National Council for Scientific Research

Status of the marine environment in Lebanon

The Annual Report for 2023

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Main outcomes

- 22 out of 37 stations are classified as safe for swimming
- 6 out of 37 stations are classified as extremely polluted
- 9 stations are classified as cautious to unsafe
- Local fish is not contaminated with trace elements and organic pollutants
- Most marine sediments outside ports and industrial areas are not contaminated with trace elements
- Beach litter, namely plastics, is highly prevalent on Lebanese shores
- New in this announcement, in addition to the study of marine litter, is the availability of pollution results as WebMap and the possibility of tracking over the years through CNRS-L interactive dashboards:
  For WebMap: https://sunar-cnrs.maps.arcgis.com/apps/instant/minimalist/index.html?appid=4c3d60b21bff459191abffdcf11df366
  And for tracking over the years on the dashboard: https://sunar-cnrs.maps.arcgis.com/apps/dashboards/ef2e3cb1036543659508a7028897bc38

1. Bacteriological and organic monitoring

The National Council for Scientific Research of Lebanon announced the results of the monitoring of the Lebanese coast after the monthly sampling of 37 fixed and geographically defined stations throughout the year. The results indicate that 22 out of 37 marine stations are safe for swimming. Bacteriological analyses have proven that the concentration of fecal bacteria in these stations is within safe limits. Thus, the general environmental condition of the waters in these stations is good to very good, and swimming is recommended. Nonetheless, the other fifteen stations contain high bacterial levels, which makes the classification of these beaches fluctuate between cautious, and unsafe to very polluted and unsuitable for swimming (Figure 1) (Table 1).

Table 1: *Information about the adopted sampling stations and their vulnerability to bacteriological contamination*

Region & code	Coordinates	The location and nature of the beach	Fecal Streptococci (CFU/100ml)	Fecal coliforms (CFU/100ml)	Beach rating
Akkar (AKK-2)	N34.59438° E35.98782°	Akkar / Near Klayaat Airport (Sandy)	500	319	Critical / Unsafe for swimming
Al Minyeh (MNY-2)	N34.48423° E35.92421°	Minyeh / Sandy beach (Sandy)	500	575	Critical / Unsafe for swimming
Tripoli (TRI-2)	N34.45646° E35.80976°	Tripoli / El-Mina facing Abd el Wahab island (Rocky)	260	91	Warning / Swimming with Caution

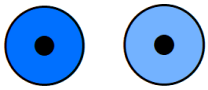
Tripoli (TRI-4)	N34.44698° E35.81119°	Tripoli / Public sandy beach (Sandy)	665	927	Extremely Polluted / Do Not Swim
Tripoli (TRI-6)	N34.42913° E35.81458°	Tripoli / South of sports city (Rocky/sandy)	97	25	Very good / Safe for swimming
Anfeh (ANF-2)	N34.36757° E35.73600°	Enfeh / Deir Al Natour (Rocky / Pebbles)	71	2	Very good / Safe for swimming
Anfeh (ANF-3)	N34.36066° E35.73096°	Enfeh /Tahet el Rih Area (Rocky)	46	7	Very good / Safe for swimming
Al Heri (HER-2)	N34.30986° E35.71418°	Heri / Sandy beach (Sandy)	31	31	Very good / Safe for swimming
Selaata (SEL-2)	N34.26810° E35.65715°	Selaata / Public beach (Rocky)	40	74	Very good / Safe for swimming
Batroun (BAT-1)	N34.25317° E35.65696°	Batroun / Al-Bahsa Beach (Rocky / Pebbles)	180	124	Good / Safe for swimming
Batroun (BAT-2)	N34.25113° E35.65696°	Batroun / Al Hima below NCMS-CNRS-L (Rocky)	50	4	Very good / Safe for swimming
Amchit (AMC-2)	N34.16108° E35.63333°	Amchit / Public beach (Rocky / Pebbles)	58	0	Very good / Safe for swimming
Byblos (BYB-2)	N34.12384° E35.64325°	Byblos / Al-Bahsa public beach (Pebbles, sandy)	57	7	Very good / Safe for swimming
Byblos (BYB-4)	N34.11264° E35.64883°	Byblos / Public sandy beach (Sandy)	76	36	Very good / Safe for swimming
Fidar (FID-2)	N34.10237° E35.65058°	Fidar / Below Fidar Bridge (Rocky / Pebbles)	60	31	Very good / Safe for swimming
Okaybeh (Nahr Ibrahim) (NIB-2)	N34.06059° E35.64242°	Okaibeh / Nahr Ibrahim beach (Sandy)	65	153	Good/ Suitable for swimming
Bowar (BOR-2)	N34.04697° E35.63123°	Bouar / Rocky public beach (Rocky)	86	7	Very good / Safe for swimming
Safra (SFR-2)	N34.03432° E35.62494°	Safra / Rocky beach (Rocky / pebbles)	26	43	Very good / Safe for swimming
Jounieh (JUN-2)	N34.01058° E35.64383°	Jounieh / Maameltein (Sandy / Pebbles)	13	2	Very good / Safe for swimming
Jounieh (JUN-6)	N33.98336° E35.62677°	Jounieh / Public sandy beach (Sandy)	1000	745	Extremely Polluted / Do Not Swim
Dbayeh (DBY-2)	N33.94504° E35.59080°	Dbayeh / North Dbayeh Marina (Sandy)	3000	2500	Extremely Polluted / Do Not Swim
Antelias (ANT-2)	N33.91642° E35.58660°	Antelias / Nahr Antelias Mouth (Sandy / Rocky)	10000	9080	Extremely Polluted / Do Not Swim

Beirut (BEY-2)	N33.90199° E35.47462°	Beirut / New Fishing Port (Rocky)	250	93	Warning / Swimming with Caution
Beirut (BEY-4)	N33.90051° E35.47038°	Beirut / Manara (Rocky)	800	506	Polluted / Do Not Swim
Beirut (BEY-6)	N33.87868° E35.47971°	Beirut / Ramlet El Bayda public beach (Sandy)	6000	761	Extremely Polluted / Do Not Swim
Khaldeh (KHL-2)	N33.78508° E35.47509°	Khaldeh / Sandy beach (Sandy)	250	21	Warning / Swimming with Caution
Damour (DAM-2)	N33.70347° E35.43825°	Damour / Sandy beach (Sandy, pebbles)	138	166	Good / Safe for swimming
Jiyeh (JYH-2)	N33.65953° E35.41700°	Jiyeh / private sandy beach (Sandy)	82	20	Very good / Safe for swimming
Rmeyleh (RME-2)	N33.61291° E35.39802°	Rmeileh / private sandy beach (Sandy)	85	10	Very good / Safe for swimming
Awali (AWL-2)	N33.59460° E35.38777°	Public beach Awali / North of Awali River (Sandy / Pebbles)	180	108	Good / Safe for swimming
Saida (SDA-2)	N33.57847° E35.38218°	Saida / Public sandy beach (Sandy)	500	79	Critical / Unsafe for swimming
Ghazieh (GHZ-2)	N33.50801° E35.34844°	Ghazieh / Public beach (Sandy)	300	152	Warning / Swimming with Caution
Sarafand (SAF-2)	N33.46720° E35.30285°	Sarafand / Public beach (Sandy / Rocky)	200	308	Warning / Swimming with Caution
Adloun ADL-2	N33.40717° E35.26404°	Adloun / Public beach (Sandy / Rocky)	79	2	Very good / Safe for swimming
Tyre (Sour) (SUR-1)	N33.26471° E35.20414°	Tyre / Sandy beach of the restaurant street (Sandy)	300	415	Warning / Swimming with Caution
Tyre (Sour) (SUR-2)	N33.25990° E35.20890°	Tyre / Sandy public beach (TCNR) (Sandy)	35	2	Very good / Safe for swimming
Naqoura (NAQ-2)	N33.13839° E35.15363°	Naqoura / Near Fishing Port (Rocky)	45	3	Very good / Safe for swimming

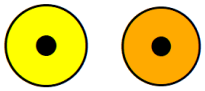
1.1. Scientific classification methodology

Samples are taken from the specified stations over a period of 12 months a year from the surface at a depth of 50 cm, by applying the methodology recommended by the United Nations Beach Observation Program (MEDPOL) used for this type of field research. The results announced annually represent the means of the surveys over a period of two years. The period extends from July 2021 to June 2023. The 95th percentile of fecal streptococci colonies is adopted as an indicator of bacteriological contamination are the percentages of colonies according to the standards approved by the World Health Organization (Guidelines for safe recreational water environments, WHO 2003). These guidelines are summarized as follows:

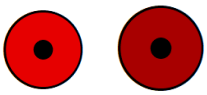
Very good to good: 1 to 200 bacterial colonies per 100 milliliters of seawater



Warning to critical unsafe: from 201 to 500 bacterial colonies in 100 milliliters of seawater



Polluted to extremely polluted: more than 500 bacterial colonies in 100 milliliters of seawater



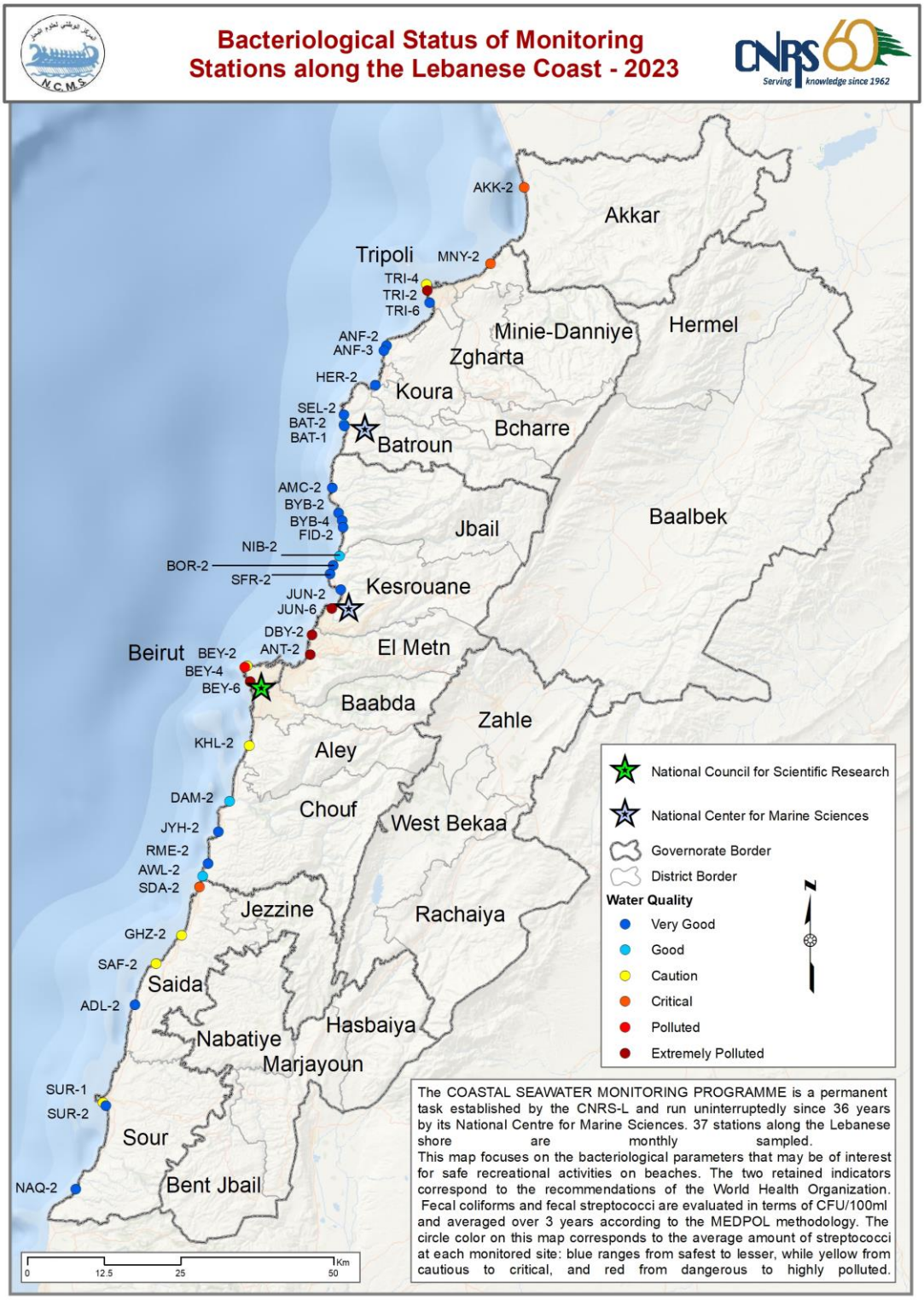


Figure 1: *Map showing the bcteriological status of monitored stations along the Lebanese coast (also available on* https://sunar-cnrs.maps.arcgis.com/apps/instant/minimalist/index.html?appid=4c3d60b21bff459191abffdcf11df366).

1.2. Scientific guidelines for beach classification

The National Center for Marine Sciences of the National Council for Scientific Research has begun the monthly monitoring of bacteriological, organic, and other chemical pollutants and heavy metals along the Lebanese coast for 39 years. The number of stations being surveyed increased from 6 in the mid-eighties of the last century to 37 reference stations today, extending along the Lebanese coast from the Aarida in the north to Naqoura in the south.

Samples from the chosen stations are taken periodically and regularly throughout the year, in accordance with the environmental standards and indicators adopted by the World Health Organization, with the aim of determining beach pollution and its impact on public health. These fixed stations can be considered as points that represent the most prominent environments that characterize the Lebanese coast. These fixed stations are considered a reliable scientific source for publishing accurate scientific information, and they include:

Public sandy and rocky beaches
Vicinity of rivers' mouths
Some private beaches
Beaches near industrial plants and sewage outflows (for comparison)

1.3. Main results

Based on the bacteriological analyses at the specified stations, the following results are attained:

22 of the 37 stations are classified as good to very good. These stations are characterized by low bacterial and organic pollution, and the concentration of fecal bacteria in these stations is within safe limits. The general environmental condition of the waters in these stations is good to very good, and swimming is recommended. These stations are:

Tripoli / South of sports city, Enfeh / Deir Al Natour, Enfeh / Tahet el Rih Area, Heri / Sandy beach, Selaata / Public beach, Batroun / Al-Bahsa Beach, Batroun / Al Hima below NCMS-CNRS-L, Amchit / Public beach, Byblos / Al-Bahsa public beach, Byblos / Public sandy beach, Fidar / Below Fidar Bridge, Okaibeh / Nahr Ibrahim beach, Bouar / Rocky public beach, Safra / Rocky beach, Jounieh / Maameltein, Damour / Sandy beach, Jiyeh / Private sandy beach, Rmeileh / Sandy beach, Awali / North of Awali River, Adloun / Public beach, Tyre / Sandy public beach (TCNR), Naqoura / Near Fishing Port

6 of the 37 stations are classified as polluted to very polluted and unsafe for swimming. These stations are contaminated with large quantities of fecal bacteria as the levels are higher than the safe limits. These stations are:

Tripoli / Public sandy beach, Jounieh / Public sandy beach, Dbayeh / North Dbayeh Marina, Antelias / Nahr Antelias Mouth, Beirut / Manara, Beirut / Ramlet El Bayda public beach

9 of the 37 stations are classified as cautious to critical unsafe. The percentages of bacteriological contamination in their waters are considered moderate and the waters in these stations are subject to intermittent pollution. The stations are:

Akkar / Near Klayaat Airport, Minyeh / Sandy beach, Tripoli / El-Mina facing Abd el Wahab island, Beirut / New Fishing Port, Khaldeh / Sandy beach, Saida / Public sandy beach, Ghazieh / Public beach, Sarafand / Public beach, Tyre / Sandy beach of the restaurant street.

1.4. The positive and negative changes in the studied stations

After comparing the results of 2023 with those of 2022, we conclude the following:

Positive changes:

- Bouar / Rocky public beach improved from good to very good
- Safra / Rocky beach improved from good to very good
- Batroun / Al-Bahsa Beach improved from cautious to good
- Tyre / Sandy beach of the restaurant street improved from polluted to cautious
- Amchit / Public beach improved from good to very good
- Fidar / Below Fidar Bridge improved from good to very good
- Jounieh / Maameltein improved from good to very good
- Adloun / Public beach improved from good to very good

Negative changes:

- Awali / North of Awali River deteriorated from very good to good
- Damour / Sandy beach deteriorated from very good to good
- Beirut (Ain el Mraisseh)/ New Fishing Port deteriorated from very good to cautious
- Ghazieh / Public beach deteriorated from very good to cautious
- Sarafand / Public beach deteriorated from very good to cautious

Variations between 2018 and 2023 can be tracked on https://sunar-cnrs.maps.arcgis.com/apps/dashboards/ef2e3cb1036543659508a7028897bc38

1.5. Reasons

Based on the results, it appears that the bacteriological contamination, which was clearly identified in some studied stations, is mainly due to wastewater and leachate from main dumps that pollute the waters of the Lebanese coast. This contamination lies in the context of the lack

of wastewater treatment, and the fact that the few operating wastewater treatment plants are still in the primary stage and operating partially and below capacity.

2. A study showing whether fish and sediments contain harmful chemical pollutants

2.1. Are local fish resources safe to eat?

Based on the analysis of trace element concentrations (cadmium, lead and mercury) in the tissues of three species of local fish and one type of seashell (Figure 2): white seabream (*Diplodus sargus*), little tunny (*Euthynnus alletteratus*), red mullet (*Mullus barbatus*) and *Patella rustica complex* (limpet) that were collected from the marine waters of three coastal regions: Tripoli, Beirut and Tyre in 2023. It was found that the concentration of all these elements is below the threshold based on the levels set by the European Union Reference Laboratory for Food and Feed (EURL).

The percentages of persistent organic pollutants were also analyzed: Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs). It was found that the concentration of all these organic pollutants is below the threshold based on the levels set by the European Union Reference Laboratory for Food and Feed (EURL).

Hence, we conclude that the local fish that are caught by Lebanese fishermen away from sewage or industrial outlets are healthy, not contaminated with harmful chemical pollutants, and safe for consumption.

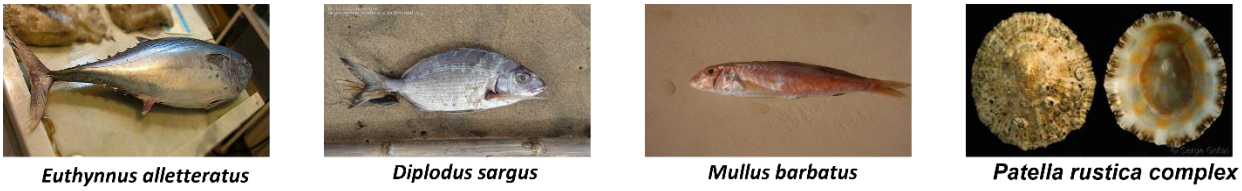


Figure 2: *The fish and seashell species studied*

2.2. What are the percentages of trace elements in Lebanese marine sediments?

The results of trace element analysis (vanadium, lead, copper and cadmium) in the marine sediments along the Lebanese coast showed that their concentrations are low, i.e., less than the international thresholds, with the exception of the sediments in Ramlet El Bayda, which showed levels slightly higher than natural backgrounds. The sediments of Dora showed very high levels of cadmium, lead and copper.

Note: Cadmium levels are slightly higher than natural backgrounds.

3. A study showing the solid waste pollution of Lebanese beaches

The quantity and type of litter scattered along three Lebanese beaches were studied and followed up: Byblos/Al Bahsa public beach, Beirut/Ramlet El Bayda public beach, and Saida/public beach (Figure 3).

Figure 3: *Litter found on Lebanese beaches*

It was found that the number of litter items on the three beaches exceeds 10,000 items/100 meters, which is a very high number when compared to the number recorded by several studies on other beaches in other countries.

The most common category is plastic, followed by the clothes category in Byblos, and the paper cardboard, glass, and metal categories in Beirut and Saida.

A total of 10,646 items/100 meters were recorded on the Byblos beach, while 21,251 items/100 meters were recorded in Beirut. As for the highest number, it was recorded on Saida public beach to be 23290 pieces/100 meters (Figures 4 and 5).

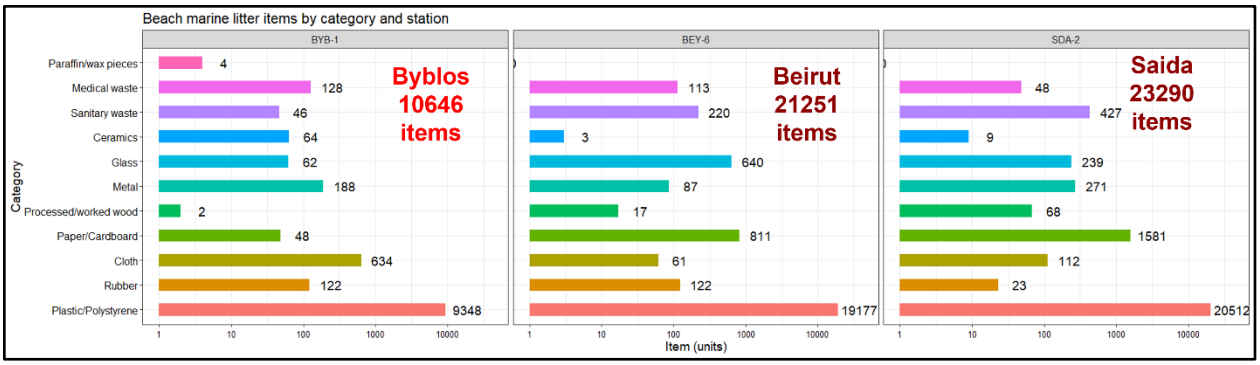


Figure 4: *The number of litter items per category in each of the studied stations.*

Figure 5: *Beach litter field campaign and subsequent sorting and analysis*

It was also found that the most common items are plastic pieces of sizes ranging between 2.5 and 50 cm (plastic caps and cigarette butts, reported especially in Saida) (Figure 6).

Figure 6: *The most common litter categories*

4. Conclusions

- 22 out of 37 stations are classified as safe for swimming
- 6 out of 37 stations are classified as extremely polluted
- 9 stations are classified as cautious to unsafe
- Local fish is not contaminated with trace elements and organic pollutants
- Most marine sediments outside ports and industrial areas are not contaminated with trace elements
- The number of litter items on the three beaches (Byblos, Beirut, Saida) exceeds 10,000 items/100 meters

This report constitutes a multidimensional environmental survey of high importance for the Lebanese coast.

CNRS-L aspires to monitor as many points as possible so that its results will be more comprehensive and inclusive. CNRS-L has made results available through interactive digital platforms that allow quick access to all data.

For the WebMap: https://sunar-cnrs.maps.arcgis.com/apps/instant/minimalist/index.html?appid=4c3d60b21bff459191abffdcf11df366

For the Dashboard: https://sunar-cnrs.maps.arcgis.com/apps/dashboards/ef2e3cb1036543659508a7028897bc38

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