandatory value of 2000 bacteria / 100 mL;
- At least 90% of fecal Streptococci results are less than or equal to the guideline value of 100 bacteria / 100 mL.

* **Category B:** Medium quality waters for swimming.

- The water quality is medium when the imperative number set by the directive for *E. coli* and faecal coliforms of 2000 CFU / 100mL is respected in less than 95% of the samples.

* **Category C:** Waters temporarily polluted.

- Water monitoring points for which the frequency of exceeding the mandatory number for *E. coli* or faecal coliforms is between 5% and 33.3% is considered to be temporarily polluted. This pollution can be the subject of immediate or medium-term measures to permanently improve the quality of water.
- It is important to note that if less than 20 samples are taken during the whole season on one point, a single exceeding of the imperative number in *E. coli* or faecal coliforms, is enough to cause the classification of the beach in category C.

* **Category D:** Poor quality waters.

- Where, for the *E. coli* or faecal coliform parameter, the conditions relating to the imperative number are exceeded at least once in three, the bathing water concerned is considered to be of poor quality. All areas classified as Category D for two consecutive years shall be prohibited from swimming unless significant improvements occur.

Waters classified in categories A or B comply with the bathing standard, however, waters classified in categories C or D do not comply with the standard.

III. RESULTS AND DISCUSSION

During our surveillance mission, several bathing water samples were taken at the Main beaches of the region. Monitoring includes bi-monthly site visits, climate surveys, physicochemical measurements and microbiological analyzes (faecal coliforms and faecal streptococci).

The Main results of the analyzed parameters "in situ" and the microbiology laboratory of the Ministry of the Environment are summarized in Tables 3 to 10.

Table 3: Monthly variation of bacterial contamination of Mehdia Beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	20	19	8,15	Low	500	9	162
05 June	26	24,3	8,1	Low	4200	0	10
19 June	27	26	8,1	High	5100	2	25
03 July	26	25	8,15	High	7000	266	40
17 July	28	26	8,15	Low	7300	150	25
31 July	28	26	7,85	Rising	8000	645	154
17 August	27	25	7,85	Low	8000	14	12
04 September	25	24	8	Low	5500	0	4
18 September	26	24	8,05	High	3000	0	0
29 January	19	17	8,05	High	30	15	10

In our monitoring of the bacterial load of beaches, it has been found that:

- * in the Mehdia beach, the contamination standard is exceeded in 30% of samples for CF and 20% for SF (**Table 3**);
- * in the Nations beach, the contamination is exceeded in 10% for CF and 0% for SF (**Table 4**);
- * in the Rabat-Salé beach, the contamination standard is exceeded in **100%** of the samples for CF and **70%** for SF (**Table 5**);
- * in the Témara beach, the contamination threshold is exceeded in **50%** for CF and in none (0%) for SF (**Table 6**);
- * in the Harhoura beach, the contamination threshold is exceeded in 20% for CF and 10% for SF (**Table 7**);
- * in the Sable D'or beach, the sample contamination exceeds 30% for CF and 10% for SF (**Table 8**);
- * in the Val D'or beach (**Table 9**) no exceedance of the guide value (VG) for faecal coliform (**0%**) and fecal streptococci (**0%**) concentrations was recorded.
- * in the Skhirat beach area the contamination of samples is exceeded in **40%** for CF and 10% for SF (**Table 10**).

The relatively high percentages of exceedance for faecal coliform guideline values were recorded at the beaches of Mehdia, Rabat-Sale, Temara, Sable d'Or and Skhirat with over 30% exceedance (**Tables 5, 6, 8, 10**). The highest percentages of contamination not faecal coliforms were detected in the Rabat-Sale beach (100%). The highest level for streptococci is found in the Rabat-Sale beach (70%).

Table 4: Monthly variation in bacterial contamination of the Nations beach.

	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	20	18,8	8,30	Low	14	77	92
05 June	21	19,3	8,20	Low	34	50	13
19 June	20	18,5	8,20	High	70	6	0
03 July	25	24,6	8,11	High	900	36	23
17 July	23	21,2	8,11	Low	1400	54	26
31 July	27	25	8,15	Rising	3000	120	52
17 August	30	30	8,15	Low	3000	47	7
04 September	28	26	7,85	Low	20	7	4
18 September	27	25,5	7,85	High	10	1	3
29 January	16	16	8,00	High	2	4	0

Table 5 : Monthly variation in bacterial contamination of the Rabat-Sale beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
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	Air	Water					
15 May	19	18,8	8,14	Low	36	2800	750
05 June	20	19,3	8,14	Low	73	130	75
19 June	20	18,5	8,13	High	200	160	50
03 July	26	24,6	8,09	High	400	7400	1100
17 July	24	21,2	8,24	Low	1700	2400	210
31 July	26	25	8,7	Rising	2000	4000	710
17 August	31	30	8,68	Low	3000	780	570
04 September	28	26	8,55	Low	300	160	190
18 September	27	25,5	8,55	High	50	240	10
29 January	20	25	8,23	High	9	860	164

Table 6 : Variation Monthly variation in bacterial contamination of the Témara beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	20	18,8	8,15	Low	16	12	4
05 June	20	19	8,1	High	700	320	9
19 June	21	19	8,1	High	800	200	28
03 July	25	24,3	8,15	Low	1400	170	71
17 July	28	26	8,15	Rising	2500	329	25
31 July	27	25	7,85	Low	2600	770	13
17 August	27	26	7,85	Low	1200	30	18
04 September	26	26	8	High	17	90	4
18 September	27	25	8,05	Rising	6	40	33
29 January	17	16	8,05	High	0	18	18

Table 7 : Monthly variation in bacterial contamination of the Harhoura beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	19	18,8	8,15	Low	15	141	27
05 June	19	19	8,1	High	300	15	9
19 June	21	19,2	8,1	High	300	4	19
03 July	25	24,3	8,15	Low	700	40	88
17 July	27	25,7	8,15	Rising	800	30	33
31 July	25	24	7,85	Low	850	189	30
17 August	27	26	7,85	Low	1100	80	91
04 September	26	26	8	High	350	41	30
18 September	26	25	8,05	Rising	40	7	12
29 January	19	17	8,05	High	7	67	176

Table 8 : Monthly variation in bacterial contamination of the Sable D'or beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	19	18,8	8,1	Low	0	4	0
05 June	20	19	8,15	High	30	9	3
19 June	21	19	8,12	High	460	1	58

03 July	25	24,4	8,06	Low	1450	30	32
17 July	27	26,6	8,2	Rising	1000	15	3
31 July	27	25	8,15	Low	2100	1450	800
17 August	30	28	7,9	Low	1800	1070	70
04 September	29	26	7,9	High	800	140	58
18 September	26	25	8	Rising	800	31	4
29 January	18	17	8	High	10	8	6

Table 9 : Monthly variation in bacterial contamination of the Val D'or beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	19	18,1	8,15	Low	7	1	1
05 June	20	18,5	8,1	High	60	0	0
19 June	22	19,4	8,1	High	350	14	1
03 July	22	20,1	8,15	Low	600	0	2
17 July	23	19,7	8,15	Rising	600	16	3
31 July	24	22	7,85	Low	750	28	12
17 August	25	22	7,85	Low	1000	4	11
04 September	22	22	8	High	250	9	1
18 September	25	24	8,05	Rising	100	5	4
29 January	19	17	8,05	High	4	15	60

Table 10 : Monthly variation in bacterial contamination of the Skhirat Amphitrite beach.

Date	Temperature		pH	Tide	Population	CF/100mL	SF/100mL
	Air	Water					
15 May	19	18	8,25	Low	36	0	0
05 June	20	18	8,15	High	90	0	11
19 June	21	19,2	8,15	High	300	2	20
03 July	21	20,6	8,13	Low	500	120	115
17 July	23	20,4	8,15	Rising	800	114	5
31 July	25	21	8	Low	2000	700	63
17 August	25	22	8	Low	2500	240	69
04 September	23	22	7,9	High	34	13	22
18 September	24	24	8	Rising	3	9	8
29 January	19	18	8	High	0	58	87

IV. CONCLUSION

The assessment of the quality of the beaches that were monitored during the 2008 surveys based on the Moroccan standard NM 03.7.200 (**Table 2**) and the classification grid made it possible to list the clean beaches and the beaches. improper ranges and prioritize them as follows:

- ❖ The beaches of Nations, Harhoura and Val D'or are classified A;
- ❖ The beaches of Mehdiya, Temara, Sable D'or and Skhirat are classified B;
- ❖ The beach of Rabat-Sale is classified C.

In addition, the annual evolution of beach safety has shown a significant increase in bacterial contamination during the summer period, which begins in May-June. The highest infections are noted in July and August and decrease in spring and winter. This variation in the level of contamination is explained by the following facts:

- The beginning of the seaside activity by the occupation of the secondary houses at the edge of the beaches and the swimming start at the end of May;
- The school holidays in July August coincide with the maximum contaminations;

- The increase in the number of summer visitors in coastal cities, which has an impact on pollution flows from coastal emissions;
- Increased flow of tourists and Moroccans living abroad.

Observations made in the field during the summer have shown that the density of summer visitors is maximum in the afternoon, it is even more during the weekend (**Table 3-10**). The flow of holidaymakers reaches its peak especially during the months of July and August; period when all homes, hotels and inns are over-saturated.

The waters sampled at the beaches of Temara, Sable D'or and Skhirat are of average quality for bathing because of a more pronounced contamination by the indicator germs of fecal contamination. This pollution and degradation of the environment are mainly related to the activities of summer visitors during the summer. The temperature and pH of water are favorable for the survival of bacteria (**Table 3-10**).

This contamination is aggravated by the lack of infrastructure (garbage cans, toilets, showers, signs, etc.), the lack of liquid sanitation networks and the use of septic tanks and poor solid waste management.

Mehdia beach has an average quality for swimming. It is a special ecosystem due to the presence of the estuary of Sebou river which drains wastewaters from three major cities Fez, Meknes and Kenitra estimated at more than 200 000 m³ / day. In fact, the pollution generated is very impressive because of the agricultural, port and industrial activities of this river: sugar factories, paper mills, oil mills, tanneries, cement factories, textiles, refineries,...etc.

The temporal monitoring of the level of contamination of the waters of Rabat-Salé beach has led to the conclusion that this beach is not bathing. This observation could be interpreted by the diversity of the sources of pollution, the variations of the flow rate and finally the mortality of the bacteria.

In fact, the sewage as soon as they arrive in the rivers is diluted by the rains. Similarly, domestic pollution is dampened by industrial and agricultural waste rich in heavy metals and pesticides that prevent the proliferation of microorganisms due to bacterial inhibition by toxicity and eutrophication.

The beaches of the Nations, Val d'Or and Harhoura are of good quality for swimming due to the absence of wastewater discharges and urban activities and also the low pressure of summer visitors.

In conclusion of our study it appears that the efforts made by the Moroccan government to preserve the environmental quality of beaches must be reinforced by:

- * activation of the establishment of wastewater treatment plants and the necessary and adequate sanitation systems, both for solid discharges and for liquid discharges in coastal cities;
- * put in place and implement the legislative and regulatory measures necessary to preserve the coastline, notably through the activation of the enactment of the law on the protection of the coastline;
- * ensure compliance with the provisions of the regulatory texts governing standards for direct and indirect discharges of wastewater;
- * create a national institution responsible for coastal zone management;
- * endow the shoreline with master plans and beaches with development plans for recreation, hygiene and safety infrastructures;
- * provide the ports with the necessary means of decontamination;
- * strengthen the beaches in material and human resources for safety, hygiene and cleaning.

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