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REPORT ON THE STATE OF THE MARINE AND COASTAL ENVIRONMENT IN 2012

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CONTENTS

ABSTRACT

The state and evolution trends of the Romanian Black Sea coastal environment were monitored in 2012 from the physical, chemical and biological point of view, compared to the reference periods dating back in the early 1960s or in more recent years.

During the winter of 2012, as a follow-up of low temperatures during January-February along with an exceptional storm, specific ice structures - ice pegs, grouped in ridge steps - developed on the entire area of the beach, continued by ice belts. For the northern sector of the coast, the accumulated areas covered ~74 ha, while the eroded areas covered ~153 ha. The shoreline advancement by >10 m was reported on ~12% of the total length, shoreline retreat by >10 m on ~52%, the rest of the coast being in dynamic balance - the shoreline retreated or advanced by less than +/- 10 m.

Sea level showed in 2012 three distinct fluctuation stages in relation to the monthly multiannual means (1933-2011). Thus, during January - April, the level was below the monthly multiannual means, during May to September the values exceeded slightly the monthly multiannual means for these months. In September and October, the monthly multiannual means were almost equal to the monthly multiannual means for these months, while during November and December the monthly multiannual means were again exceeded.

Marine water temperature in 2012 was 1.57°C higher compared to the reference period (1959-2011). For the western part of the Black Sea, three characteristic water masses were pointed-out: the upper quasi-homogenous layer (UQH), the intermediate cold layer (ICL) and the seasonal thermocline. In autumn (October), the intermediate cold layer reaches depths beyond 25 m.

The sea state is due to the frequency of waves higher than 1 m. From this point of view, the maximum height of 6.00 m was reported in February, while the predominantly calm, wavy and rippled sea periods were reported in March, June and October.

The sea ice phenomenon occurred in the winter of 2012 in the last decade of January and the first decades of February, when littoral zone temperatures dropped below freezing point (-0.8°C).

During summer, three upwelling phenomena were recorded in the coastal area (May and June), caused by the dominant western and south-western winds.

The transparency value distribution points-out the high variability range of marine waters, which, in the northern area, are still under the influence of river input.

The salinity of surface waters framed within the typical variability range of waters in the Romanian Black Sea coast, being influenced mainly by river input, lower in 2012.

During the studied period, the waters in the surface layer of the Black Sea coast were well oxygenated in all three water bodies. In the water column, there were some values below the allowed limit (80%) both for the ecological state and the human activity impact area stipulatedin Order 161/2006. No anoxia phenomena were reported in 2012.

The pH of Romanian Black Sea waters ranged within normal limits.

All maximum values of phosphate concentrations were reported at the surface, in stations under the influence of Danube input or of the Constanța urban area. With 93% of the values below 0.60 µM, phosphate concentrations at the Romanian coast showed, during

the studied period, values close to the reference period of the 1960s. In 2012, the multiannual mean monthly concentrations of nitrates (April and October) recorded the lowest values measured since 1976. Nitrites also recorded low values, ranging between 0.02 (LOD) - 1.68 µM (mean 0.28 µM). Ammonia concentrations recorded values ranging between 0.31 - 46.47 µM (mean 4.40 µM). The mean annual concentrations of silicates in seawater in Constanța ranged between 6.7 µM (1993) - 66.3 µM (1972) and, in 2012, they recorded the lowest value of the past 20 years, namely 7.7 µM.

In 2012, the mean annual content of chlorophyll *a* in coastal waters recorded a value close to 2011 (3.67 µg/l compared to 4.91 µg/l), but below the annual mean calculated for the period 2001-2010 (6.27 µg/l), thus confirming the recovery trend of the ecological state of the Black Sea costal ecosystem.

Heavy metal contamination of coastal areas may be directly correlated with urban or industrial sources, such as factories, thermo-electric plants, harbors, water treatment plants. River influence on the coastal area is significant, being a major source of metals, mainly as particulates, extreme hydrological events (floods) enhancing such an input. The distribution of metals in waters and sediments from the transitional, coastal and marine areas highlighted the differences between different sectors of the coast, generally being reported slightly elevated concentrations in some coastal areas subject to different anthropogenic pressures (harbors, sewage discharges), but also in the marine area under the influence of the Danube. The concentrations of most heavy metals in water, sediment and biota generally framed within the variation range of mean multiannual values (2007 - 2011).

In 2012, low values (<200 µg/l) of the total petroleum hydrocarbon content - TPH (µg/l) were determined in water samples. The distribution of concentrations on water body types did not point-out any significant differences between the means of the three water bodies, yet the highest values were recorded in marine waters. The petroleum hydrocarbon pollution level of 2012 is significantly lower compared to the period 2006-2009. In 2012, the decreasing trend of hydrocarbon concentrations in investigated environmental components recorded lately (2010-2011) was continued.

In 2012, the analysis of polycyclic aromatic hydrocarbons (PAH) pointed-out high values for the following pollutants: pyrene, fluoranthene, anthracene, phenanthrene and benzo[a]anthracene. The mean values were within similar variation ranges compared to 2006-2011.

Concerning pesticide contamination, in 2012, littoral waters were dominated by lindane, for which the highest values were measured in most stations, both in transitional, coastal and in marine waters. The highest organochlorine pesticide concentrations were measured in transitional waters, mainly in the Portița area. However, high organochlorine concentrations were reported, though, in coastal waters between Constanța South and Vama Veche. In sediments pertaining to transitional and coastal waters, the dominant compounds were lindane, aldrine, p,p’ DDT and its metabolites. The highest concentrations were recorded in sediments pertaining to transitional waters in the Sulina area. In biota, the bioaccumulation phenomenon was more intense for the species *Rapana* and *Mya*, for most investigated compounds. In 2012, both in water and in sediments, compared to 2006-2008, the decreasing trend of organochlorine pesticide concentrations of the past years (2009-2011) is maintained, for most investigated compounds.

With reference to the microbiological load, the situation identified during the 2012 summer season pointed-out an evolution of marine water quality depending directly on exceptional hydrological and weather conditions of the past five years (2008-2012), characterized by heat waves in summer, with very high temperatures of shallow marine waters. The maximum values of the analyzed bacterial indicators (>16,000 germs/100 ml) were identified, as in previous years, in areas influenced by waste water discharges, with a potential negative impact on the marine environment and human health. In 2012, only the faecal streptococci exceeded regulated values.

2012 was characterized by a poor development of the phytoplankton community (the mean of phytoplankton amounts in spring $2.85 \cdot 10^6$ $cel \cdot l^{-1}$ and 1.06 $g \cdot m^{-3}$ and in autumn $96.6 \cdot 10^3$ $cel \cdot l^{-1}$ and 0.38 $g \cdot m^{-3}$), while algal bloom phenomena were absent throughout the year, except for the developments of the diatom *Skeletonema costatum*, characteristic for the marine ecosystem in spring.

The mean density and biomass values of non-trophic zooplankton recorded lower values compared to previous years, also due to the fact that its maximum development season (summer) was not sampled (the surveys performed only reflect the structure of zooplankton in spring and autumn). The trophic component recorded the maximum development values near the shore, in the southern part of the coast, both in spring and in autumn. 30 taxa belonging to 12 taxonomic groups were identified in the qualitative structure of zooplankton, the highest number since 2004 to the present.

In the summer of 2012, 20 taxa were identified, divided as follows: 9 species belonging to the Chlorophyta phylum, 1 species - Phaeophyta phylum (*Cystoseira barbata*), 8 species of the Rhodophyta phylum (7 species and one variation, namely *Ceramium rubrum* var. *barbatum)* and 2 phanerogames (*Zostera (Zosterella) noltei* and *Stuckenia pectinata*). The dominance of green opportunistic algae was reported in the northern sector of the Romanian coast and the occurrence of the brown alga *Cystoseira barbata* in Mangalia, 2 Mai and Vama Veche, where it is known that marine waters have a better quality, allowing the recovery and development of this key-species for the marine ecosystem. In Mangalia, in summer, well developed *Cystoseira barbata* thickets were reported.

In 2012, 52 macrozoobenthos species were identified, the fauna array maintaining the features of previous years. In 2012, a higher species diversity was reported in transitional waters, where 43 macrozoobenthos species were identified, comparable to 2011. The multiannual trend of the number of species identified in the Romanian Black Sea waters showed a slight, but continuous trend of qualitative balancing. The assessment of benthic community response to anthropogenic pressure on the marine environment quality was made using the biotic indexes (AMBI and M-AMBI) and the mean values obtained for the water bodies investigated during 2011-2012 showed a moderate quality state, with slight trends towards a good state in the south of the coast, less influenced by eutrophication.

The state of biodiversity was defined by the occurrence of 300 species, compared to 200-300 identified during the past 15 years (700 sp. throughout the entire period): 26 endangered species of the 48 in the Red List.

The pressure was expressed by 29 alien species, 8 commercially exploited species (2 molluscs and 6 fish) and 12 anthropogenic activities.

The Red List of marine species was fully updated in 2008 and just for fish in 2009.

It comprises 220 species, listed in 8 IUCN categories: 18 macrophytes and angiosperms, 56 invertebrates, 141 fish and 4 mammals. The IUCN classification of fish species was fully changed in 2009.

Among the 30 species identified in 2012, 3 are rated Vulnerable VU (*Acipenser stellatus*, *Trachurus mediterraneus ponticus* and *Alosa pontica pontica*), 13 are rated Nearly Threatened NT, and 6 are Data Deficient (DD).

In 2012, the industrial fishery activity in the Romanian Black Sea sector was made in two ways: active gear fishing, with coastal trawler vessels, up to 20 m depths, and fixed gear fishing, practiced along the coast in 18 fishing points, between Sulina - Vama Veche, in shallow waters, 3 - 11 m/trap nets, and also at 20 - 60 m depths/gillnets and longlines. The population structure shows, as in previous years, the occurrence in catches of a great number of species (more than 20), of which the most significant are small-sized species (sprat, anchovy, whiting, horse mackerel, gobies), as well as larger species (turbot and Danube shad). We point-out the low share of dogfish, garfish, mullet and bluefish, and also the occurrence of isolated individuals of blue mackerel and bonito. After a decreasing trend during 2002-2010, when catches dropped from more than 2,000 tons in 2002 to 1,390-1,940 t, during 2003-2006, and below 500 t during 2007-2009, reaching a minimum value in 2010/258 t, in the past 2 years the catches recorded an increasing trend, namely 568 t, in 2011, and 835 t, in 2012.

Since December 2011, NIMRD took again into custody the marine protected area “Vama Veche - 2 Mai Marine Littoral Aquatory“ for a period of five years, by Agreement no. 306/13.12.2011, concluded between MEF and the Institute. Researchers and technicians from the Institute provided permanence during this peak summer season period, carrying-out, besides research and monitoring the parameters and state of the marine protected area activities, ecological education and awareness raising activities, by lecturing and distributing brochures and flyers with information on the marine reserve and the marine environment in general. Communication and awareness raising activities are some of the pillars of the custodian team activity. For such purposes, information flyers with the description of the Reserve were drawn-up and printed, distributed both to tourists in the area and during various events hosted by NIMRD.

In 2012, research aiming at identifying and classifying the marine habitats in the two newly designated marine sites at the Romanian coast were performed, namely *ROSCI0281 Cape Aurora* and *ROSCI0293 Costineşti - 23 August*.

In 2012, the following results were obtained in the field of MSP: setting-up the legal framework in fisheries, adaptable and easy to update; identifying the international legislation harmonized at national level, drawn-up and/or under implementation in Romania; setting-up the integration of marine fisheries in the field of maritime spatial planning; identifying the specific situations concerning conflicts (national and international) and pointing-out support-issues to solve case studies; creating maps, photographs of the main coastal activities in land and marine protected areas, the thematic and integrated marine uses - in the field of fisheries, as well as the distribution of the most important species in the Romanian and Bulgarian maritime area.

Concerning the Integrated Coastal Zone Management activities, at EU level, during 11-12 September 2012, NIMRD was part in the Joint EIONET and Member State Expert groups on Maritime Spatial Planning and Integrated Coastal Zone Management, organized by the European Environment Agency - Copenhagen (EEA). At national level, the National Committee for Coastal Zone Meeting convened in September 2012 and projects in the coastal zone were debated.

The main anthropogenic pressures were dealt with in extenso in the *Initial Assessment of the Marine Environment State*, pursuant to Article 8 of the Marine Strategy Framework Directive. Thus, at the Romanian Black Sea coast, several economic activities and users of the marine environment, acting directly on it, were identified. The local pressures generating organic substances/pollutants are concentrated in the southern part of the Romanian Black Sea coast, this area being the most developed from the industrial and urban point of view.

* * *

The state and evolution trends of the Romanian marine and coastal environment were monitored in 2012 from the physical, chemical and biological point of view, compared to the reference period of the 1960s and more recent data.

The state of the marine and coastal environment in 2012 confirms the general trend of slight improvement of the monitored parameters.

With the aim of protecting and preserving marine biodiversity, the national and European coherent marine protected area network was developed in 2012, by the designation of 2 new sites: ROSCI0281 Cape Aurora and ROSCI0293 Costineşti - 23 August.

The synthesis of data for 2012, compared to historical data, on the state and evolution trends of the Romanian coastal and marine environment, is part of the "Romanian Environmental Factors State Report".

KEY WORDS: *Black Sea, Romanian coastal area, eutrophication, contamination, biodiversity, endangered species, habitats, protected areas, marine living resources, sustainable development, maritime spatial planning, anthropogenic pressures*

CHAPTER 1
1.1. STATE OF THE BLACK SEA WATERS
1.1.1. STATE OF THE LITTORAL AND COASTAL ZONE

COASTAL PROCESSES

Field measurements were performed during surveys organized together with the Hydrographic Maritime Directorate. The measurements were shoreline surveys using GIS class GPS devices (GeoXH, ProXH, Juno-INCDM) and geodetic GPS devices (Leika GPS - DHM). Field trips were performed approximately during the same period for each section (May-June for Sulina - Ciotica, September for Zăton - Periboina).

Graphic representations generated by measurement results were made with an ArcGIS 9.3/10 system application. The ArcGIS spatial analysis techniques were developed on spatial data representations (GPS data) in a referenced plan/configuration model, which allowed to assess the morphological dynamics of the coastal area, the results being represented/layered to compared data from the two study years.

During the winter of 2012, as a follow-up of low temperatures during January-February along with an exceptional storm, specific ice structures - ice pegs, grouped in ridge steps - developed on the entire area of the beach, continued by ice belts (Fig. 1.1.1.1.-1.1.1.7.). For the Mamaia Bay (shallow waters and low choppiness due to breakwater dams), the ice cap developed up to 200 m offshore, with 1 m thick ice.

Shoreline studies in the northern sector

The field campaign was carried-out south of the Chituc Levee up to the Grăniceri point (the northern parts were unreachable, the levee being flooded). The observations and GPS measurements outlined an ice layer developed in steps on the beach, with a thickness exceeding 1 m, continued by a considerable ice belt (0.7 - 1.0 m). At the date of observations, it was already receding, however considerable widths were estimated. North of the breakwater of the Vadu Fishery, the thickness of the ice layer exceeded the water line due to ice floes being pushed by the NE waves and the longitudinal current formed.

Fig. 1.1.1.1. - North of Vadu Fishery (NIMRD original photo)

Fig. 1.1.1.2. - Beach covered by ice sprinkled with sand (NIMRD original photo)

Fig. 1.1.1.3. - Ice ridges, CSA 7 (NIMRD original photo)

Fig. 1.1.1.4. - Breaking the ice cap (NIMRD original photo)

Fig. 1.1.1.5. - Ice cap (NIMRD original photo)

Fig. 1.1.1.6. - Breaking the ice cap (NIMRD original photo)

Fig. 1.1.1.7. - Ice cap, landmark CSA 8 (NIMRD original photo)

In the delta and lagoon shore area (Fig. 1.1.1.9. and Fig. 1.1.1.10), the following were found:

- Sulina area - shoreline advancement by 7-15 m;
- Gârla Împuțita - Câșla Vădanei - shoreline retreat by 5-10 m, up to 30 m in the Canal Sonda area;
- Sf. Gheorghe - Sachalin - shoreline retreat by 10 up to 20 m in the Sf. Gheorghe area; in the central part of the Sachalin Peninsula, the shoreline retreated by 20 m up to 50 m, accumulation processes being dominant in the south;
- In the Ciotica-Perișor-Gura Portiței area, a relative balance was maintained, with shoreline advancement areas up to 15 m in the Periteașca area;
- Portița-Vadu area: the shoreline retreated by up to 14 m in the Portița Lighthouse area, 15-30 m in the Gura Periboina area, up to 20-40 m in the Edighiol area and up to 40 m in the Chituc Levee area, and advanced by 19-30 m in the Vadu area.

For the northern sector of the coast, the accumulated areas covered ~74 ha, while the eroded areas covered ~153 ha. The shoreline advancement by >10 m was reported on ~12% of the total length, shoreline retreat by >10 m on ~52%, the rest of the coast being in dynamic balance - the shoreline retreated or advanced by less than +/- 10 m (Fig. 1.1.1.8.).

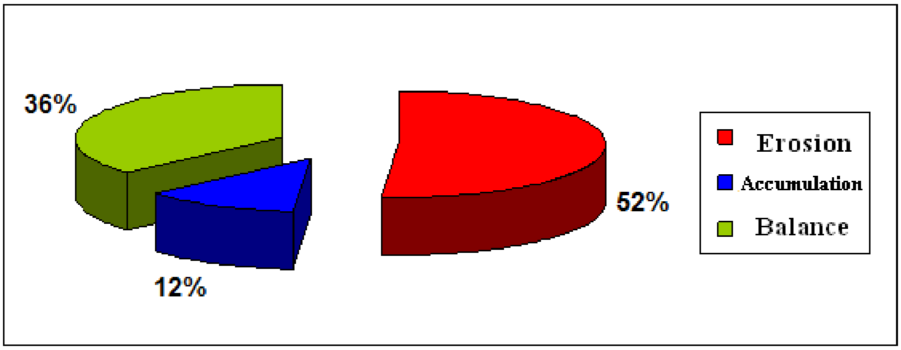


Fig. 1.1.1.8. - Share of coastal processes (erosion/relative balance/accumulation) in the Sulina - Cape Midia shore sector, 2011-2012

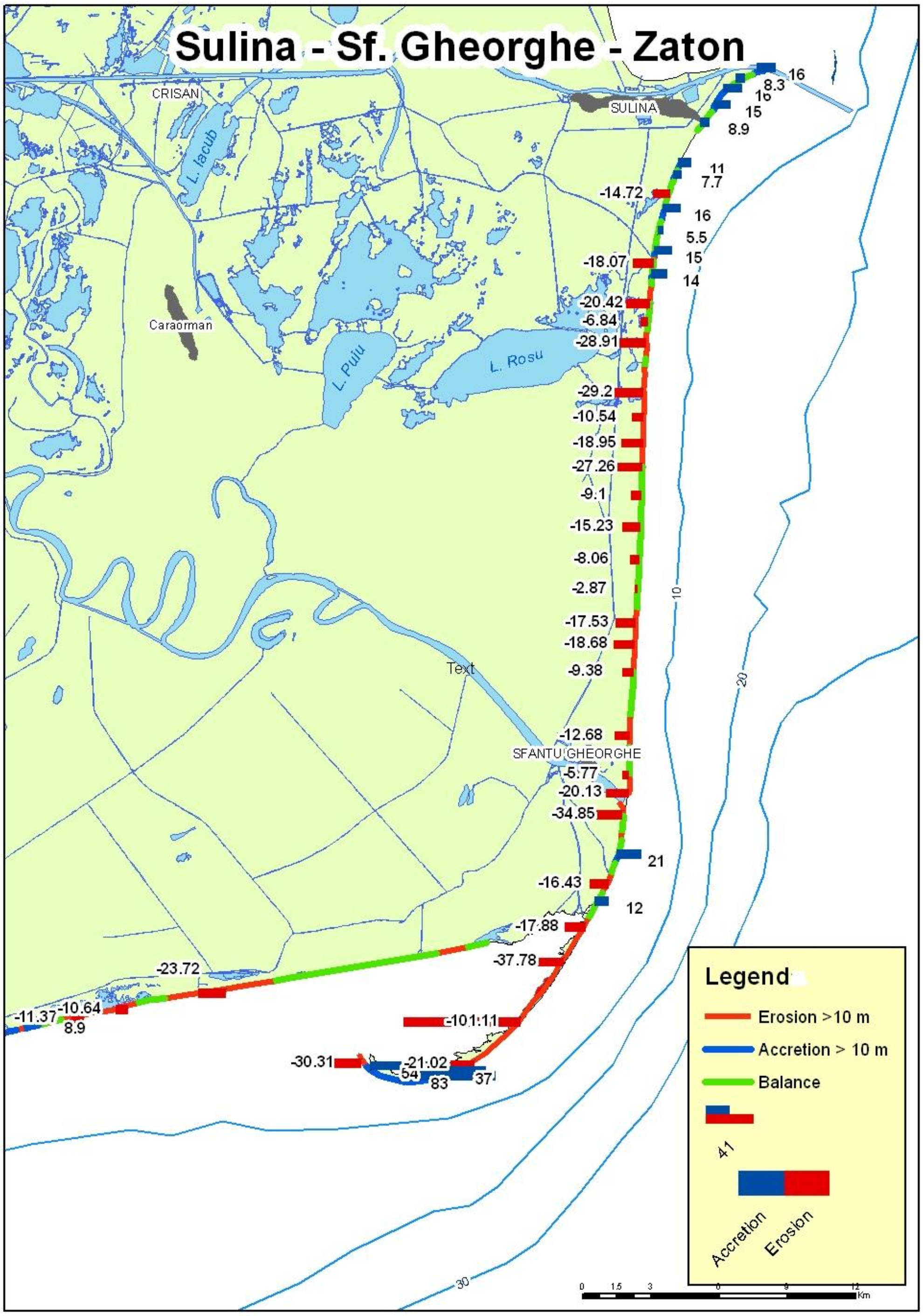


Fig. 1.1.1.9. - Accumulation/erosion 2011-2012

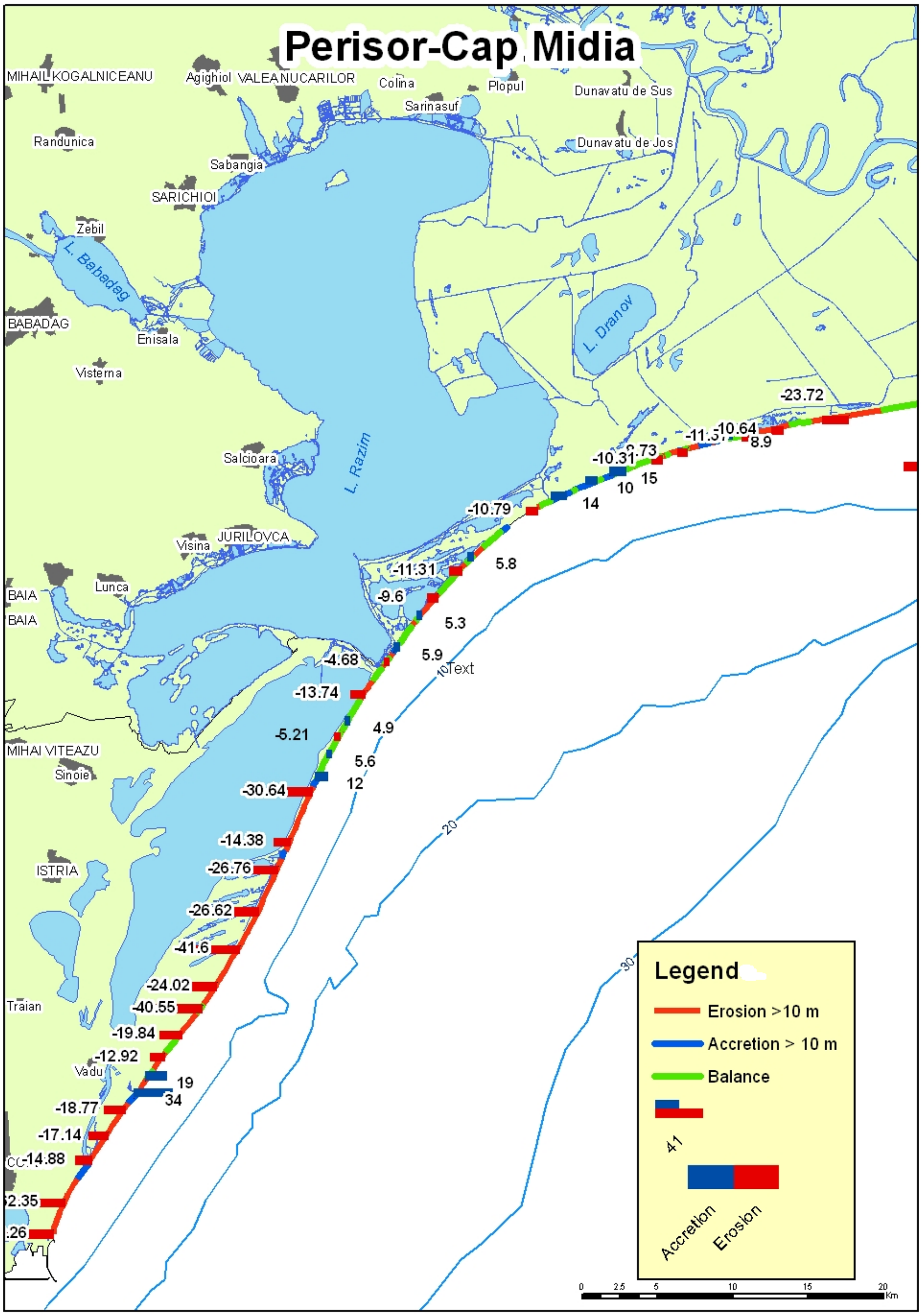


Fig. 1.1.1.10. - Accumulation/erosion 2011-2012

SEA LEVEL

Sea level, as one of the coastal zone state indicators, showed in 2012 three distinct fluctuation stages in relation to the monthly multiannual means (1933-2011).

Thus, during January - April, the level was below the monthly multiannual means, during May to September the values exceeded slightly the monthly multiannual means for these months. In September and October, the monthly multiannual means were almost equal to the monthly multiannual means for these months, while during November and December the monthly multiannual means were again exceeded.

The minimum monthly multiannual mean of 0.7 cm was recorded in March, while the maximum monthly multiannual value of 30.0 cm was recorded in May. The annual mean was 3.3 cm higher that the multiannual mean for 1933-2011.

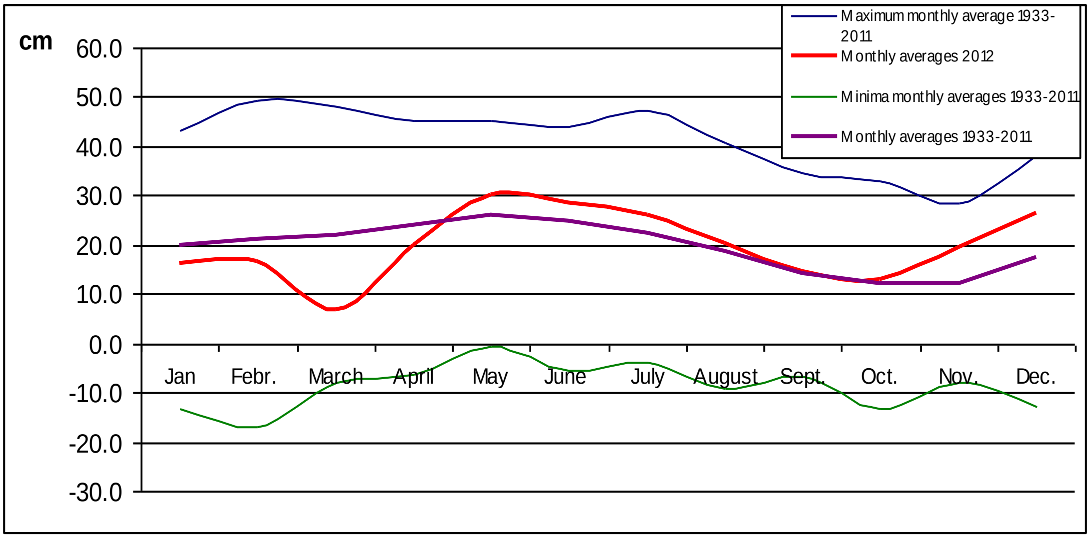


Fig. 1.1.1.11. - Sea level variations at the Romanian coast in 2012

1.1.2. PHYSICAL INDICATORS

The evolution of the main hydrological indicators at the Romanian coast and on the Romanian coastal shelf was determined, in 2012, based on the observations and measurements of parameters such as: sea surface choppiness (daily measurements of the typical wave features in Constanța); seawater temperature [N=188 surface samples collected from the Constanța Station and from the water column collected during two oceanographic surveys (in April, N=73, and in October, N=151), from the network comprising 51 stations located in the Sulina - Vama Veche area]. The network covers all water types included in the Water Framework Directive and the Marine Strategy Framework Directive, as follows: transitional waters - 10 stations (Sulina, Mila 9, Sf. Gheorghe, Portiţa - up to the 20 m isobath, inclusively), coastal waters - 23 stations (Gura Buhaz, East Constanţa, Casino Mamaia, Constanţa North, Constanţa South, Eforie, Costineşti, Mangalia, Vama Veche, up to the 20 m isobath inclusively) and marine waters - 11 stations (all stations in the network located on the 30 m and 50 m isobaths).

The main physical indicators (temperature, salinity, waves) were analyzed, as well as the phenomena characterizing water masses typical for the Western Black Sea: upwelling and littoral zone frost.

Temperature was measured in-situ, using reversible thermometers of the Nansen sample collection equipment and salinity was determined using the Knudsen-Mohr method.

The analysis of upwelling and frost phenomena was based of temperature, air, wind resultant, marine water temperature satellite data of the Giovanni on-line data system, developed and maintained by NASA GES DISC (http://disc.sci.gsfc.nasa.gov/giovanni) and water temperature (NIMRD data).

The data obtained were processed with the Surfer software (trial version), Excel 2007.

SEA STATE

Sea state. The almost fully meridian orientation of the Romanian coast and its bathymetric features enable an enhancement of the sea state, by waves caused by the wind, acting in a sector covering about 180° between the N and S of the right side of the meridian, depending on the duration and intensity thereof.

The results of measurements during 01.01.2012-31.12.2012 (N = 494 observations), made daily at three intervals, in Constanța, compared to the reference period (1971-2011), were analyzed. In 2012, marine choppiness was weak in June (7.53%) and March (9.68%), with waves caused by the wind, and moderate during the other months (except for July, with a peak of 43.01%), when wave frequency did not exceed 27%. This estimation also considered the height of waves exceeding 1.25 m. The maximum degree of sea choppiness, on the Beaufort scale, was 5-7 (wave height 6.5 m) and was recorded in February (Fig. 1.1.2.1. and Table 1.1.2.1.). During this months, although the mean wind speed was only 2.48 m/s, there was a stormy period (7-8 February 2012), during which wind speed in Constanța reached 12-20 m/s nort-east and gales up to 30 m/s on the Gloria Platform (www.wunderground.com). Compared to the reference period, a maximum of ~6 m wave height was recorded in January 1981. Their distribution on propagation directions is determined by the distribution of dominant winds and the general orientation of the shoreline, respectively. As such, 43.83% of waves caused by the wind are dispersed from the N, NNE and NE (cold season), while, due to stronger refraction at higher wave lengths, 9.6% of the surge (April) was dispersed from the SSE (Fig. 1.1.2.2).

The mean annual evolution of calm periods (wave height smaller than 0.1 m) showed that the duration of sea calmness is maximum in March, June and October, and the minimum was reported in July (Table 1.1.2.1.)

Table 1.1.2.1. - Wave features in Constanța, during January - December 2012

Month	*01*	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*	*11*	*12*
Hmax. (m)	5.0	6.0	0.6	1.7	1.2	0.7	2.0	1.0	1.5	1.0	2.00	5.50
Hmin. (m)	0.4	0.5	0.4	0.4	0.5	0.5	0.3	0.5	0.4	0.4	0.50	0.50
Hmean (m)	**1.84**	**2.04**	**0.54**	**0.65**	**0.76**	**0.53**	**0.81**	**0.71**	**0.74**	**0.63**	**0.99**	**2.00**
Tmax. (s)	6.2	8.90	5.3	7.2	4.4	3.8	4.7	4.1	5.2	6.5	7.00	7.80
Tmin. (s)	3.2	3.3	3,2	3.2	3.3	3.3	3.3	3.3	3.3	3.4	3.50	3.90
Tmean (s)	**4.41**	**4.85**	**3.62**	**3.88**	**3.78**	**3.41**	**3.73**	**3.64**	**3,87**	**4.44**	**4.67**	**5.87**
0-0.1m (%)	**40.86**	**35.63**	**60.22**	**43.33**	**46.24**	**58.06**	**27.96**	**52.69**	**38.71**	**59.14**	**37.63%**	34.41%
Wind wave (%)	**26.88**	**20.69**	**9.68**	**19.36**	**21.51**	**7.53**	**43.01**	**18.28**	**23.66**	**13.98**	**23.66%**	17.20%
Sea swell (%)	**1.08**	**2.30**	**1.08**	**2.22**	**0.00**	**0.00**	**0.00**	**0.00**	**2.15**	**1.08**	**4.30%**	**5.38%**
No data (%)	31.18	42.53	29.03	34.44	32.26	34.41	29.03	29.03	35.48	25.81	34.41%	43.01%

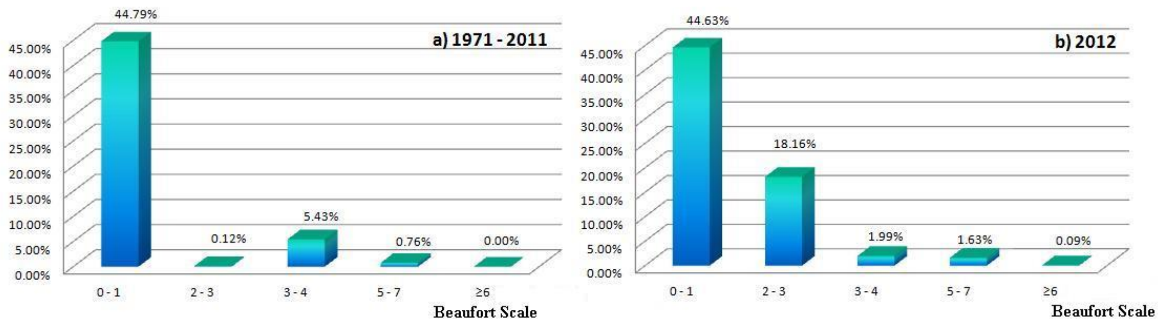


Fig. 1.1.2.1. - Sea state during January - October 2012 (Beaufort Scale)

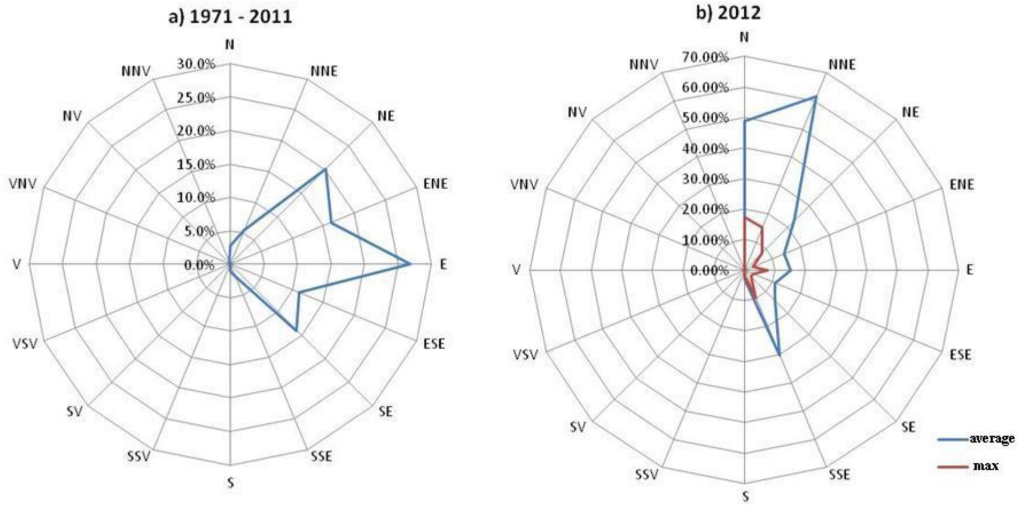


Fig. 1.1.2.2. - Wind rose in Constanța during a) the reference period (1971 - 2011) and b) 2012

SEAWATER TEMPERATURE

Temperature. The evolution of temperature in the active layer is determined by the periodical changes of the thermal balance at the air-water interface, while in deeper layers the vertical distribution is maintained by the geothermal flow.

Seawater temperature in Constanța, throughout the 12 months of the analyzed period, was 1.57°C higher than the reference period (1959 - 2011) (Fig. 1.1.2.3.) The monthly means varied between -0.9°C, in February (daily minimum -3.0°C on 22 February) and 24.9°C in July (daily maximum 28.6°C on 29 July), predictably given the air temperature evolution. Compared to the multiannual situation, the means in Constanța were lower during the first semester (January-April) and equal to or higher during the other half of the year (Fig. 1.1.2.3. b)

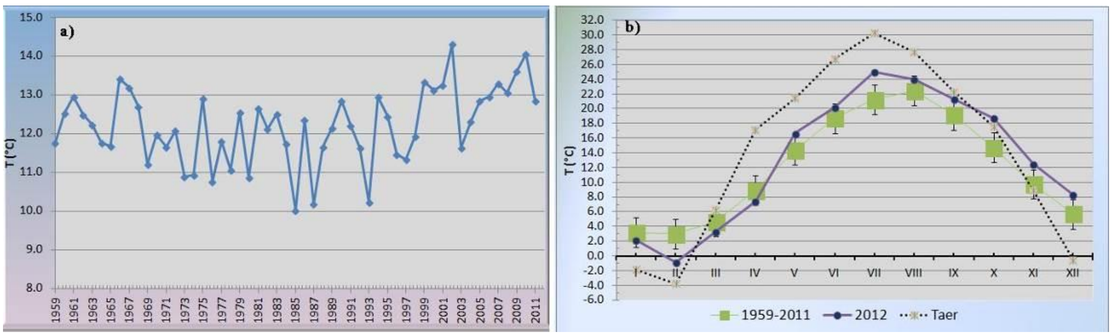


Fig. 1.1.2.3. - Compared situation of the multiannual (a) and annual (b) means of seawater temperature in Constanța, during 1959 - 2011 and 2012

Along the western Romanian Black Sea continental shelf, in the entire water column, the seawater temperature ranged between 3.1°C and 21.0°C. The minimum values were recorded in March, at 10 m depth, regardless of the water body analyzed, in accordance with air temperature (Table 1.1.2.2.).

Table 1.1.2.2. - Main seawater temperatures of the Romanian Black Sea along the Romanian coast in 2012

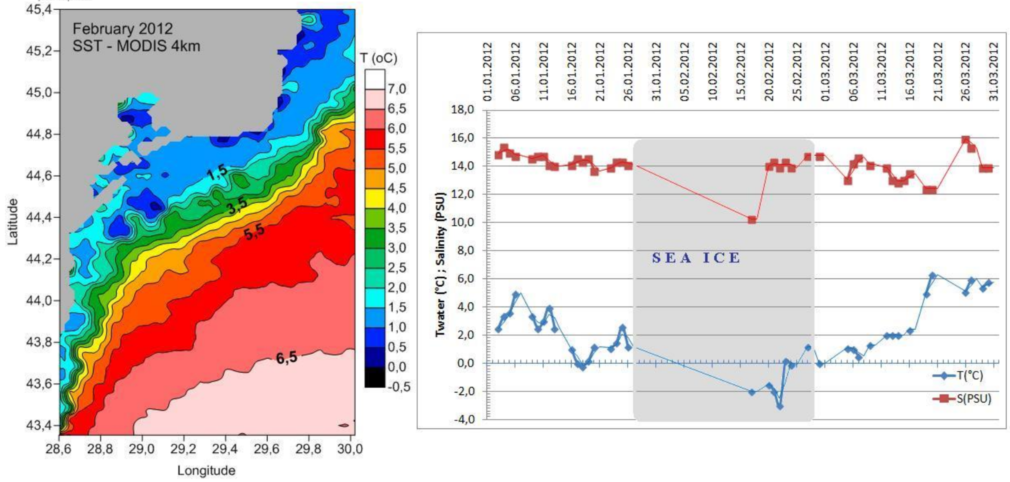
Water body type	No. of samples	Min. (°C)	Station	Month	Max. (°C)	Station	Month	Median (°C)	St. Dev. (°C)
Transitional waters	60	**3,1**	Portița 20 m (10 m)	March	**20.4**	Portița 20 m (0 m)	October	13.1	6.2
Coastal waters	74	**6,0**	Constanța S 20 m (20 m)	April	**20.87**	Costinești 20 m (0 m)	October	9.5	6.5
Marine waters	88	**3,3**	Portița 30 m (10 m)	March	**21.0**	Portița 40 m (20 m)	October	8.7	6.9

*The values between brackets are the water column depths

SEA ICE

Sea ice. It must be noted that the frost phenomenon of marine water in the coastal zone is not periodical, the time frame between two occurrences varying between 13 years (1972-1985) and a single year (1985-1986, 1986-1987, 2010-2011). The spatial extent also varies greatly, from ice bridges a couple of tens of metres wide, during 1928-1929, 1953-1954 and 1995-1996 (when the sea froze up to the visible horizon and ice was up to 2 m thick), to ice caps covering the entire visible horizon (1972, 1987).

In the winter of 2012, late January and early February, water temperature remained below freezing limit (-0.8°C), which led to the formation of an ice bridge approx. 300 m wide from the shore (on 3 February), given the evolution of air temperature (Fig. 1.1.2.4.a). Due to relatively low salinity, low temperatures in winter, the fresh water input from the Danube, ice was formed in the western part of the Romanian Black Sea coastal zone.

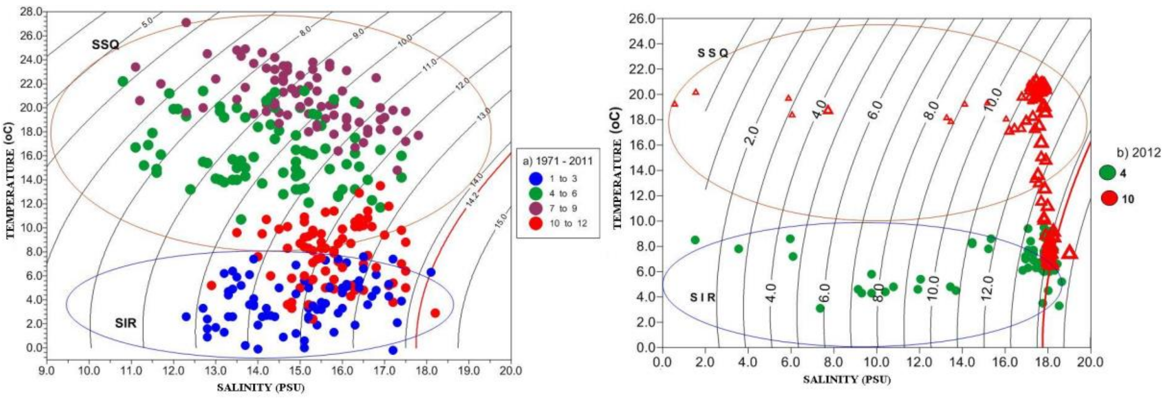


a) **b)**

Fig. 1.1.2.4. - a) Seawater temperature at surface, monthly means MODIS SST - Level 3 resolution 4 km (http://oceancolor.gsfc.nasa.gov/); b) seawater temperature and salinity in Constanța (January - March 2012)

Water masses. The vertical distribution of temperature depends on the thermal regime of the atmosphere and the dynamic factors of the sea (currents and waves), which cause the mixing of water masses. The intensive mixing of water usually reaches 100-150 m in depth and only seldom 200 m. The water column has three obvious layers in the western part of the Black Sea, where the maximum depth reaches 50 m and the salinity is typical for an estuary (Fig. 1.1.2.5. a and b). In the upper quasi-homogenous layer (UQH), the spatial distribution of salinity is variable and depends on the local circulation and the Danube flow variations (Fig. 1.1.2.5. a and b, Fig. 1.1.2.6.).

In winter, the almost linear increase of temperature and salinity along with depth were pointed-out, when the upper layer simply disappears and the T-S chart represents the mixture of only two water masses (Fig. 1.1.2.4. a).



a) **b)**

Fig. 1.1.2.5. - Seasonal T-S chart in the western part of the Black Sea: a) 1971 - 2011; b) 2012

The subsequent warming separates the upper layer waters from cold waters by means of a high gradient density layer (seasonal thermocline), which impedes mixing and thermally insulates bottom waters, which maintain low temperatures (Fig. 1.1.2.6.).

The 18 isohaline marks, at the surface of water, the front between coastal and central waters (Fig. 1.1.2.5. a, 1.1.2.6.). according to the T-S diagram, in spring (4^{th} month), the salinity trend of marine waters, throughout the Romanian continental shelf, is to drop (Fig. 1.1.2.5. b) and the volume of the continental cold water upper limit to grow (Fig. 1.1.2.6. April). Water temperature in the upper mixed layers during the warming period (spring) showed low monthly mean values - 7.4°C (Fig. 1.1.2.7. b).

Later (in October), the drop of Danube freshwater input and the continuation of the cooling cause the deepening of the thermocline. The cold water layer (Twater=8°C) is homogenous in autumn, reaching depths bigger than 25 m, yet the mean values of the upper mixed layer (0-20 m) are higher compared to the reference period 1971 - 2011 (Fig. 1.1.2.5., Table 1.1.2.2.).

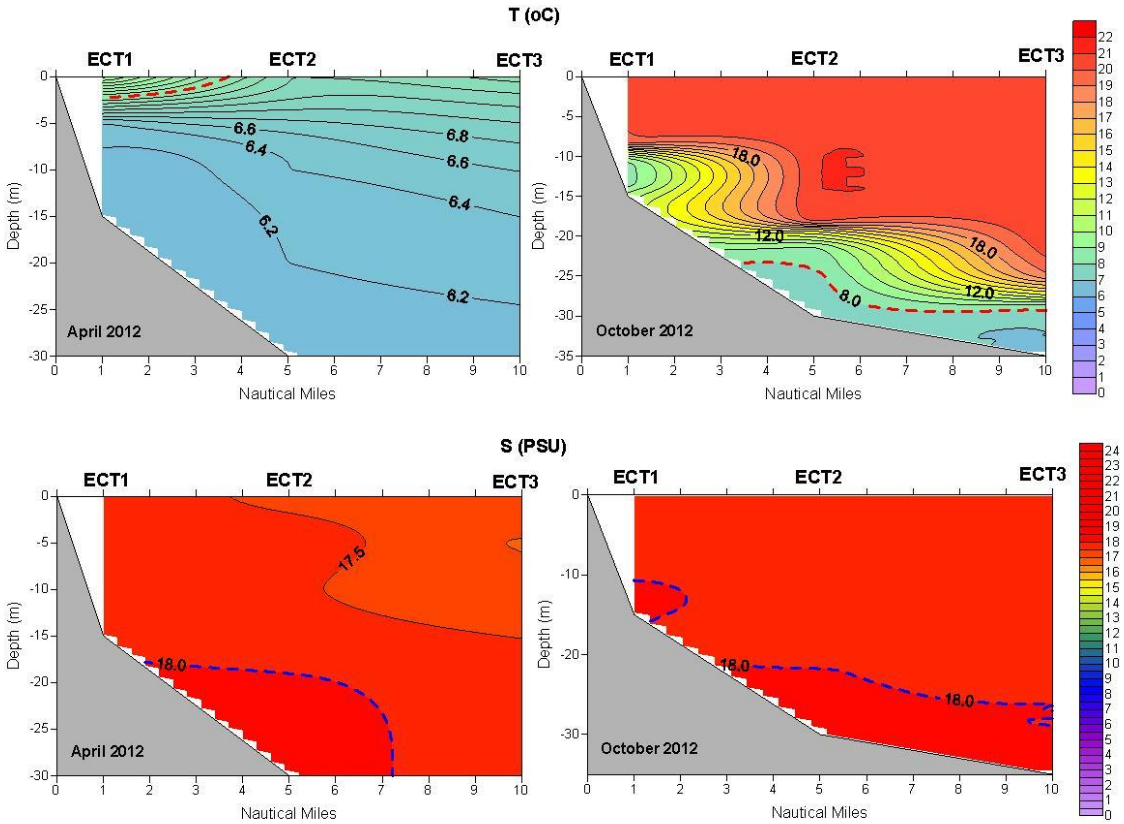


Fig. 1.1.2.6. - Vertical distribution of water masses in 2012, East - Constanța profile

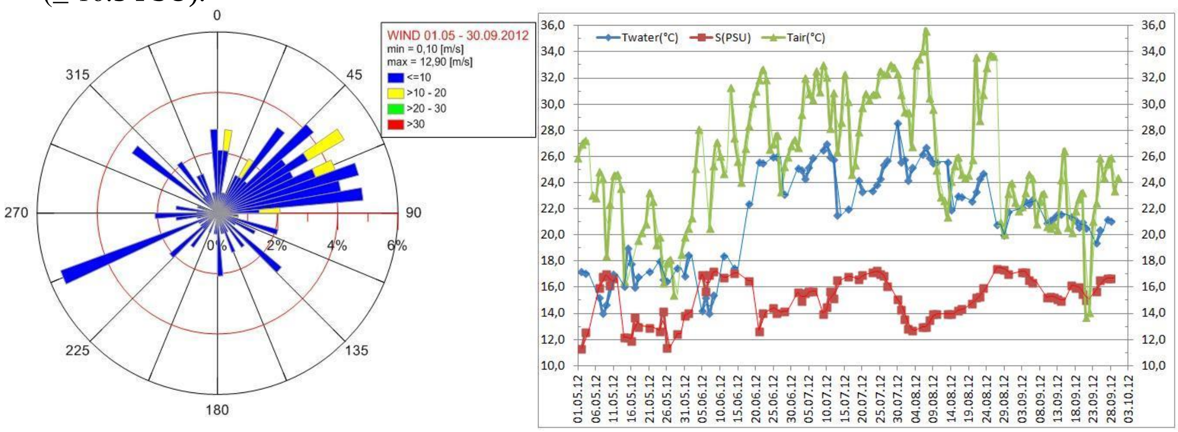
UPWELLING PHENOMENA

The coastal upwelling process, driven by the western and south-western winds, causes the raise of deep water masses (low temperature and high salinity), favoring algal blooms due to nutrient input.

In the Constanța station, three upwelling phenomena lasting more than 15 days were recorded (Fig. 1.1.2.7. a), when the minimum temperature dropped by up to 4.3°C, under the influence of dominant western and south-western winds.

During 2-15 May, the value recorded by seawater temperature near shore dropped by approximately 1°C (from 15.2°C on 7 May to 14°C on 8 May) and the salinity increased from 12.57 PSU on 3 May to 16.82 PSU on 8 May), under the action of western winds, blowing with 3 m/s speed (Fig. 1.1.2.7. b). The monthly mean of temperature was 2.3°C below the multiannual mean and the salinity above the multiannual mean by 0.35 PSU (Fig. 1.1.2.3). A similar situation was also reported in June, yet the upwelling phenomenon was less intense (1-11 June), with temperature drops by up to 4.3°C in 4 days and salinity increase by 2.92 PSU (Fig. 1.1.2.7. a). The monthly water temperature mean was lower than the usual temperature (1959-2011, Fig. 1.1.2.3. b) by 0.35°C.

The dominant action of south-western wind (Fig. 1.1.2.8.), with speeds ranging from 0.66 m/s (25 November) up to 5.6 m/s (28 November) caused the emergence of an autumn upwelling process, lasting for 9 days (25 November - 3 December). The multiannual mean water temperature during the reference period (1953 - 2011) was characteristic for November (9.7°C), compared to the monthly mean of 2012 (12.5°C). Water temperature dropped by approximately 0.8°C and salinity increased by ~ 3.22 PSU during 48 hours (26-28 November 2012). The influence of this phenomenon on littoral waters was significant on 29 November, by high values of silicates (34.2 µM) and salinity typical for very deep waters (≥ 16.5 PSU).



a) b)

Fig. 1.1.2.7. - Evolution of a) wind rose during May - September 2012
b) water temperature and salinity in Constanța

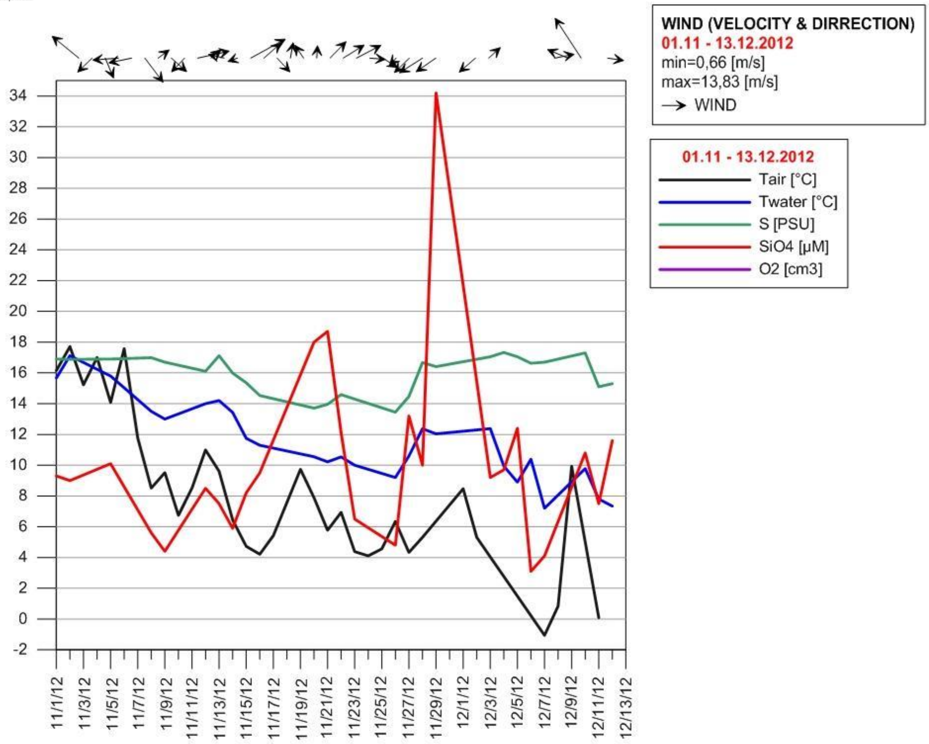


Fig. 1.1.2.8. - Evolution of air temperature, marine water temperature, salinity, silicates and winds in Constanța during 1 November - 13 December 2012

CONCLUSIONS

Marine water temperature in 2012 was 1.57°C higher compared to the reference period (1959-2011).

For the western part of the Black Sea, three characteristic water masses were pointed-out: the upper quasi-homogenous layer (UQH), the intermediate cold layer (ICL) and the seasonal thermocline. In autumn (October), the intermediate cold layer reaches depths beyond 25 m.

The sea choppiness degree is due to the frequency of waves higher than 1 m. From this point of view, the maximum height of 6.00 m was reported in February, while the predominantly calm, wavy and rippled sea periods were reported in March, June and October.

The frost phenomenon occurred in the winter of 2012 in the last decade of January and the first decades of February, when littoral zone temperatures dropped below freezing point (-0.8°C).

During summer, three upwelling phenomena were recorded in the coastal area (May and June), caused by the dominant western and south-western winds.

1.1.3. PHYSICAL-CHEMICAL INDICATORS

The physical-chemical indicators investigated in 2012, with the aim of monitoring the quality of transitional, coastal and marine waters of the Romanian Black Sea coast, were obtained as a follow-up of analyzing 144 waters samples from the surface and the water column (0-50 m) collected during two surveys (in April, N = 70, and in October, N = 74) from the network comprising 35 stations located between Sulina and Vama Veche. The network covers all water body types comprised in the Water Framework Directive and Marine Strategy Framework Directive, namely:

- ***Transitional waters*** - 8 stations (Sulina, Mila 9, Sf. Gheorghe, Portiţa - up to the 20 m isobath inclusively);
- ***Coastal waters*** - 18 stations (Gura Buhaz, East Constanţa, Casino Mamaia, Constanţa North, Constanţa South, Eforie, Costineşti, Mangalia, Vama Veche, up to the 20 m isobath inclusively) and
- ***Marine waters*** - 9 stations (all stations in the network located on the 30 m and 50 m isobaths).

The long-term statistical analysis was performed based on 189 daily samples collected in 2012 from the Casino Mamaia 0 m station and historical data (1959/1976/1980 - 2011) for the same sampling site.

The main physical-chemical and state indicators which characterize and regulate the eutrophication level were analyzed, namely: transparency, salinity, pH, dissolved oxigen, anorganic nutrients.

Salinity was measured in situ using the CTD. Dissolved oxygen was determined by the Winkler method. pH was measured using the potentiometric method. Transparency was measured in situ using the Secchi disc. Nutrients in seawater were quantified by analytical spectrophotometric methods, internally validated in the laboratory complying with the quality system pursuant to SR EN ISO/IEC 17025:2005 and using as reference the manual "Methods of Seawater Analysis" (Grasshoff, 1999). The detection limits and the extended relative uncertainties, k = 2, coverage factor 95.45% are given in Table 1.1.3.1. The UV-VIS Shimadzu spectrophotometer, measuring range: 0-1,000 nm, was used to perform measurements.

Table 1.1.3.1. - Detection limits and the extended relative uncertainties for the determination of nutrient concentrations in seawater

Ref. no.	Measured parameter	MU	Detection limit ($\mu mol/dm^3$)	Relative uncertainty, U (c), Extended (%), k=2, coverage factor 95.45%
1.	$(NO_3)^-$	µM	0.12	8.4
2.	$(NO_2)^-$	µM	0.03	6.6
3.	$(NH_4)^+$	µM	0.12	7.1
4.	$(PO_4)^{3-}$	µM	0.01	14.0
5.	$(SiO_4)^{4-}$	µM	0.30	3.3

The data were processed using the Ocean Data View version 4.5.3 (Schlitzer, 2013) and Excel 2010 softwares.

TRANSPARENCY

Transparency (N=36) ranged between 0.3 - 12.0 m *(mean 5.67 m, median 4.8 m, standard deviation 3.8 m)*. Both extremes were recorded in April, as follows: the minimum in Sulina 10 m, in transitional waters under the direct influence of river input, and the maximum in Vama Veche 20 m, in marine waters (Table 1.1.3.2.). In transitional and marine waters in the northern part of the coast, the minimum values are below 2 m, the allowed value both for ecological state and the impact area of anthropogenic activity stipulated in Order no. 161/2006 - "Regulation for the classification of surface water quality with the view to establishing the ecological state of water bodies".

Table 1.1.3.2. - Main statistical values of water transparency at the Romanian coast - 2012

Water body type	No. of samples	Min. (m)	Station	Month	Max. (m)	Station	Month	Median (m)	St. Dev. (m)
Transitional waters	10	**0.3**	Sulina 10 m	April	**10.5**	Portiţa 20 m	October	2.0	2.9
Coastal waters	14	**3.5**	C-ța South 5 m	April	**12.0**	Vama Veche 20 m	April	7.3	2.6
Marine waters	12	**1.1**	Sf. Ghe. 30 m	April	**11.5**	Costinești 30 m	April	7.5	4.4

The distribution of transparency medians and standard deviations pointed-out the lowest values in transitional waters, as well the high variability range of marine waters, which, in the northern area, are under direct river input influence, as far as the 30 m isobath (Fig. 1.1.3.1.).

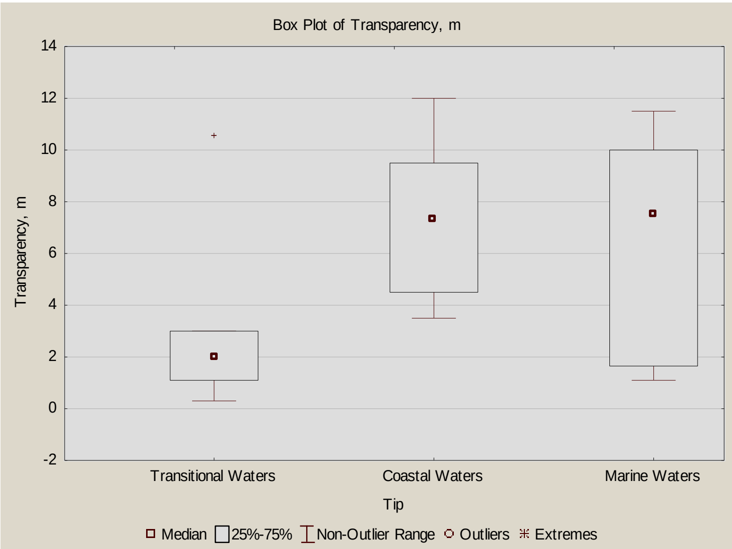


Fig. 1.1.3.1. - Seawater transparency (m) at the Romanian coast - 2012

SALINITY

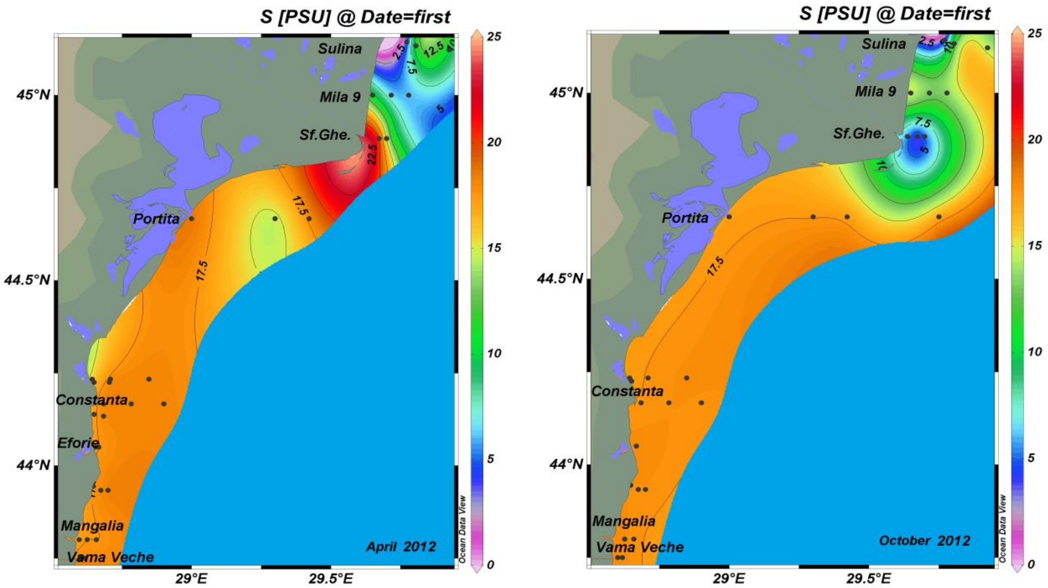
The **salinity** of Romanian coastal waters ranged between 0.56 - 24.22 PSU (*mean 16.19 PSU, median 17.67 PSU, standard deviation 3.80 PSU).* The minimum values were determined in surface waters, as a follow-up of freshwater river or anthropogenic input. As a consequence of a droughty year, the maximum value was recorded in transitional waters in the north (Table 1.1.3.3.).

Table 1.1.3.3. - Main salinity statistical values of seawater along the Romanian coast - 2012

Water body type	No. of samples	Min. (PSU)	Station	Month	Max. (PSU)	Station	Month	Median (PSU)	St. Dev. (PSU)
Transitional waters	26	**0.56**	Sulina 10 m (0 m)*	October	**24.22**	Sf. Ghe. 20 m (0 m)	April	15.19	6.02
Coastal waters	51	**15.34**	C-ţa South 20 m (0 m)	April	**18.43**	Mangalia 20 m (10 m)	April	17.81	0.48
Marine waters	56	**3.55**	Sulina 30 m (0 m)	April	**18.64**	Sf.Ghe. 30 m (30 m)	April	17.61	3.55

*The values between brackets are the water column depths

The space distribution of salinity along the Romanian coast shows the increasing gradient from the Danube mouths towards the southern area, regardless of the season. Due to a smaller river input, the influence area was much narrower in 2012 (Fig. 1.1.3.2.).



(a) **(b)**

Fig. 1.1.3.2. - Horizontal distribution of surface water salinity in April (a) and October (b) 2012 along the Romanian coast

The study of salinity distribution pointed-out as outliers the low values recorded in the northern part of the coast, due to river input and wind and wave regime, in marine waters (Fig. 1.1.3.4.)

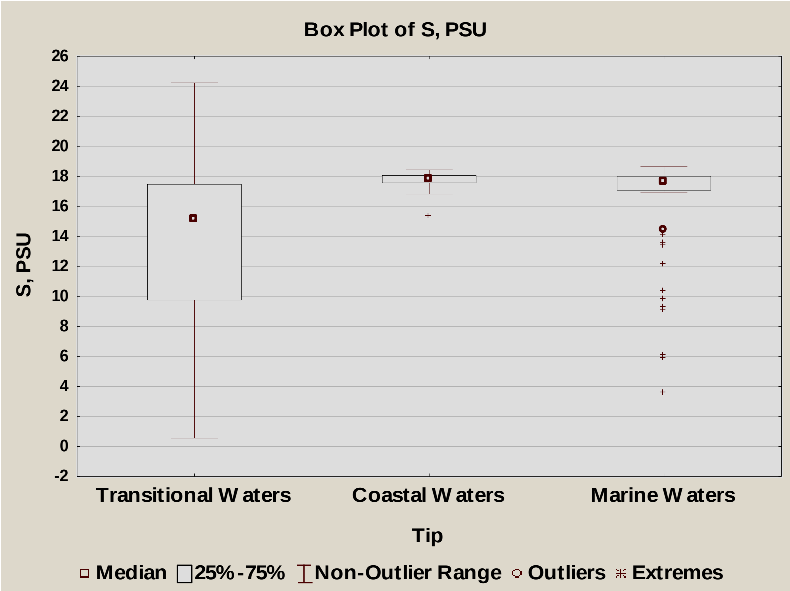
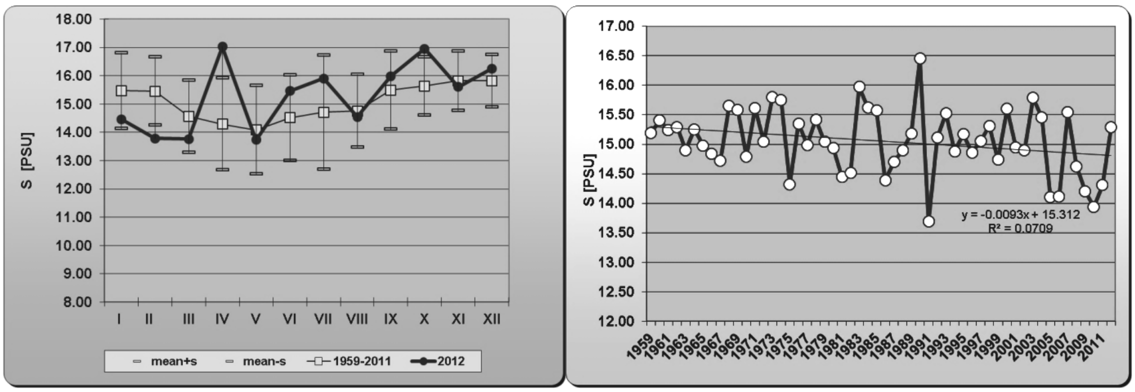


Fig. 1.1.3.3. - Salinity distribution along the Romanian coast - 2012

On the long-term, the monthly means in 2012 differ **insignificantly** from those recorded during 1959-2011 *(t test, confidence interval 95%, p=0.5452, t=0.6144, df=0.22, standard deviation of the difference = 0.3912)*. In 2012, the absolute minimum of salinity in Constanța was 10.27 PSU (17 February) and the absolute maximum 17.82 PSU (1 October).



(a) **b)**

Fig. 1.1.3.4. - The comparative situation of multiannial (a) and annual (b) seawater salinity during 1959-2011 and 2012

Within a decreasing trend by approximately 0.009 PSU/year for the period 1959-2011, the annual salinity mean of 2012 (15.29 PSU) frames within the variability range of the period 1959-2011 (Fig. 1.1.3.4.)

pH

The **pH** of coastal waters in the Constanța area recorded absolute values ranging between 7.92 in February and 8.60 in April (mean 8.28, median 8.17, standard deviation 0.13). The monthly pH means during 1998-2011 and 2012 differ **insignificantly** *(t test, confidence interval 95%, p=0.8014, t=0.2546, df=22, difference std. dev. = 0.033)* (Fig. 1.1.3.5.).

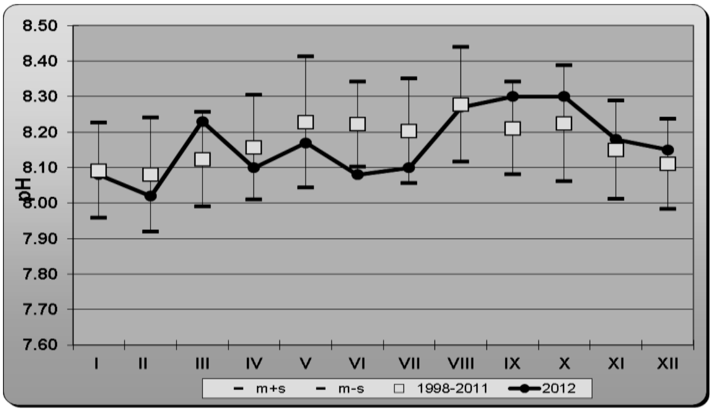


Fig. 1.1.3.5. - pH values in coastal waters in the Constanța area (1998-2011 and 2012)

In April and October 2012, the pH of Romanian Black Sea waters ranged within normal values in the water column 7.64 - 8.74 (*mean 8.28, median 8.31, standard deviation 0.20)*, being correlated significantly with salinity (r = 0.73), oxygen saturation (r = 0.57), phosphate concentration (r = - 0.87), silicate concentration (r = - 0.79), nitrate concentration (r = - 0.73) and ammonia concentration (r = - 0.86) (Fig. 1.1.3.6.)

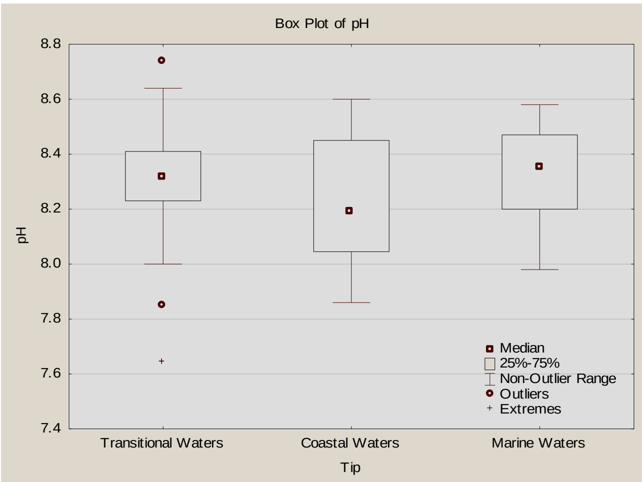


Fig. 1.1.3.6. - pH values of Black Sea waters at the Romanian coast in 2012

DISSOLVED OXYGEN

At the Romanian coast, dissolved oxygen concentrations ranged between 129.7 µM (2.91 cm^3/L) and 577.9 µM (12.94 cm^3/L) *(mean 300.3 µM - 6.72 cm^3/L (6.72 cm^3/L), median 293.6 µM (6.57 cm^3/L), standard deviation 77.3 µM (1.73 cm^3/L))*. All minimum values were recorded during the late summer season, at the water-sediment interface (Table 1.1.3.4.).

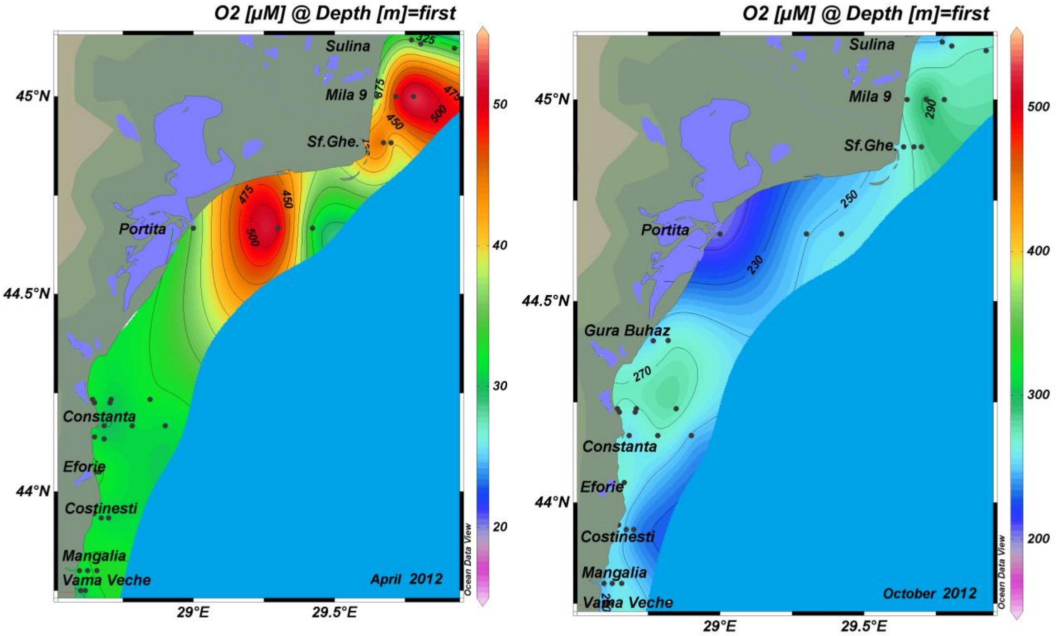
From the spatial point of view, surface waters were well-oxygenated both under the influence of atmosphere exchanges and the intensity of spring photosynthesis (Fig. 1.1.3.7.).

In October, at the end of the warm season, low saturation values were recorded (38.5% - 77.8%), mainly in the north and center of the coast, values below the allowed limit (80%) both for ecological state and the impact area of anthropogenic activity. They were reported in the water column, as a follow-up of water mass layering and oxygen consumption in the oxidative decay process of organic matter (Fig. 1.1.3.8.).

Table 1.1.3.4 - Main values of dissolved oxygen concentrations in Romanian Black Sea waters - 2012

Water body type	**No. of samples**	**Min. (µM/** cm^3/L**)**	**Station**	**Month**	**Max. (µM/** cm^3/L**)**	**Station**	**Month**	**Median µM/** cm^3/L	**St. Dev. µM/** cm^3/L
Transitional waters	30	**129.7**	Sf.Ghe. 20 m (20 m)*	October	**531.5**	Mila 9 20 m (0 m)	April	304.3	112.4
		2.91			**11.90**			6.81	2.52
Coastal waters	59	**144.6**	Casino 20 m (20 m)	October	**339.9**	Casino 20 m (10 m)	April	286.7	37.9
		3.24			**7.61**			6.42	0.85
Marine waters	51	**148.1**	Sf. Ghe. 30 m (28 m)	October	**577.9**	Portiţa 30 m (0 m)	April	312.6	82.9
		3.32			**12.94**			6.99	1.86

*The values between brackets are the water column depths



(a) (b)

Fig. 1.1.3.7. - Horizontal distribution of dissolved oxygen in Romanian Black Sea waters in April and October - 2012

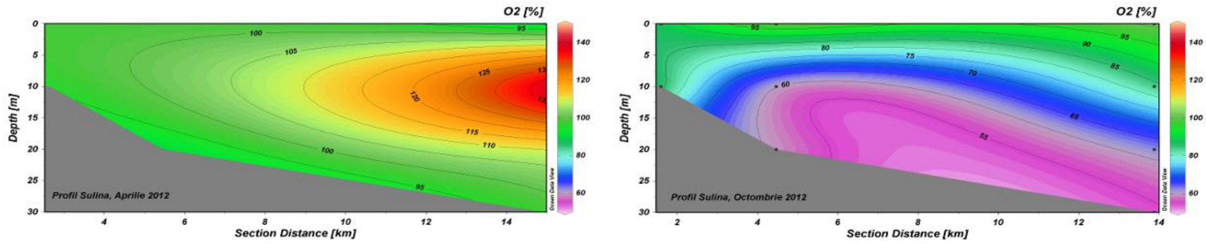
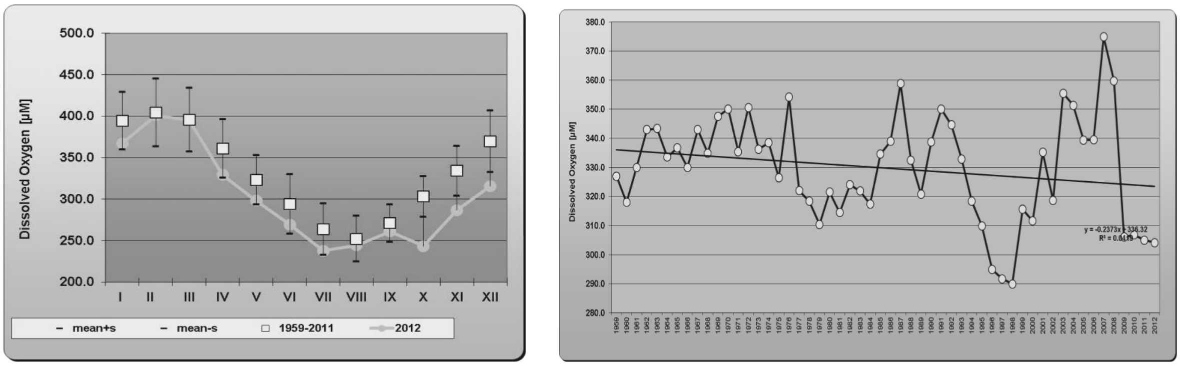


Fig. 1.1.3.8. - Vertical distribution of oxygen saturation (%) in seawater - Sulina profile, 2012

On the long-term, although in the warm season a drop trend of monthly means compared to the characteristic range of the area was recorded, the multiannual means during 1959-2011 and 2012 differ insignificantly (t test, confidence interval 95%, $p=0.2650$, $t=1.1438$, $df=22$, difference st. dev. = 23.04). As such, the lower values can be due to the natural variability of the Constanța coastal zone, as well as due to very good negative correlation with temperature ($r = -0.88$) (Fig. 1.1.3.9.a)



(a) **(b)**

Fig. 1.1.3.9. - Comparative situation of multiannual (a) and annual (b) means of seawater dissolved oxygen concentrations in Constanța, during 1959-2011 and 2012

The long-term annual means of the period 1959-2011 range between 289.9 µM (1998) - 374.9 µM (2007), the mean of 2012 was 304.1 µM. The evolution of annual means points-out that the dissolved oxygen concentrations maintained the decreasing trend of the past years (Fig. 1.1.3.9.b)

1.1.4. EUTROPHICATION INDICATORS
1.1.4.1. NUTRIENTS

PHOSPHATES

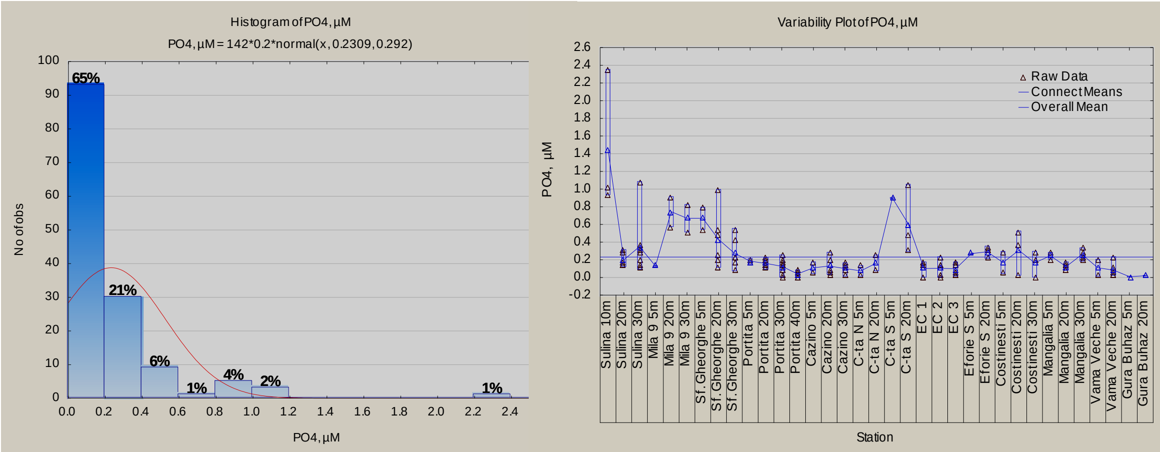
The concentrations of **phosphates, $(PO4)^{3-}$,** recorded in April and October 2012 values ranging between "undetectable" and 2.35 µM (*mean 0.23 µM, median 0.15 µM, standard deviation 0.29 µM*). 35% of the values were below the detection limit of the method (0.01 µM), all outside the influence area of the Danube (Table 1.1.4.1.1. and Fig. 1.1.4.1.1.a).

Table 1.1.4.1.1. - Main phosphate concentration values in Romanian Black Sea waters - 2012

Water body type	No. of samples	Min. (µM)	Station	Month	Max. (µM)	Station	Month	Median (µM)	St. Dev. (µM)
Transitional waters	27	**0,10**	Portița 20 m (20 m)	October	**2.35**	Sulina 10 m (0 m)*	October	0.22	0.49
Coastal waters	59	**<LOD**	35% of values, N=50	October	**1.05**	C-ța South 20 m (0 m)	April	0.12	0.19
Marine waters	58	**<LOD**		October	**1.08**	Sulina 30 m (0 m)	October	0.14	0.19

*The values between brackets are the water column depths

All maximum values were reported at the surface, in stations under the influence of Danube input or of the Constanța urban area (Fig. 1.1.4.1.1.b).



(a) **(b)**

Fig. 1.1.4.1.1. - Phosphate concentration value distribution (a) and spatial variability (b) in Romanian Black Sea waters - 2012

With 93% of the values below 0.60 µM, phosphate concentrations at the Romanian coast showed, during the studied period, values close to the reference period of the 1960s (Fig. 1.1.4.1.2.).

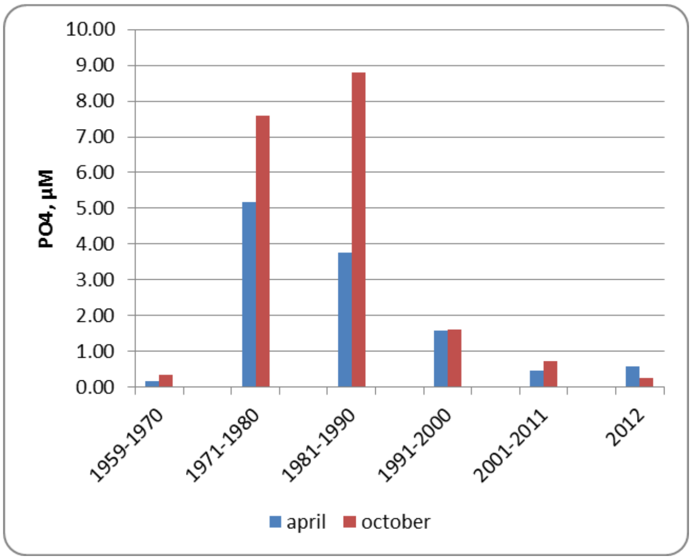
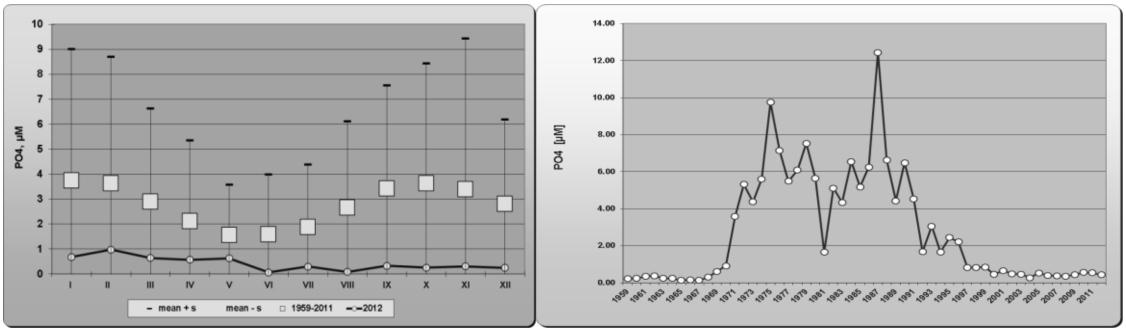


Fig. 1.1.4.1.2. - Comparative situation of monthly multiannual means (April and October) of phosphate concentrations in surface waters along the Romanian Black Sea coast - 1959-2012

The monthly means of 2012 differ significantly (*t test, confidence interval 95%, p<0.0001, t=9.4596, df=22, difference std. Dev.=0.248*) from the multiannual means, 1959-2011, due to the low values recorded in 2012 (Fig. 1.1.4.1.3.a).



(a) **(b)**

Fig. 1.1.4.1.3. - Compared multiannual (a) and annual (b) monthly means of phosphate concentrations in seawater in Constanța during 1959 - 2011 and 2012

During 1959-2011, the anual mean phosphate concentrations ranged between 0.13 µM (1967) - 12.44 µM (1987) (*median 0.89 µM, standard deviation 2.95 µM*), noting a drop of phosphate concentrations starting with 1987. The mean value of 2012, 0.43 µM, is within the characteristic range of the reference period of the 1960s (Fig. 1.1.4.1.3.b)

NITRATES

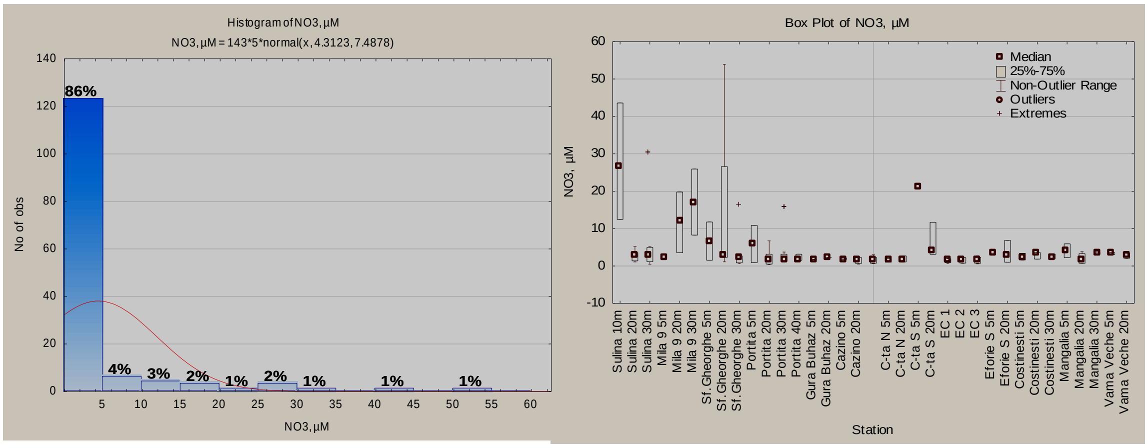
Nitrate concentrations, $(NO_3)^-$, recorded, during the studied period, values ranging between 0.34 - 53.93 µM (*mean 4.28 µM, median 2.23 µM, standard deviation 7.44 µM*) (Table 1.1.4.1.2.).

Table 1.1.4.1.2. - Main nitrate concentration values in Romanian Black Sea waters - 2012

Water body type	No. of samples	Min. (µM)	Station	Month	Max. (µM)	Station	Month	Median (µM)	St. Dev. (µM)
Transitional waters	27	**0.34**	Portița 20 m (10 m)*	October	**53.93**	Sf.Ghe. 20 m (10 m)	October	3.16	13.68
Coastal waters	59	**0.50**	Casino 20 m (10 m)	October	**21.39**	C-ţa South 5 m (0 m)	April	2.73	3.03
Marine waters	59	**0.49**	Sulina 30 m (10 m)	October	**30.16**	Sulina 30 m (0 m)	April	2.14	5.45

*The values between brackets are the water column depths

The minimum values were determined in October, in the water column. The maximum concentration was recorded in transitional waters, in October, as a follow-up of river input, and in coastal waters, in October, in the influence area of the Constanța South waste water treatment plant. Thus, unlike phosphates, the main source of nitrates seems to be river input, where the maximum value frames within the range typical for the area (Fig. 1.1.4.1.4.).



(a) **(b)**

Fig. 1.1.4.1.4. - Value distribution (a) and spatial variability (b) of nitrate concentrations at the Romanian Black Sea coast - 2012

In 2012, the nitrate multiannaual monthly mean concentrations (April and October) showed the lowest values measured starting with 1976 (Fig. 1.1.4.1.5.).

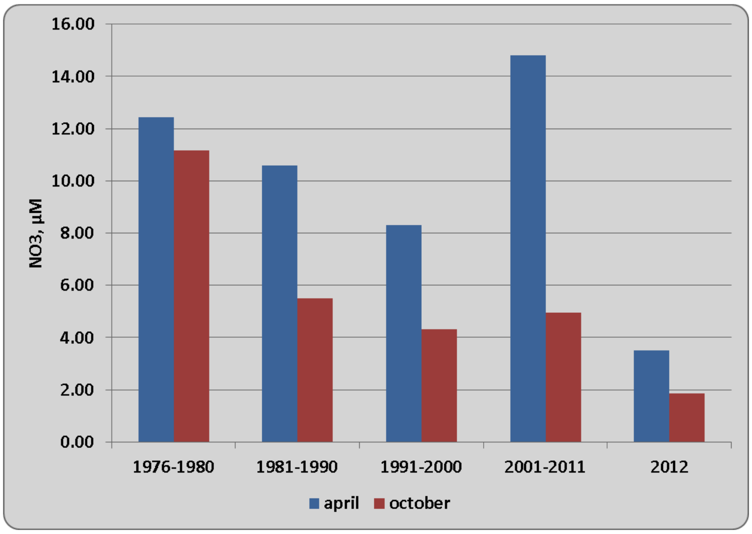
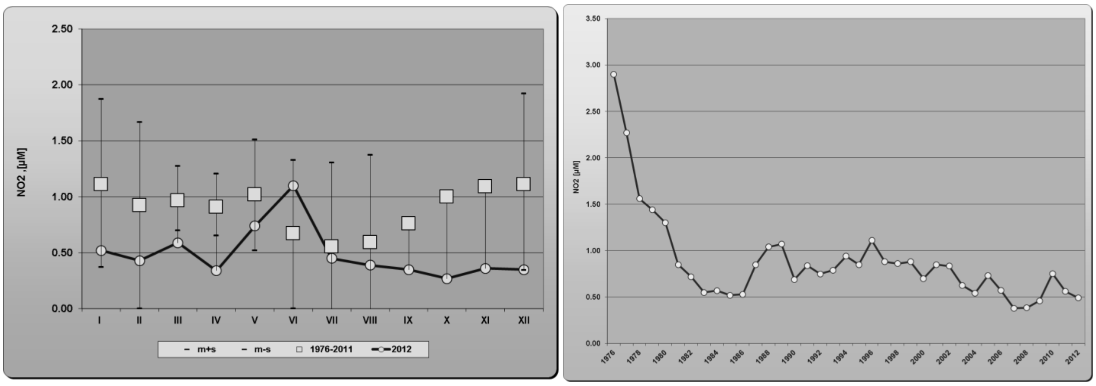


Fig. 1.1.4.1.5. - Compared situation of multiannaual monthly mean concentrations (April and October) of nitrates in Romanian Black Sea surface waters - 1976-2012

In Constanța, the multiannual monthly means 1976-2011 and the monthly means of 2012 differ **significantly** (*t test, confidence interval 95%, p=0.6349, t=0.4815, df=22, difference std. dev. = 2.565*), as a follow-up of low concentrations measured in 2012 (Fig. 1.1.4.1.6.a).

On the long-term (1976-2012), in 2012 we reported the historical annual minimum. (Fig. 1.1.4.1.6.b).



(a) (b)

Fig. 1.1.4.1.6. - Compared situation of multiannual (a) and annual (b) monthly means of nitrate concentrations in seawater in Constanța during 1976-2011 and 2012

NITRITES

Nitrites, $(NO_2)^-$, intermediary forms in redox processes involving inorganic nitrogen species, recorded low values, ranging between 0.02 (LOD) - 1.68 µM (mean 0.28 µM, median 0.17 µM, standard deviation 0.32 µM) (Table 1.1.4.1.3.).

Table 1.1.4.1.3. - Main nitrate value concentrations in Romanian Black Sea waters - 2012

Water body type	No. of samples	Min. (µM)	Station	Month	Max. (µM)	Station	Month	Median (µM)	St. Dev. (µM)
Transitional waters	27	**0.04**	Sulina 20 m (10 m)*	October	**1.68**	Sf. Ghe. 20 m (0 m)	April	0.40	0.45
Coastal waters	59	**0.02 LOD**	EC 2 (10 m and 20 m)	October	**0.92**	Casino 5 m (0 m)	October	0.16	0.18
Marine waters	59	**0.02 LOD**	Casino 30 m (20 m)	April	**1.63**	Sf. Ghe. 30 m (30 m)	April	0.15	0.31
			Sulina 30 m (30 m)	October					
			Sf. Ghe. 30 m (20 m)	October					

* The values between brackets are the water column depths

AMMONIA

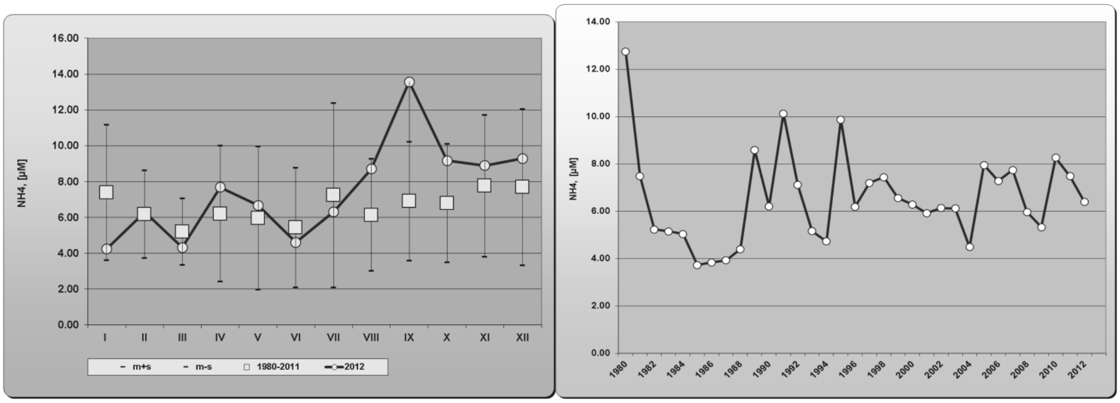
Ammonia, $(NH_4)^+$, the polyatomic ion in which nitrogen holds the maximum oxidation number, +3, is the most easily assimilated inorganic nitrogen form. Its concentrations recorded values ranging between 0.31 - 46.47 µM (*mean 4.40 µM, median 2.41 µM, standard deviation 5.74 µM*) (Table 1.1.4.1.4.).

Table 1.1.4.1.4. - Main ammonia concentrations in Romanian Black Sea coast waters - 2012

Water body type	No. of samples	Min. (µM)	Station	Month	Max. (µM)	Station	Month	Median (µM)	St. Dev. (µM)
Transitional waters	27	**0.31**	Portița 20 m (10 m)*	April	**29.72**	Sulina 10 m (0 m)	October	4.58	6.97
Coastal waters	59	**0.31**	Casino 20 m (10 m)	October	**46.47**	C-ţa South 5 m (0 m)	April	2.58	6.78
Marine waters	59	**0,52**	Mangalia 30 m (30 m)	April	**11.81**	Sulina 30 m (0 m)	October	1.67	3.25

*The values between brackets are the water column depths

The maximum values exceed, in all cases, the allowed concentration (0.1 mgN-NH4/dm^3 and 7.14 µM, respectively) both for the ecological state and the human activity impact area in Order 161/2006 - "Regulation on the classification of surface water quality with the view to establishing the ecological state of water bodies" (Table 1.1.4.1.4.). The influence of the Constanța South Waster Water Treatment Plant on coastal waters is felt in case of ammonia, as well, which recorded an extreme concentration in October.



(a) **(b)**

Fig. 1.1.4.1.7. - Compared situation of multiannual (a) and annual (b) monthly means of ammonia concentrations in seawater in Constanța, during 1980-2011 and 2012

In Constanța, the multiannual monthly means 1980-2011 and the monthly means of 2012 differ insignificantly (*t test, confidence interval 95%, p=0.2719, t=1.1271, df=22, difference std. dev.=0.811*) (Fig. 1.1.4.1.7.a). On the long term (1980-2012), in 2012 the mean of 6.40 µM was recorded (Fig. 1.1.4.1.7.b).

SILICATES

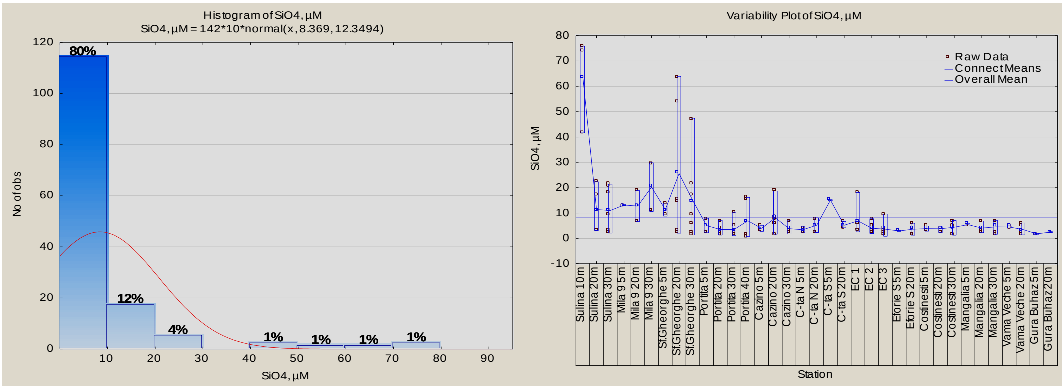
Silicates, $(SiO4)^{4-}$, recorded concentrations ranging between 0.9-75.7 µM (*mean 8.3 µM, median 4.4 µM, standard deviation 12.3 µM*) (Table 1.1.4.1.5.).

Table 1.1.4.1.5. - Main silicate concentrations in Romanian Black Sea coast waters - 2012

Water body type	No. of samples	Min. (μM)	Station	Month	Max. (μM)	Staţia	Month	Median (μM)	St. Dev. (μM)
Transitional waters	27	**1.5**	Portiţa 20 m (10 m)*	October	**75.7**	Sulina 10 m (0 m)	April	8.9	22.6
Coastal waters	59	**1.4**	Eforie 20 m (0 m)	October	**18.5**	Casino 20 (20 m)	October	4,3	3.4
Marine waters	78	**0.9**	Portiţa 40 m (0 m)	October	**47.3**	Sf. Ghe. 30 m (0 m)	October	3.1	8.5

*The values between brackets are the water column depths

The highest concentrations were recorded off the Danube mouths (Fig. 1.1.4.1.8.).



(a) **(b)**

Fig. 1.1.4.1.8. - Value distribution (a) and spatial variability (b) of silicate concentrations at the Romanian Black Sea coast - 2012

Given the fact that the main silicate source of the Romanian Black Sea coast is river input, the low Danube flow in 2012 caused the drop of silicate concentrations in the Romanian Black Sea waters to mean values up to 5-10 times smaller than during the reference period, namely in the 1960s (Fig. 1.1.4.1.9).

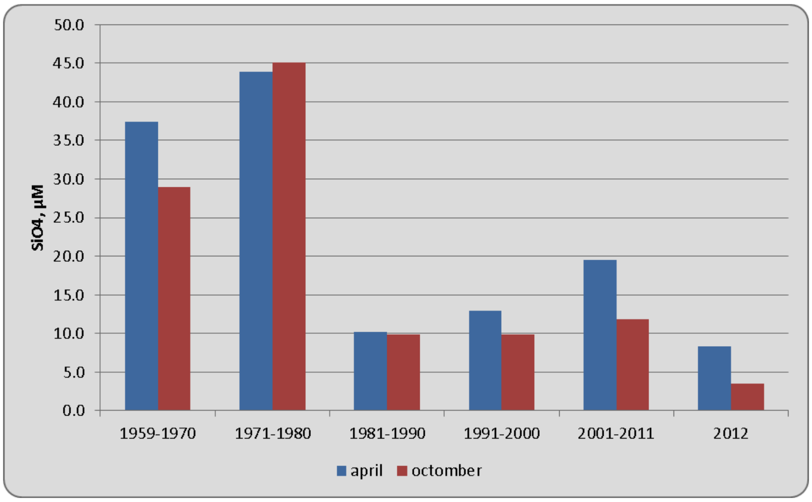
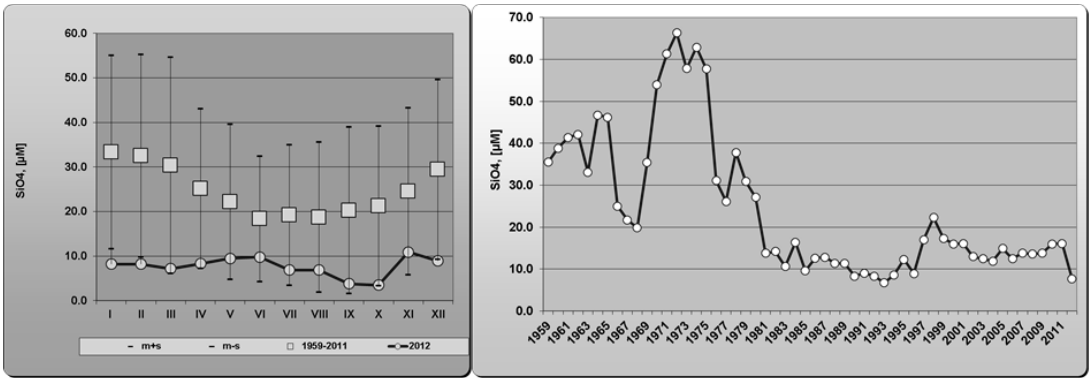


Fig. 1.1.4.1.9. - Compared situation of multiannual monthly means (April and October) of silicates in Romanian Black Sea surface waters - 1959-2012

In Constanța, the multiannual monthly means 1959-2011 and the monthly means of 2012 differ **significantly** (*t test, confidence interval 95%, p<0.0001, t=9.8191, df=22, difference std. dev. 1.721*), due to lower concentrations compared to the 1960s (Fig. 1.1.4.1.10.a).



a) b)

Fig. 1.1.4.1.10. - Compared situation of multiannual (a) and annual (b) monthly means of silicate concentrations in seawater in Constanța, during 1959-2011

The maximum value, 34.2 µM, was measured in Constanța on 29 November 2012, as a result of the upwelling occurring at the same date, caused by wind. Thus, less oxygenated waters, but richer in nutrients reached the surface, replacing surface waters.

The mean annual concentrations of silicates in seawater in Constanța ranged between 6.7 µM (1993) - 66.3 µM (1972) (median 16.1 µM, std. dev. 16.7 µM) and, in 2012, it recorded the lowest value of the past 20 years, namely 7.7 µM (Fig. 1.1.4.1.10.).

CONCLUSIONS

The **transparency** value distribution points-out the high variability range of marine waters, which, in the northern area, are still under the influence of river input.

The **salinity** of surface waters framed within the typical variability range of waters in the Romanian Black Sea coast, being influenced mainly by river input, lower in 2012.

During the studied period, the waters in the surface layer of the Black Sea coast were **well oxygenated** in all three water bodies. In the water column, there were some values below the allowed limit (80%) both for the ecological state and the human activity impact area in Order 161/2006. No anoxia phenomena were reported in 2012.

The **pH** of of Romanian Black Sea waters ranged within normal limits.

1.1.4.2. CHLOROPHYLL *A*

Chlorophyll *a* is one of the most frequently determined biochemical parameters, being an indicator of plant biomass and primary productivity. Due to its significance in the marine ecosystem and the fact that it is more easily measured that phytoplankton biomass, chlorophyll *a* was listed under “Eutrophication“ indicators of the EU Water Framework Directive, being one of the impact parameters to be monitored.

Chlorophyll *a* content ranged between 0.40 and 55.94 $\mu g \bullet l^{-1}$. The seasonal distribution of chlorophyll *a* peaked first in winter (7.66 $\mu g \cdot l^{-1}$ in winter), during the development of the diatom *Chaetoceros similis f. solitarius*, species typical for the cold season (Fig. 1.1.4.2.1.). A second peak was recorded in March, along with the development of the diatom *Skeletonema costatum* (55.94 $\mu g \cdot l^{-1}$). After late spring, generally characterized by low chlorophyll *a* concentrations, two development peaks were also recorded in May and June, caused by the diatom *Nitzschia delicatissima* (7,62 $\mu g \cdot l^{-1}$) and, in June, by the dinoflagellate *Peridinium quinquecorne* (5.32 $\mu g \cdot l^{-1}$).

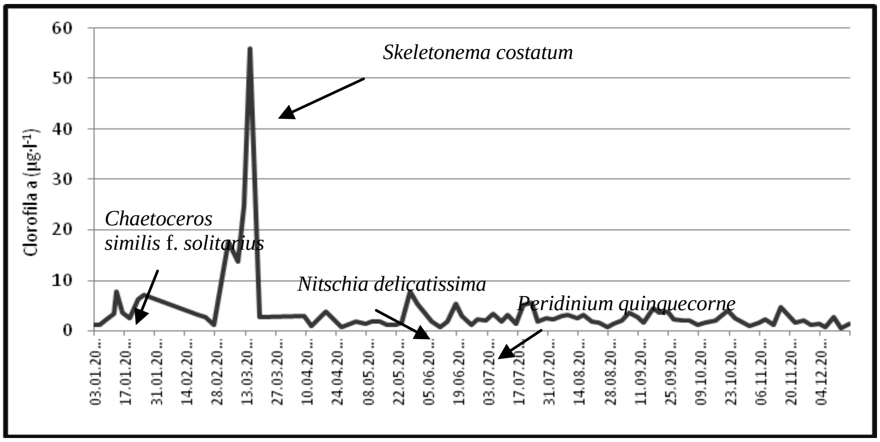


Fig. 1.1.4.2.1. - Seasonal variation of chlorophyll *a* ($\mu g \cdot l^{-1}$) in Romanian coastal waters in 2012

The mean chlorophyll *a* concentrations were about three times lower in October in transitional waters compared to April, the peak being recorded at the 20 m isobaths in Mila 9 (7.18 µg·l^{-1}) and Sulina (4.17 µg·l^{-1}) (Fig. 1.1.4.2.2.). The waters off the Danube mouths, beyond the 30 m isobaths, were characterized by a larger development of phytoplankton compared to coastal waters in the south of the coast, the peak being reported in Sf. Gheorghe - 5.46 µg·l^{-1}, being two times smaller than the one reported in the same area (12.14 µg·l^{-1}) in April.

April 2012 (µg·l^{-1}) **October 2012 (µg·l^{-1})**

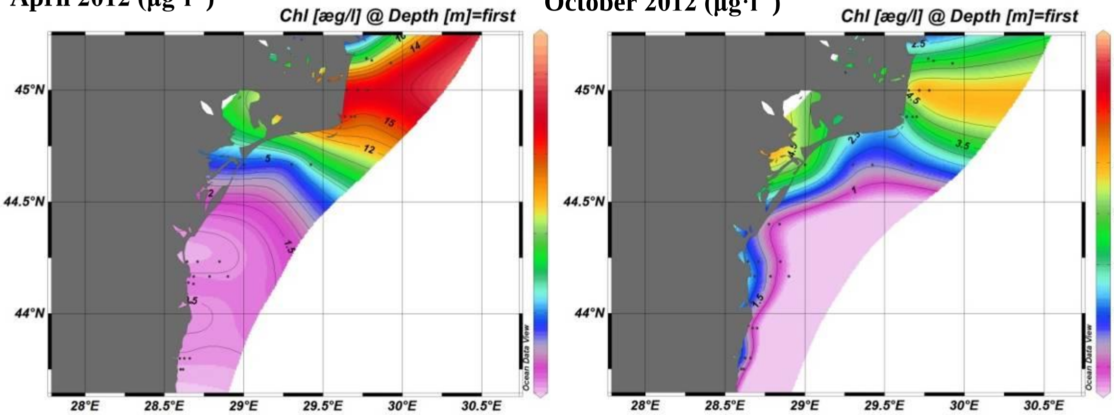


Fig. 1.1.4.2.2. - Spatial surface distribution of chlorophyll *a* in coastal Romanian Black Sea waters, April and October

In 2012, the mean annual content of chlorophyll *a* in coastal waters recorded a value close to 2011 (3.67 µg/l compared to 4.91 µg/l), but below the annual mean calculated for the period 2001-2010 (6.27 µg/l), thus confirming the recovery trend of the ecological state of the Black Sea coastal ecosystem.

1.1.5. CONTAMINATION INDICATORS

1.1.5.1. HEAVY METALS

Heavy metal contamination of coastal areas may be directly correlated with urban or industrial sources, such as factories, thermo-electric plants, harbors, water treatment plants. River influence on the coastal area is significant, being a major source of metals, mainly as particulates, extreme hydrological events (floods) enhancing such an input.

The metal atmosphere flows, with both natural and anthropogenic nature, are also considered as having a significant share, both in coastal areas and in the entire basin, also depending on the variability of local weather and climate conditions.

Physical-chemical and hydrodynamic conditions in coastal areas affect the transport routes and distribution of these elements. Metals in seawater may suffer reactions of complexation, ion exchange or precipitation, followed by accumulation in sediments, from where metals can then return in the water column. Due to these factors, heavy metal concentrations in marine waters are heavily influenced by spatial (depth, distance from the river mouth or contamination source) or temporal variations (season). Coastal sediments have a lower degree of variability comparing with the water column. However, metals in sediment are not permanently fixed. Variation in physical-chemical parameters (pH, salinity, redox potential and concentration of organic ligands) causes the release of metals from sediment in the water column. Metal accumulation by the biota is conditional upon certain physical-chemical and biological processes which cause their bio-solubilization and bio-availability. High concentrations of metals in the environment affect biota by their ability to bioaccumulate, transferring along the food chain and finally to human consumers.

Heavy metal monitoring in 2012 was conducted by analyzing samples of seawater (surface horizon), surface sediment and biota collected during the two surveys (March-April and October) from transitional (Sulina - Portița, 5-20 m), coastal (Gura Buhaz - Vama Veche, 0-20 m) and marine areas (depths over 20 m) (total 40 monitoring stations, 13 transects). The analytic determination of copper, cadmium, lead, nickel and chrome content was made by atomic absorption spectrophotometry, using a SOLAAR M6 DUAL Zeeman, Thermo Electron - UNICAM device.

Transitional, coastal and marine waters

The heavy metal concentrations determined during the year 2012 in monitoring stations were within the following variation ranges: copper 2.08±1.60 (0.18-8.36) µg/L; cadmium 2.19±2.04 (0.40-9.12) µg/L; lead 3.29±1.96 (1.13-8.61) µg/L; nickel 4.27±3.70 (0.81-22.78) µg/L; chrome 1.22±0.90 (0.28-5.1) µg/L. In relation to environmental quality standards for seawater recommended by national legislation (Order no. 161/2006 - 30 µg/l Cu; 5 µg/L Cd; 10 µg/L Pb; 100 µg/L Ni; 100 µg/l Cr), all measured concentrations of cadmium, lead, nickel and chrome were within the allowed limits, while for copper approximately 10% of the samples recorded slight exceedings (Fig. 1.1.5.1.1. a and b).

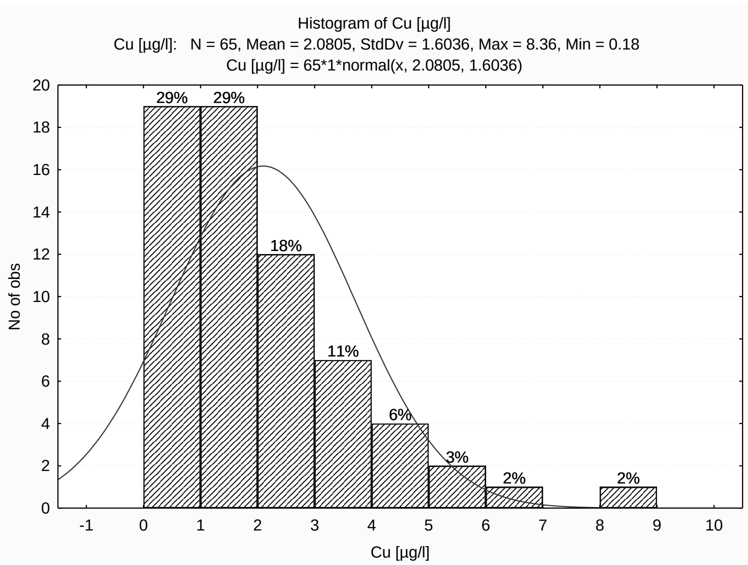


Fig. 1.1.5.1.1. a - Histogram of copper concentrations in marine water samples investigated in 2012

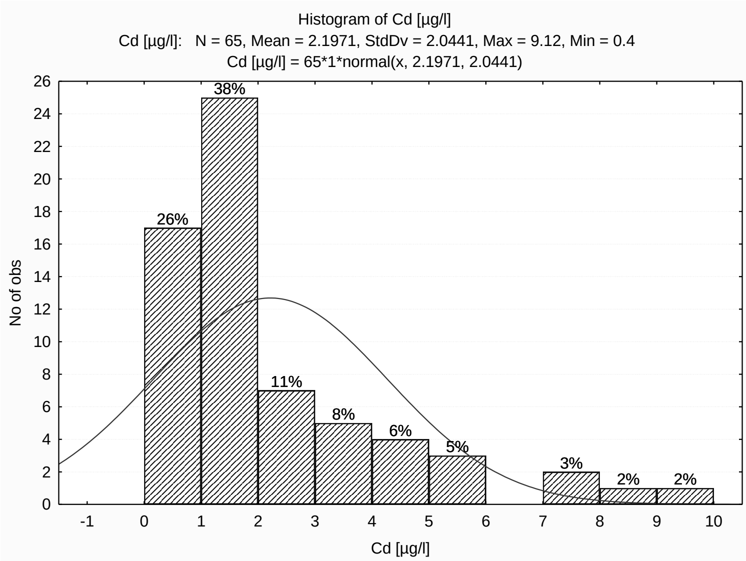


Fig. 1.1.5.1.1. b - Histogram of cadmium concentrations in marine water samples investigated in 2012

Copper concentrations were slightly higher and characterized by increased variability in the marine zone off the Danube mouths (Sulina - Sf. Gheorghe), with a decreasing gradient towards the center and south of the coast, except for the Constanța South and Eforie South stations. The median values calculated for lead were higher off the Danube mouths, as well in the southern part of the coast (Mangalia - Vama Veche). Similarly to copper, the chrome concentration gradient decreases southwards (Fig. 1.1.5.1.4.)

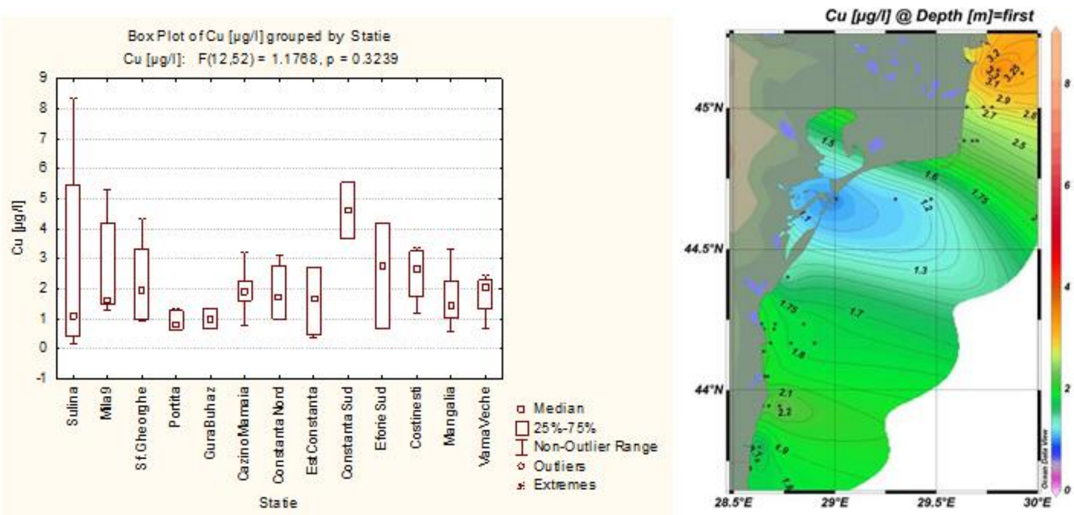


Fig. 1.1.5.1.2. - Spatial distribution of copper concentrations along the 13 transects of the national monitoring network in 2012

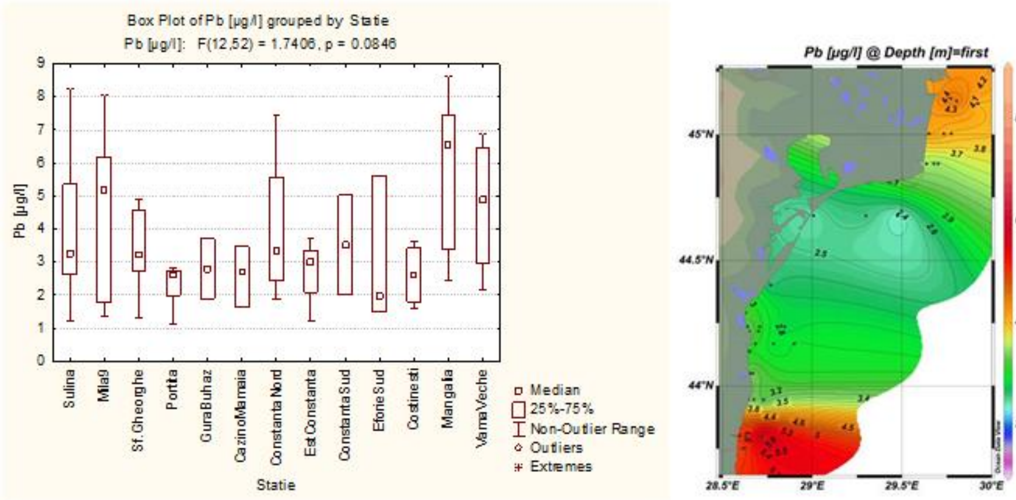


Fig. 1.1.5.1.3. - Spatial distribution of lead concentrations along the 13 transects of the national monitoring network in 2012

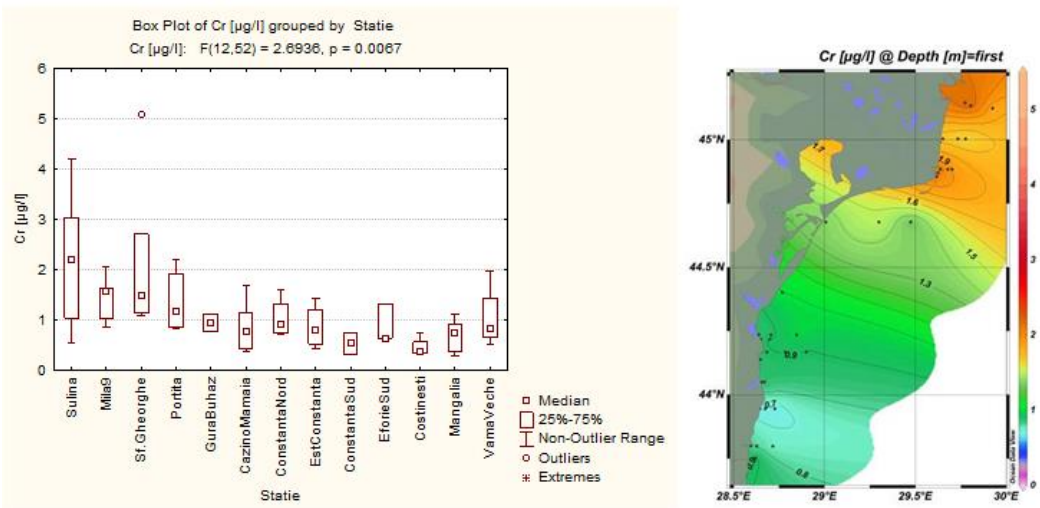


Fig. 1.1.5.1.4. - Spatial distribution of chrome concentrations along the 13 transects of the national monitoring network in 2012

The evolution trends of heavy metals in marine waters have various behaviors, depending on the investigated element. In relation to 2011, when significantly increased concentrations compared to the previous study period were recorded, two elements (copper and lead) were characterized in 2012 by much more decreased values. Cadmium showed a high variability and a slight increase trend, while nickel concentrations measured in 2012 ranged within the limits reported during 2007 - 2011.

Sediments

The distribution of heavy metal in sediments is influenced by natural and anthropogenic inputs and depends of the mineralogical and granulometric characteristics of sediments. Sediments with finer texture and a higher organic matter content tend to accumulate higher concentrations of heavy metals in comparison with coarse sediments. The heavy metal concentrations determined during 2012 in sediment samples were within the following variation ranges: copper 26.63±28.68 (3.65-144.34) µg/g; cadmium 1.13±0.83 (0.23-3.77) µg/g; lead 11.27±10.72 (0.80-66.86) µg/g; nickel 45.39±34.89 (7.43-171.53) µg/g; chrome 45.47±29.78 (9.10-122.58) µg/g. (Fig. 1.1.5.1.5.).

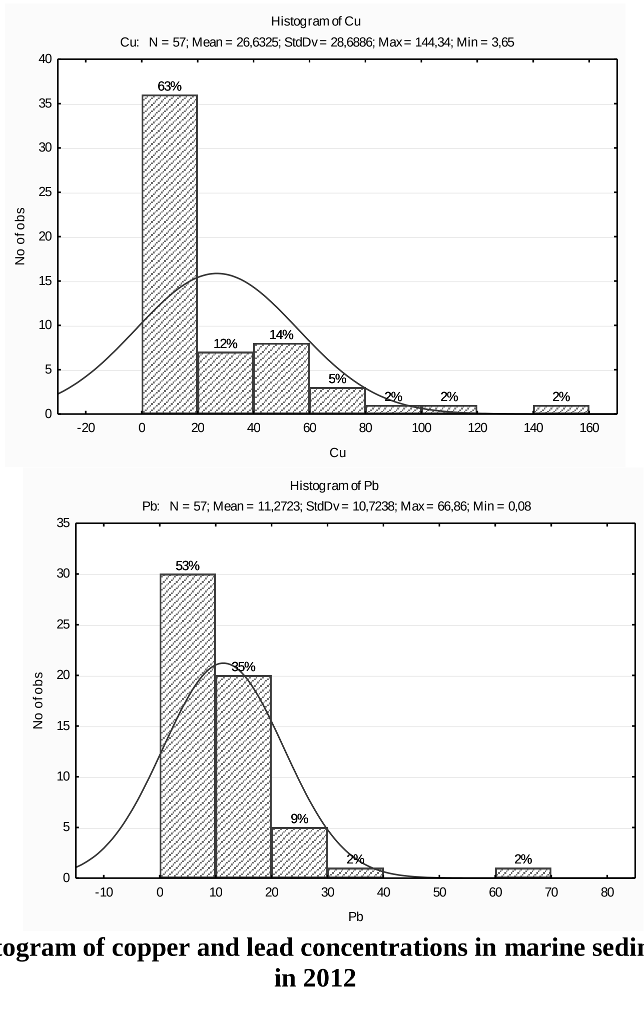


Fig. 1.1.5.1.5. - Histogram of copper and lead concentrations in marine sediments investigated in 2012

In relation to marine sediment quality standards recommended by national legislation (Order no. 161/2006: 40 µg/g Cu; 0.8 µg/g Cd; 85 µg/g Pb; 35 µg/g Ni; 100 µg/g

Cr), it was noted that the values of individual concentrations measured in some sediments collected from areas neighboring harbors or off the Danube mouths recorded slight exceedings for certain elements.

The spatial distribution in different geographical areas showed a high variability, depending on the element, sediment type, distance from the shore and the influence of anthropogenic sources. Significant differences were observed especially for copper, cadmium, nickel and chrome, these elements showing increased accumulations in front of the Danube mouths (Sulina - Portița) and in the harbor areas (Constanța South, Mangalia). Lead had a slightly more uniform distribution along the coast, yet higher values were recorded in the southern part. Normal values for most of the investigated elements were reported in the central part of the coast (Gura Buhaz - East Constanţa), as well as in the southernmost part (Vama Veche) (Fig. 1.1.5.1.6.-8.).

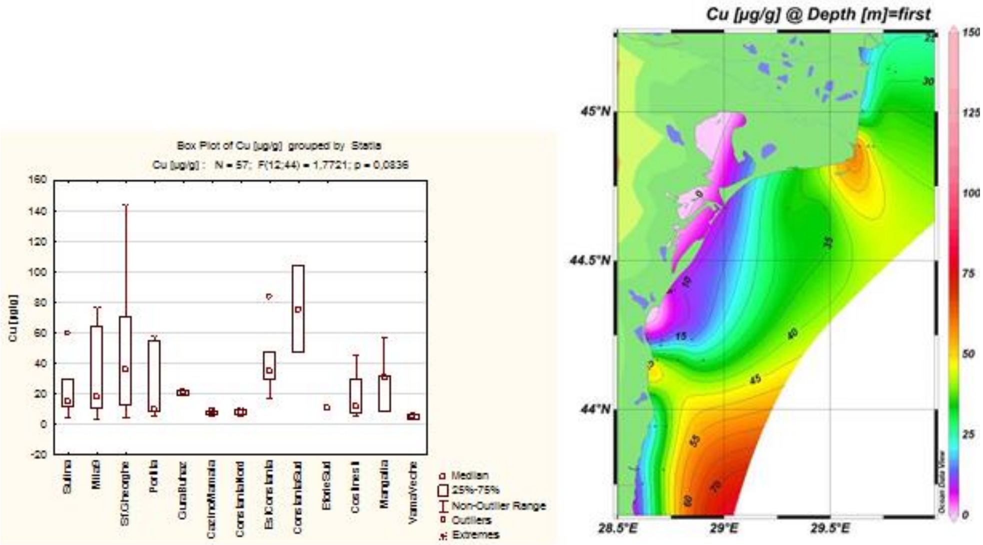


Fig. 1.1.5.1.6. - Spatial distribution of copper in marine sediments along the Romanian coast in 2012

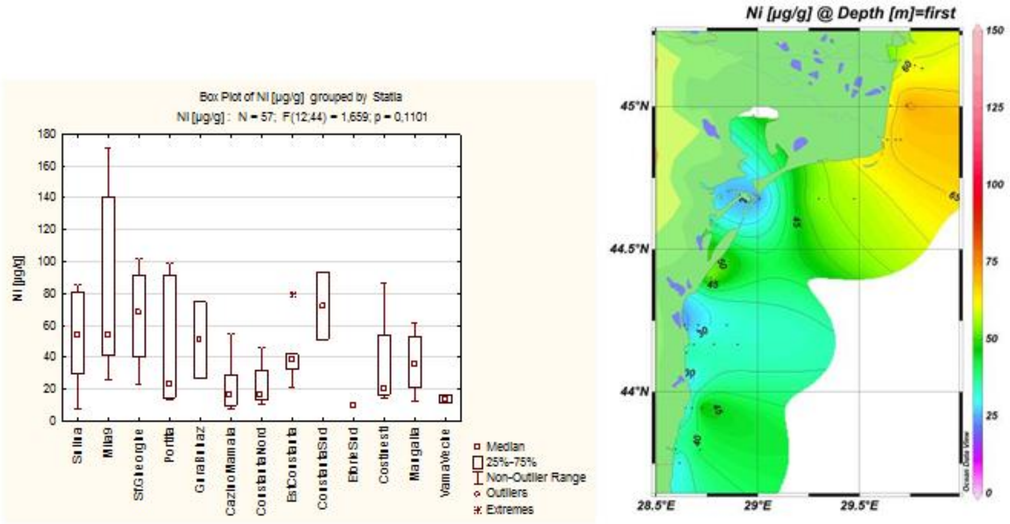


Fig. 1.1.5.1.7. - Spatial distribution of nickel in marine sediments along the Romanian coast in 2012

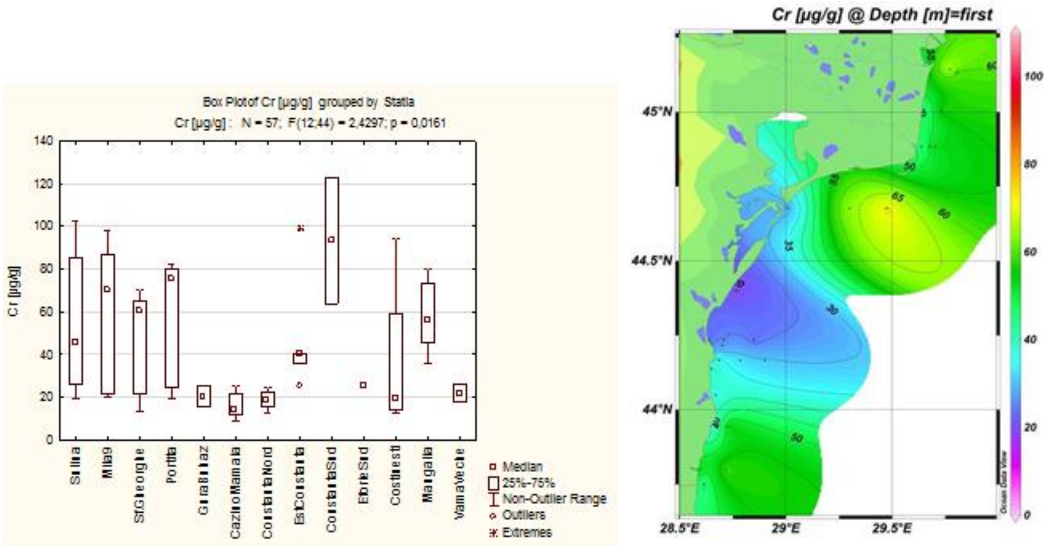


Fig. 1.1.5.1.8. - Spatial distribution of chrome in marine sediments along the Romanian coast in 2012

The evolution trends of heavy metals in marine sediments in the past 6 years show that the values measured in 2012 frame within the multiannual variation ranges, with slight decrease trends for copper, cadmium and lead (Fig. 1. 1.1.5.1.9.-11.)

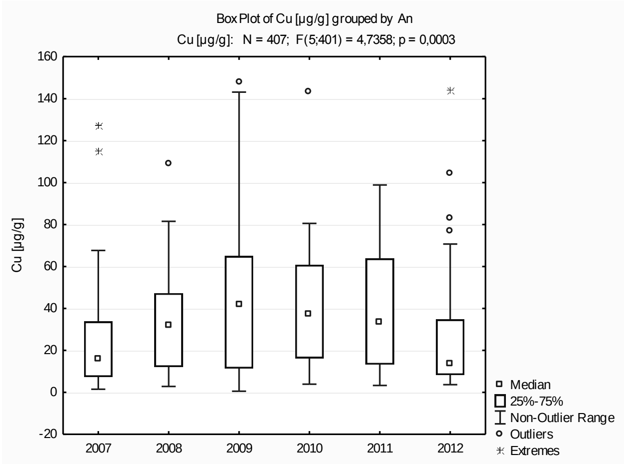


Fig. 1.1.5.1.9. - Evolution of copper concentrations in marine sediments during 2007 - 2012

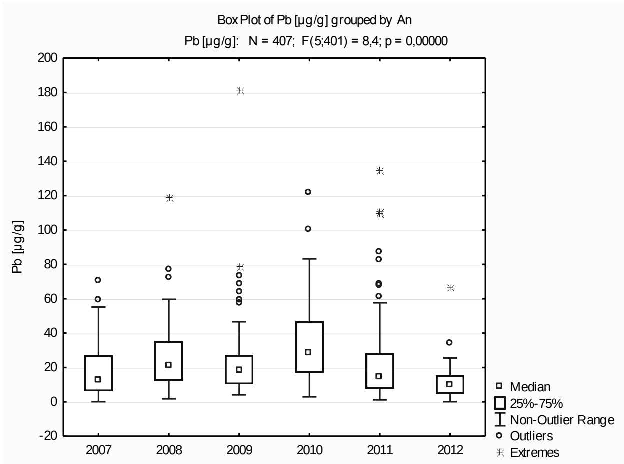


Fig. 1.1.5.1.10. - Evolution of lead concentrations in marine sediments during 2007 - 2012

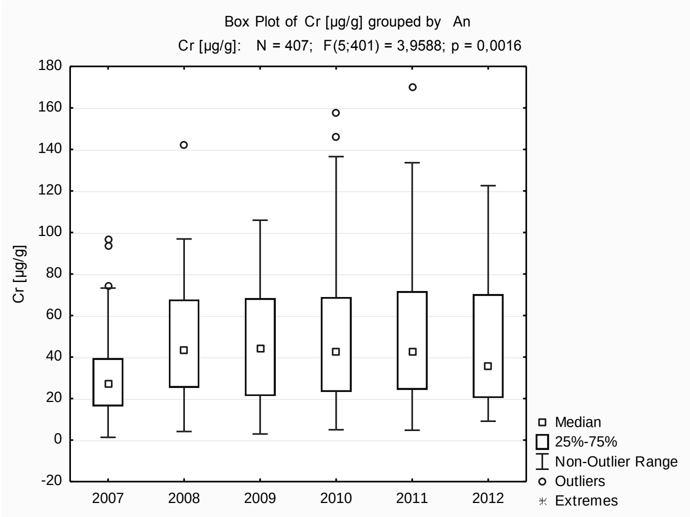


Fig. 1.1.5.1.11. - Evolution of chrome concentrations in marine sediments during 2007 - 2012

Marine organisms

The bioaccumulation of heavy metals in the tissues of marine molluscs investigated in 2011 (*Mytilus galloprovincialis*, *Rapana venosa*, *Scapharca inequivalvis* and *Mya arenaria*) was characterized by the following mean values and variation ranges: copper: 5.58±4.21 (1.55-15.35) µg/g s.p.; cadmium: 1.27±0.98 (0.09-2.81) µg/g. s.p.; lead: 0.19±0.13 (0.02-0.44) µg/g s.p.; nickel: 1.12±0.65 (0.18-2.46) µg/g s.p.; chrome: 0.61±0.47 (0.12-1.92) µg/g s.p.

Most samples showed values within the normal range of variability, although there were situations in which the measured concentrations were slightly increased, depending on the element, species or location of sampling. Some interspecific differences in the bioaccumulation of heavy metals were observed, i.e. *Rapana* is normally characterized by higher copper concentrations in tissues compared to the other molluscs, cadmium recorded high bioaccumulation in *Scapharca* and *Rapana*, while in *Mya* higher nickel and chrome values were measured (Fig. 1.1.5.1.12.-13.)

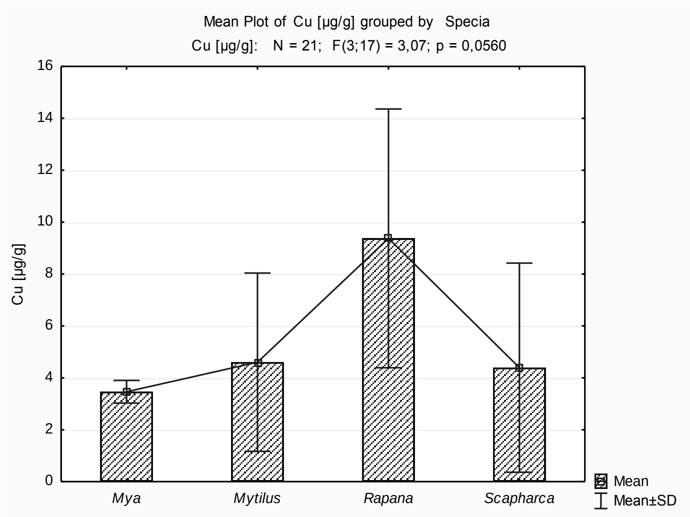


Fig. 1.1.5.1.12. - Interspecific differences of copper bioaccumulation in marine molluscs

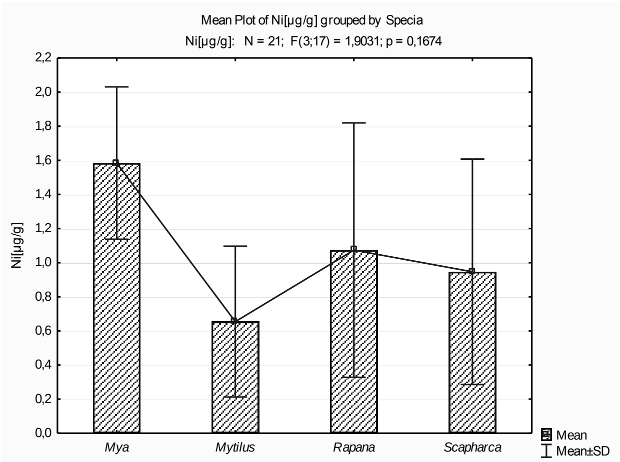


Fig. 1.1.5.1.13. - Interspecific differences of nickel bioaccumulation in marine molluscs

The heavy metal bioaccumulation values in marine molluscs can be correlared with heavy metal concentrations in the environment (water, sediment), thus reporting differences between various sampling sites (for instance, lead, nickel and chrome showed higher mean values in the northern part of the Romanian coast) (Fig. 1.1.5.1.14.-15.)

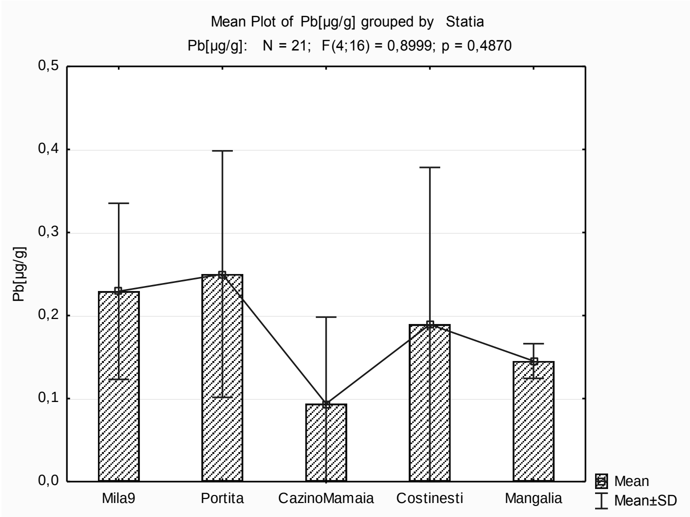


Fig. 1.1.5.1.14. - Spatial distribution of mean lead accumulation values in marine molluscs

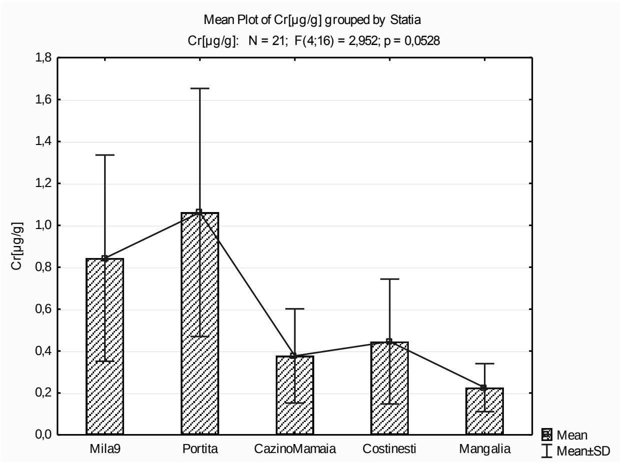


Fig. 1.1.5.1.15 - Spatial distribution of mean chrome accumulation values in marine molluscs

The mean concentrations measured in 2012 in *Mytilus galloprovincialis* usually frame within the multiannual variation ranges (2007-2011), with a slightly decreasing trend for lead, nickel and chrome.

CONCLUSIONS

- the distribution of metals in waters and sediments from the transitional, coastal and marine areas highlighted the differences between different sectors of the coast, generally being reported slightly elevated concentrations in some coastal areas subject to different anthropogenic pressures (harbors, sewage discharges), but also in the marine area under the influence of the Danube;
- the concentrations of most heavy metals in water, sediment and biota generally framed within the variation range of mean multiannual values (2007 - 2011).

1.1.5.2. PETROLEUM HYDROCARBONS
1.1.5.2.1. TOTAL PETROLEUM HYDROCARBONS

The analysis of organic pollutants was performed on 159 water samples and 60 sediment samples collected from a network comprising 44 stations, located between Sulina and Vama Veche. The monitoring performed during March-October, by analyzing water samples, covers all water body types comprised in the Water Framework Directive and the Marine Strategy Framework Directive, as follows: transitional waters - 16 samples from the Sulina, Mila 9, Sf. Gheorghe, Portiţa stations - up to the 20 m isobath inclusively, coastal waters - 41 samples from the East Constanţa, Mangalia stations up to the 20 m isobath inclusively and marine waters - 101 samples from stations in the network located on the 30 m and 50 m isobaths.

In 2012, low values (<200 µg/l) of the total petroleum hydrocarbon content - TPH (µg/l) were determined in water samples. The mean value of petroleum pollutant was 33.5 (µg/l), ranging between the variation ranges 5.8 and 758.3 (µg/l). The distribution of concentrations on water body types did not point-out any significant differences between the means of the three water bodies, yet the highest values were recorded in marine waters (Fig. 1.1.5.2.1.1.). The outlier value 758.3 (µg/l), occasionally recorded in marine waters, was not included in the statistical analysis of data. The petroleum hydrocarbon pollution level of 2012 is significantly lower compared to the period 2006-2009 (Fig. 1.1.5.2.1.2.).

A low TPH pollution level was also recorded in sediments (<100 µg/g), the petroleum hydrocarbon concentration varied between 0.4 and 81.5 (µg/g), with a mean value of 16.2 (µg/g). High concentration values, ranging between 60-90 (µg/g), were determinen din March (Fig. 1.1.5.2.1.3.), both in the northern sector, Mila 9 station, and in the southern sector, Constanța South station 20 m. The petroleum hydrocarbon pollution level of 2012 is significantly lower compared to the period 2006-2011 (Fig. 1.1.5.2.1.4.).

In 2012, the decreasing trend of hydrocarbon concentrations in investigated environmental components recorded lately (2010-2011) was continued.

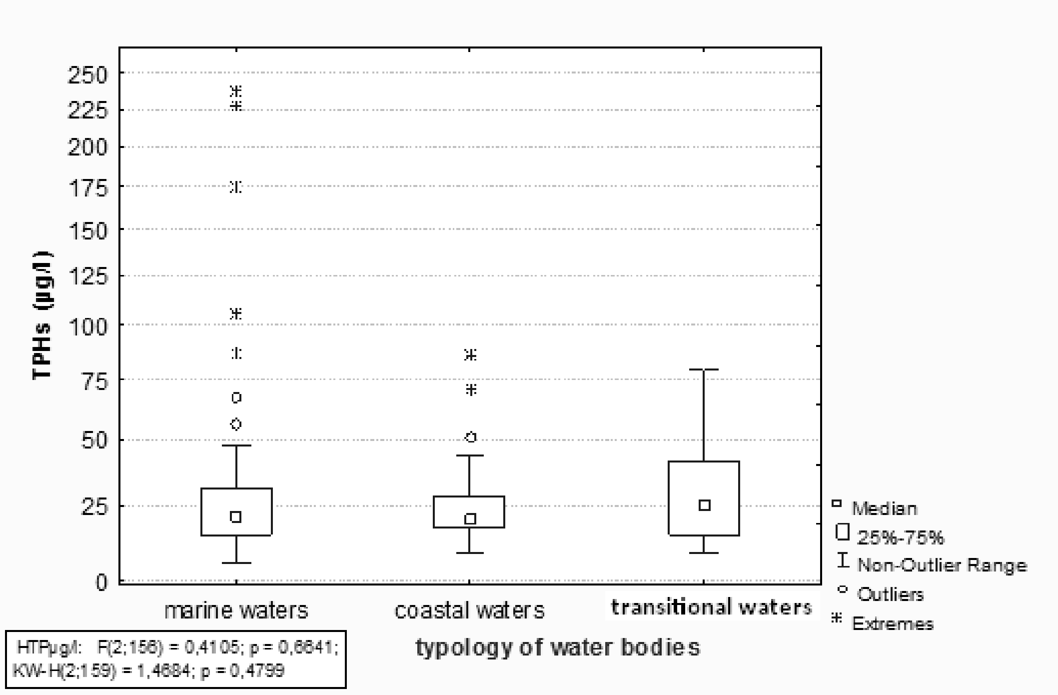


Fig. 1.1.5.2.1.1. - Distribution of petroleum hydrocarbon concentrations (µg/l) in Romanian transitional, marine and coastal waters, during March - October 2012

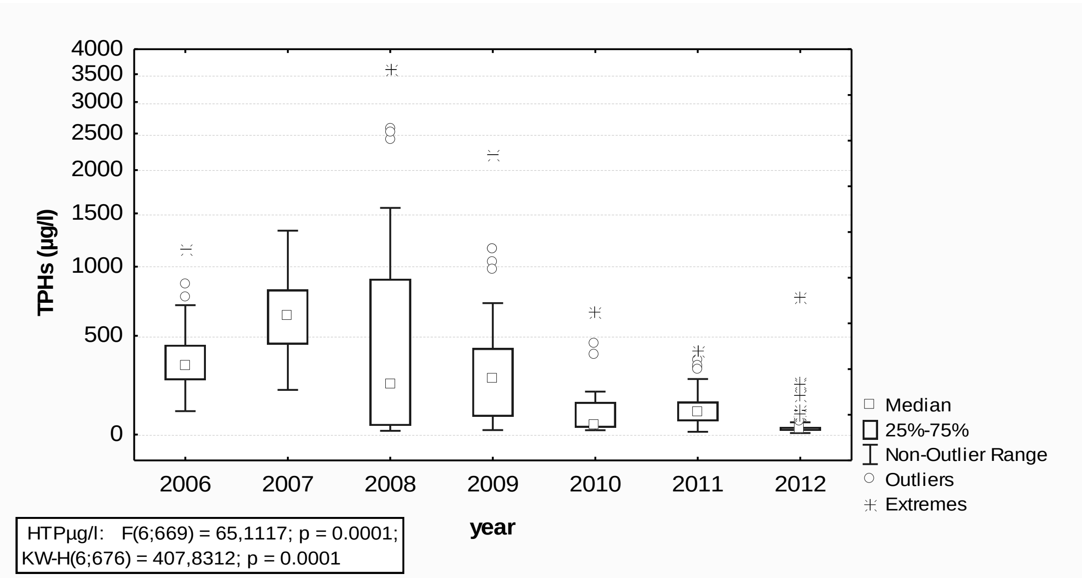


Fig. 1.1.5.2.1.2. - Distribution of petroleum hydrocarbon concentrations (µg/l) in Romanian Black Sea waters, during 2006-2012

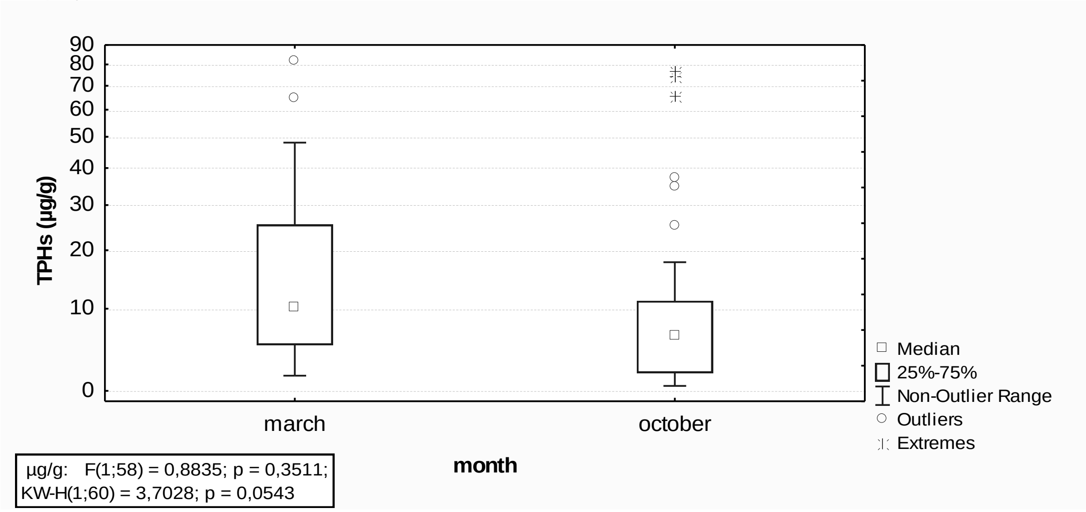


Fig. 1.1.5.2.1.3. - Distribution of petroleum hydrocarbon concentrations (µg/g) in the Romanian Black Sea sector, March-October 2012

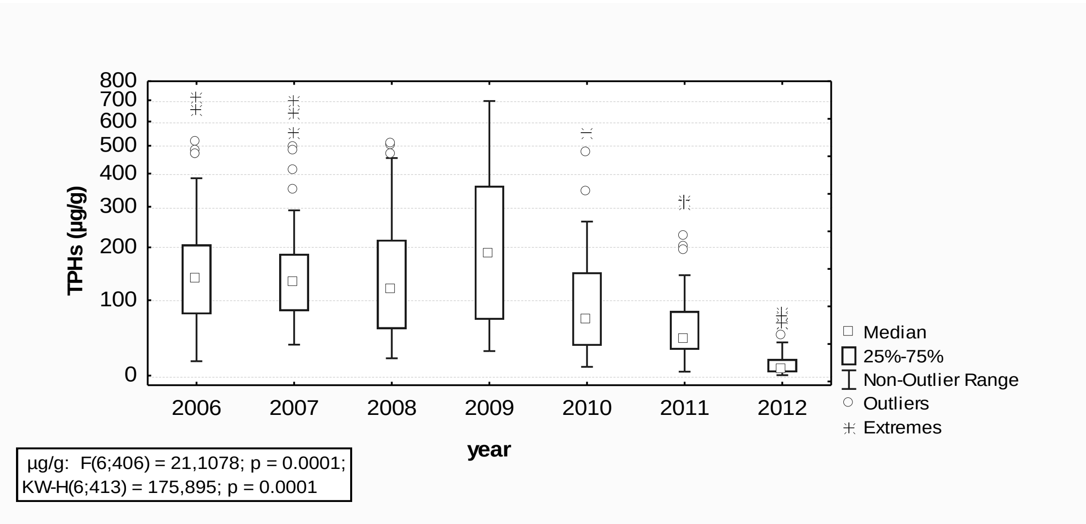


Fig. 1.1.5.2.1.4.- Distribution of petroleum hydrocarbon concentrations (µg/g) in Romanian Black Sea sector, during 2006-2012

1.1.5.2.2. POLYCYCLIC AROMATIC HYDROCARBONS

The total polycyclic aromatic hydrocarbons - ΣPAH (µg/l) content in water samples (n=148) ranged between 0.0835 and 5.4599, with a mean of 1.6998 (Fig. 1.1.5.2.2.1.). The outlier value of 82.98 (µg/l), determined in March in the Mila 9 - 20 m station, is not included in the statistical analysis of the data. This incidental value is the highest pollution level recorded during 2006-2012 (Table 1.1.5.2.2.1.). The statistical analysis of data points-out very significant differences between the mean value of 5.4496 (µg/l) during 2006-2007, with a high pollution level, and the mean of 2012 (*t test, confidence interval 95%,* *p<0.0001, t=10.93, df=216, difference std. dev.=0.34*) (Fig. 1.1.5.2.2.2.). The latter frames within the concentrations range recorded during 2008-2011 (*t test, confidence interval 95%, p <0.0759, t=1.78, df=368, difference std. dev. = 0.17*). High concentrations were determined for anthracene, phenanthrene, benzo[a]anthracene and fluoranthene, their mean values exceeding the maximum values allowed by Order no. 161/2006 (Table 1.1.5.2.2.2.).

Table 1.1.5.2.2.1. - Maximum ΣPAH (µg/l) values in Romanian marine, coastal and transitional waters, during 2006-2012

Station	Water body	Year	ΣPAH (µg/l)
Sulina	transitional	2007	15.9
Mila 9	**transitional**	**2012**	**83.0**
Sf. Gheorghe	transitional	2006	12.0
Portiţa	transitional	2009	7.9
Gura Buhaz	coastal	2007	6.6
Casino Mamaia	marine	2006	6.5
Constanţa North	coastal	2006	11.7
Constanţa South	coastal	2006	15.6
Eforie South	coastal	2006	7.0
Costineşti	marine	2006	16.5
Mangalia	marine	2009	6.9
Vama Veche	coastal	2008	15.8

Table 1.1.5.2.2.2. - ΣPAH (µg/l) concentrations overtaking the maximum allowed limits of Order no. 161/2006 in Romanian Black Sea waters

Compound name	Allowed limit* (µg/l)	Concentration µg/l			
		n	Mean	Min.	Max.
Naphthalene	2.400	143	0.2450	0.0074	1.3822
Phenanthrene	**0.030**	**140**	**0.3471**	**0.0234**	**2.0606**
Anthracene	**0.063**	**136**	**0.7079**	**0.0009**	**2.9179**
Fluoranthene	**0.090**	**107**	**0.0941**	**0.0005**	**0.8977**
Benzo[a]anthracene	**0.010**	**84**	**0.0335**	**0.0079**	**0.1188**
Benzo[b]fluoranthene	0.025	139	0.0192	0.0007	0.1956
Benzo[k]fluoranthene	0.025	122	0.0220	0.0064	0.0548
Benzo[a]pyrene	0.050	140	0.0204	0.0008	0.1214
Benzo (g,h,i)perylene	0.025	72	0.0110	0.0001	0.1572

*Order of the Ministry of the Environment and Water Management no. 161/2006 approving the Regulation for classifying the surface water body quality with the view to establishing the ecological state of water bodies.

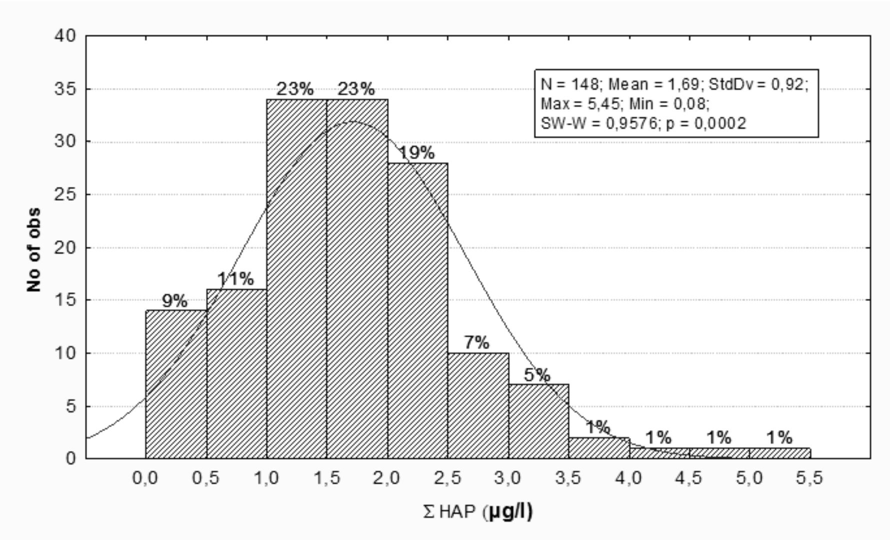


Fig. 1.1.5.2.2.1. - Histogram of the total polycyclic aromatic hydrocarbon - ΣPAH (µg/l) content in Romanian Black Sea waters in 2012

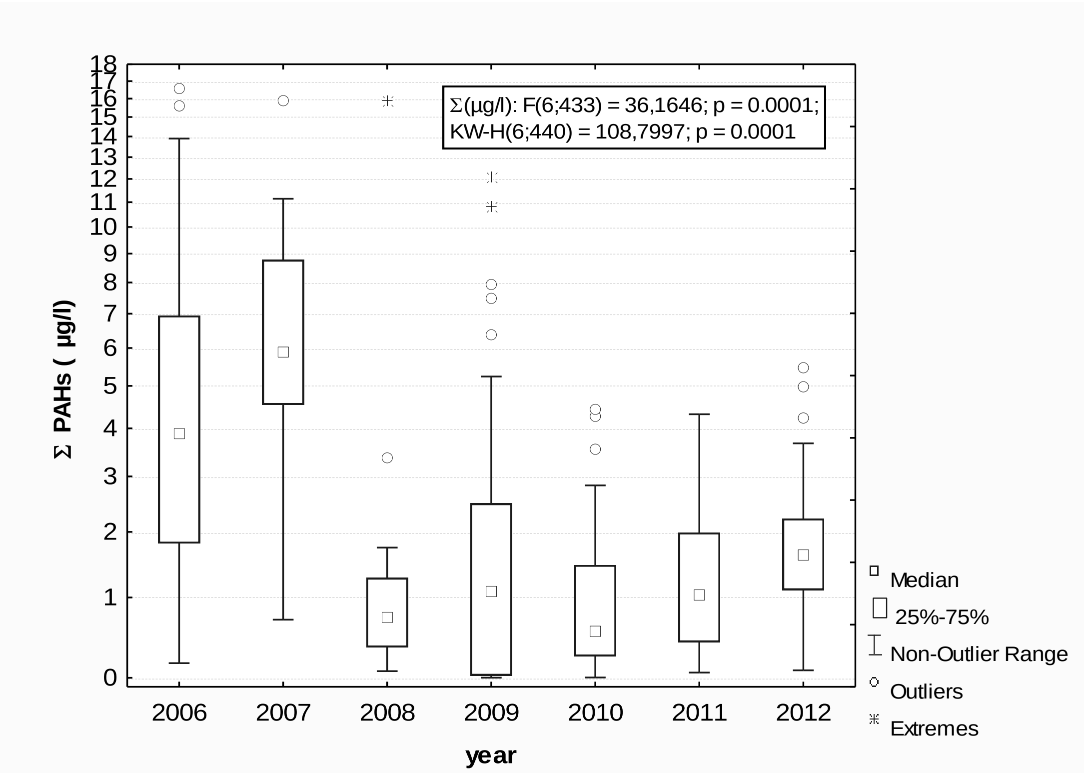


Fig. 1.1.5.2.2.2. - Distribution of the polycyclic aromatic hydrocarbons - ΣPAH (µg/l) in Romanian Black Sea waters, during 2006-2012

Identifying the potential Σ PAH sources in water

The polycyclic aromatic hydrocarbon - ΣPAH - contamination level of marine, coastal and transitional waters and the identification of potential pollution sources, using indices resulting from the single compound concentration ratios, are given in Table 1.1.5.2.2.3.

Table 1.1.5.2.2.3. - Indices used to identify the potential ΣPAH emissions in marine, coastal and transitional waters of the Romanian Black Sea sector, in 2012

ΣPAH pollution index values	Water body type		
	coastal (n=28)	marine (n=103)	transitional (n=17)
ΣPAH (µg/l)	1.373 ± 0.77	1.847 ± 0.93	1.345 ± 0.91
% Σ AH - 2-3 aromatic rings*	77.25 ± 15.6	78.87 ± 11.2	75.24 ± 11.1
% Σ AH - 4 aromatic rings**	9.96 ± 6.2	16.16 ± 10.3	12.13 ± 12.2
% Σ AH - 5 aromatic rings***	11.41± 11.8	5.72 ± 7.8	11.59 ± 9.6
% Σ AH - 6 aromatic rings****	5.80 ± 4.34	2.33 ± 1.6	4.44± 2.4
% Σ AH - 4-5-6 aromatic rings	22.75 ± 15.5	21.8 ± 13.5	24.76 ± 11.1
PAH LMW / PAH HMW	5.8 ± 5.1	4.7 ± 2.3	3.9 ± 2.2
Fl / Fl+Pyrene	0.5 ± 0.3	0.5 ± 0.2	0.7 ± 0.2
An / 178	0.5 ± 0.2	0.6 ± 0.2	0.4 ± 0.2
BA / 228	0.36 ± 0.27	0.34 ± 0.22	0.45 ± 0.37
IP / IP +BghiP	0.6 ± 0.3	0.7 ± 0.3	0.6 ± 0.3
Total ΣPAH index	6.79 ± 3.7	8.86 ± 2.5	6.00 ± 2.9

* abundance of 2-3 aromatic ring PAHs: naphtalene, acenaphthylene, acenaphtene, fluorene, phenanthrene, anthracene;

** abundance of 4 aromatic ring PAHs: fluoranthene, pyrene, benzo[a]anthracene, chrysene;

*** abundance of 5 aromatic ring PAHs: benzo[b]fluoranthene, benzo[k]fluoranthene; benzo[a]pyrene, dibenzo(a,h)anthracene;

**** abundance of 6 aromatic ring PAHs: indeno(1,2,3-c,d)pyrene, benzo (g,h,i)perylene

The polycyclic aromatic hydrocarbon level caused by anthropogenic impact is estimated as the ratio between the concentrations of 4-5-6-aromatic ring pyrolityc PAHs and the 2-3-aromatic ring PAHs forming under natural conditions, characteristic for oil and oil products. High molecular mass PAHs - $\mathbf{PAH_{HMW}}$ - with 4-6 aromatic rings {fluoranthene, pyrene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo(g,h,i)perylene, dibenzo (a,h)anthracene, indeno(1,2,3-c,d)pyrene} are generated as a follow-up of the fossil fuel (hydrocarbons, coal, oil or natural gases) incomplete combustion at high temperatures - pyrolysis. These pyrolytic PAHs are often determined in the atmosphere dust of urban areas, unlike low molecular mass PAHs - $\mathbf{PAH_{LMW}}$ - with 2-3-aromatic rings (naphtalene, acenaphtene, acenaphtylene, fluorene, phenantrene, anthracene), characteristic for discharges, oil and oil product spills. A subunitary PAHLMW/PAHHMW ratio usually indicates a pyrolytic pollution, while in case of values >1 it indicates the abundance of low molecular mass PAHs, characteristic for oil and oil products. The potential PAH emissions in the water can be different, random and irregular. It is accepted that the ratio:

- ***Fl/Fl+Pyrene*** **-** fluoranthene/(fluoranthene+pyrene) < 0.5 indicates pollution with oil PAHs, while >0.5 indicates pyroytic pollution;
- **An/178 -** anthracene/(anthracene+phenanthrene) < 0.1 indicates the occurrence of oil hydrocarbons;
- **BA/228 -** benzo[a]anthracene/228 or benzo[a]anthracene / (benzo[a] anthracene+chrysene) < 0.35 - oil pollution, values ranging between 0.2 and 0.35 mixed pollution, while > 0.35 - pollution with PAHs resulting from high temperature combustion (Yunker *et al.*, 2002);
- **IP/(IP+BghiP) -** indeno(1,2,3-cd)pyrene/indeno(1,2,3-cd)pyrene+benzo(g, h, i)perylene) < 0.2 indicates oil PAHs, values ranging between 0.2-0.5 show fossil fuel combustion and values > 0.5 suggest the combustion of wood, coal, grass (Yunker *et al.*, 2002).

In some cases, the ratios of the **Fl/Fl+Py, An/178, BA/228** and **IP/(IP+BghiP)** polycyclic aromatic hydrocarbons are not compatible, due to the fact that emission sources can be different, random and irregular. In such a case, a total PAHs index is calculated (Yunker, 2002., MANNINO, 2008), which is a normalized amount of the indices discussed above, according to the formula:

$$\text{Total PAHs index} = \frac{\frac{Fl}{(Fl+Py)}}{0.4} + \frac{\frac{An}{178}}{0.1} + \frac{\frac{BaA}{228}}{0.2} + \frac{\frac{Ip}{(Ip+BghiP)}}{0.2}$$

When the total PAHs index is > 4, it is considered that pyrolytic reactions generate the PAHs and when the index is <4 the PAH sources are oil and oil products.

PAH_{LMW}/PAH_{HMW} Ratio

The PAHLMW/PAHMW > 1 ratio calculated for the marine, coastal and transitional waters in the Romanian Black Sea sector indicates pollution with oil products, which is not confirmed by the low total petroleum hydrocarbon content (<200 µg/l) recorded in 2012. The values of the PAHLMW/PAHHMW ratio >1 only accounts for the extremely high concentrations of anthracene and phenanthrene (3-aromatic rings) determined not only in 2012, but also during 2006-2011. These are the dominant PAH compounds in Romanian Black Sea waters.

The statistical analysis of the PAHLMW/PAHHMW index on water bodies does not point-out significant differences between the values of the three water bodies (Fig. 1.1.5.2.2.3.)

Fl/Fl+Pyrene Ratio

The values of the fluoranthene/(fluoranthene+pyrene) ratio ranges between 0.1-1.0 and indicate pyrolytic pollution by incomplete combustion of fossil fuels (hydrocarbons, coal, oil or natural gases) in 65% of the samples, with the highest values in transitional waters.

An/178 Ratio

The anthracene/(anthracene+phenanthrene) ratio ranges between 0.05 şi 1.00 and indicates pyrolytic pollution in 99% of the samples. The statistical analysis of the An/178 index in water body types pointed-out significant differences between the values of the three water bodies (Fig. 1.1.5.2.2.4.), with the highest values in marine waters.

BA/228 Ratio

The benzo[a]anthracene/(benzo [a] anthracene+chrysene) ratio > 0.35 indicates pollution with PAHs generated by high temperature combustion for 50% of the samples, with the highest values in transitional waters.

IP/(IP+BghiP) Ratio

The indeno(1,2,3-cd)pyrene/indeno(1,2,3-cd)pyrene+benzo(g, h, i)perylene) ratio > 0.5 in 48% of the samples indicates wood and coal combustion, with the highest values in marine waters.

Total PAHs index

The total indices obtained for Romanian Black Sea waters in 2012 range between 0.55 - 17.27. In 90% of the samples, values > 4.00 were calculated, which proves the anthropogenic nature of the PAHs resulted from high temperature combustion. The statistical analysis of data shows extremely significant differences between the mean value of the index 8.86 ± 2.5, calculated in marine waters, and the value 6.59 ± 3.4, obtained in coastal and transitional waters (*t test, confidence interval 95%, p <0.0001, t=4.5, df=126, difference std. dev.=0.5*) (Fig. 1.1.5.2.2.5.).

Consequently, the total PAHs index calculated in 2012 indicates pyrolytic pollution, caused by the incomplete combustion of fossil fuels (hydrocarbons, coal, oil and oil products), with the highest values in marine waters.

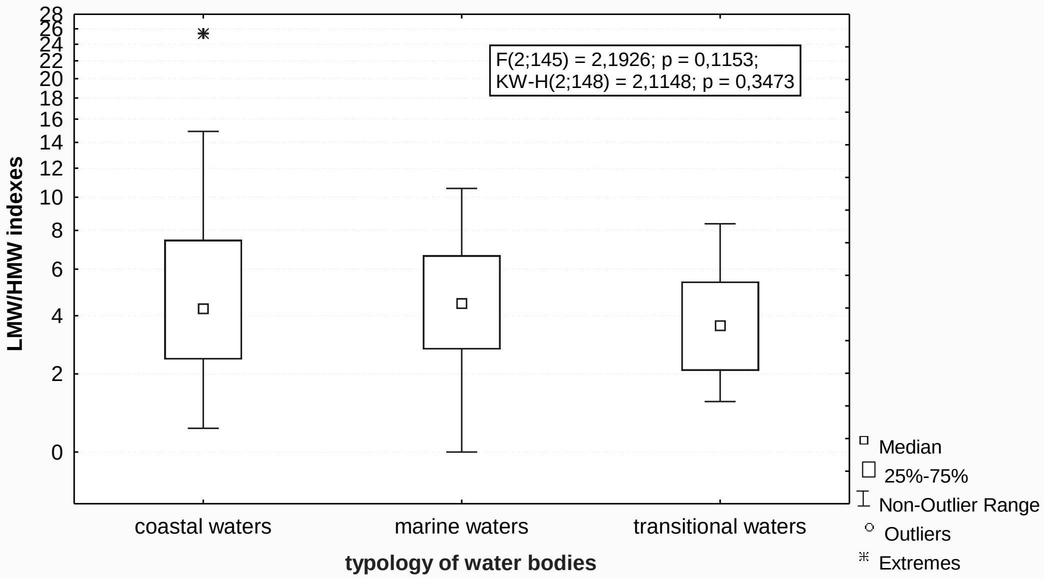


Fig. 1.1.5.2.2.3. - Distribution of the PAH_{LMW}/PAH_{HMW} ratio on water body types in the Romanian Black Sea sector, in 2012

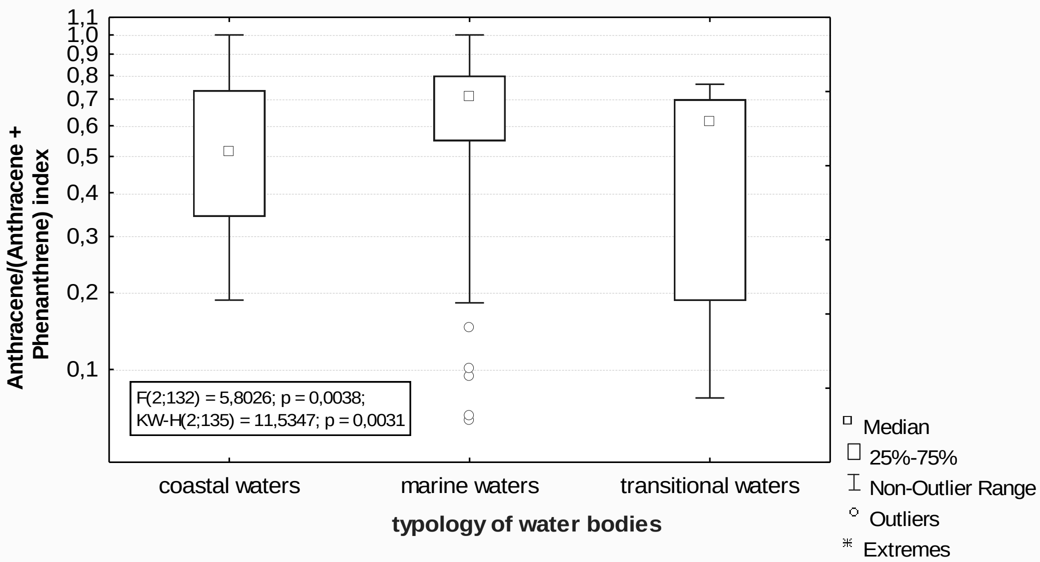


Fig. 1.1.5.2.2.4. - Distribution of the An/178 ratio on water body types in the Romanian Black Sea sector, in 2012

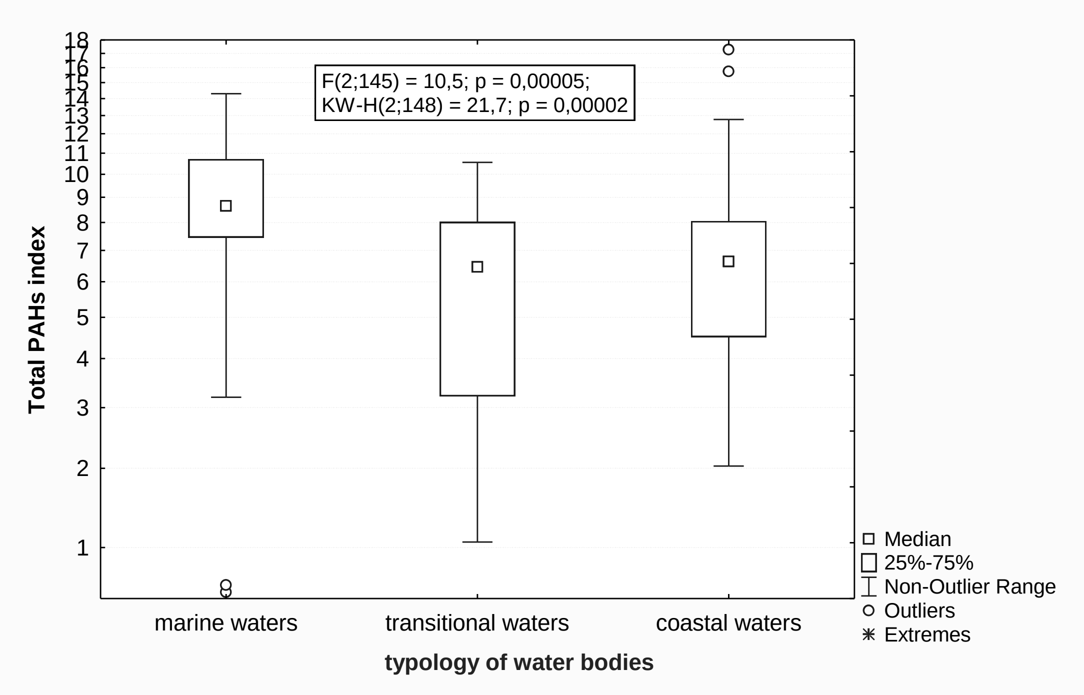


Fig. 1.1.5.2.2.5. - Distribution of the total PAH pollution index on water body types in the Romanian Black Sea sector, in 2012

The polycyclic aromatic hydrocarbon - ΣPAH - total content of the sediment samples (n=57) collected in 2012 from the Sulina - Vama Veche area ranged between 0.0310-19.4880 (µg/g), with a mean value of 2.2223 (µg/g). The ΣPAH histogram shows an extremely high pollution level in 30% of the samples, with values ranging between 2.0 – 19.5 µg/g (Fig. 1.1.5.2.2.6.) both in samples collected from the northern sector ((Mila 9 - 20 m) and the southern sector (East Constanţa St. 2 -28 m). The outlier value of 88.14 µg/g (Constanța South Waste Water Treatment Plan), recorded in March 2012, is not included in the statistical analysis of data.

The ΣPAH concentration distribution in sediments, during 2006-2012, shows that the highest values of polycyclic aromatic hydrocarbons was recorded in 2007, with a mean of 3.8618 µg/g (Fig. 1.1.5.2.2.7.). The statistical analysis of data shows significant differences between the mean of 2012 (2.2223 µg/g) and the lower mean of 2008-2011, 1.2526 µg/g (*t test, confidence interval 95%, p <0.0054, t = 2.81, df = 228, difference std. dev. = 0.345*).

The PAH monitoring in sediments indicates a very high pollution degree, with significant concentrations ranging between 0.001-9.6246 and 0.030-4.5098 (µg/g) for pyrene and fluoranthene.

Identification of potential PAH sources in sediments

The polycyclic aromatic hydrocarbon - ΣPAH - contamination level of sediments in 2012 and the identification of potential pollution sources using indices resulting from the ratios of individual compounds are given in Table 1.1.5.2.2.4. The dominant compounds in sediments were pyrene and fluoranthene (4-aromatic rings), unlike in water, where anthracene and phenanthrene (3-aromatic rings) were dominant. The calculated indices > 8 for Romanian Black Sea waters and sediments in 2012 indicated pollution with PAHs resulting from the incomplete combustion of fossil fuels (hydrocarbons, coal, oil and natural gases).

Table 1.1.5.2.2.4. - Indices used in identifying the main PAH sources in Romanian Black Sea waters and sediments in 2012

ΣPAH pollution index values	**Water (µg/l) n=148**	**Sediments (µg/g) n=57**
ΣPAH	1.699 ± 0.92	2.222 ± 3.46
% **ΣPAH** - 2-3 aromatic rings*	78.1 ± 12.1	55.9 ± 30.9
% **ΣPAH** - 4 aromatic rings**	14.6 ± 10.1	37.5 ± 32.4
% **ΣPAH** - 5 aromatic rings***	7.4 ± 9.2	5.4 ± 7.7
% **ΣPAH** - 6 aromatic rings****	3.6 ± 3.1	1.1 ± 2.1
% **ΣPAH** - 4-5-6 aromatic rings	22.3 ± 13.7	44.0 ± 30.9
PAHLMW/ PAHHMW	4.8 ± 3.1	4.4 ± 7.7
Fl / Fl+Pyrene	0.6 ± 0.3	0.6 ± 0.2
An / 178	0.6 ± 0.2	0.4 ± 0.4
BA / 228	0.4 ± 0.2	0.5 ± 0.2
IP / IP +BghiP	0.7 ± 0.3	0.4 ± 0.2
Total PAH index	8.1 ± 3.0	8.4 ± 3.3

* abundance of 2-3 aromatic ring PAHs: naphtalene, acenaphthylene, acenaphtene,fluorene, phenanthrene, anthracene;
** abundance of 4 aromatic ring PAHs: fluoranthene, pyrene, benzo[a]anthracene, chrysene;
*** abundance of 5 aromatic ring PAHs: benzo[b]fluoranthene, benzo[k]fluoranthene; benzo[a]pyrene, dibenzo(a,h)anthracene;
**** abundance of 6 aromatic ring PAHs: indeno(1,2,3-c,d)pyrene, benzo (g,h,i)perylene

In conclusion, in 2012, the analysis of polycyclic aromatic hydrocarbons pointed-out high values for the following pollutants: pyrene, fluoranthene, anthracene, phenanthrene and benzo[a]anthracene. The mean values were within similar variation ranges compared to 2006-2011.

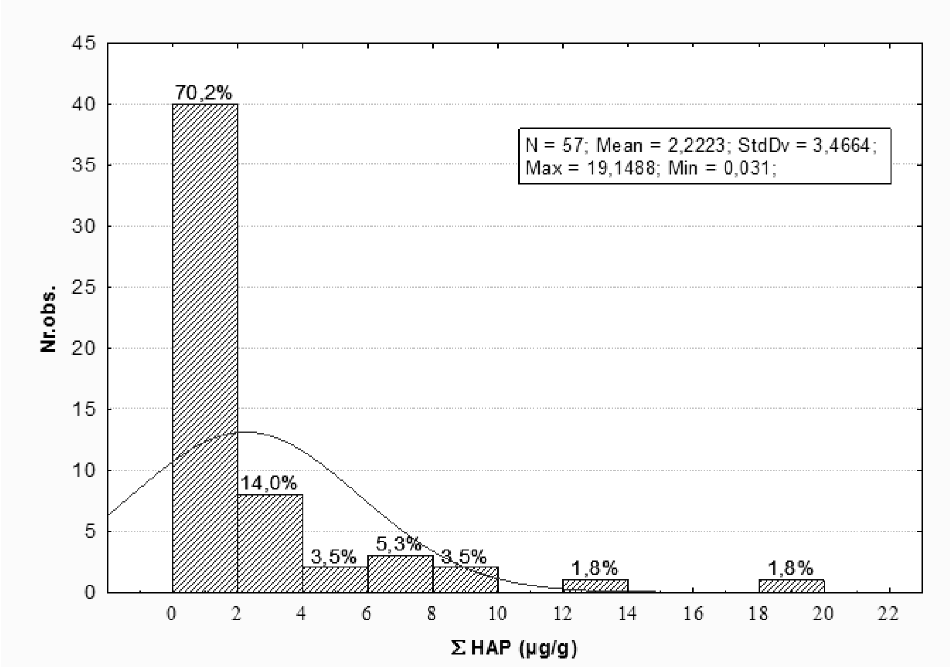


Fig. 1.1.5.2.2.6. - Histogram of the polycyclic aromatic hydrocarbons - ΣPAH - (µg/g) content in Romanian Black Sea sector sediments, in 2012

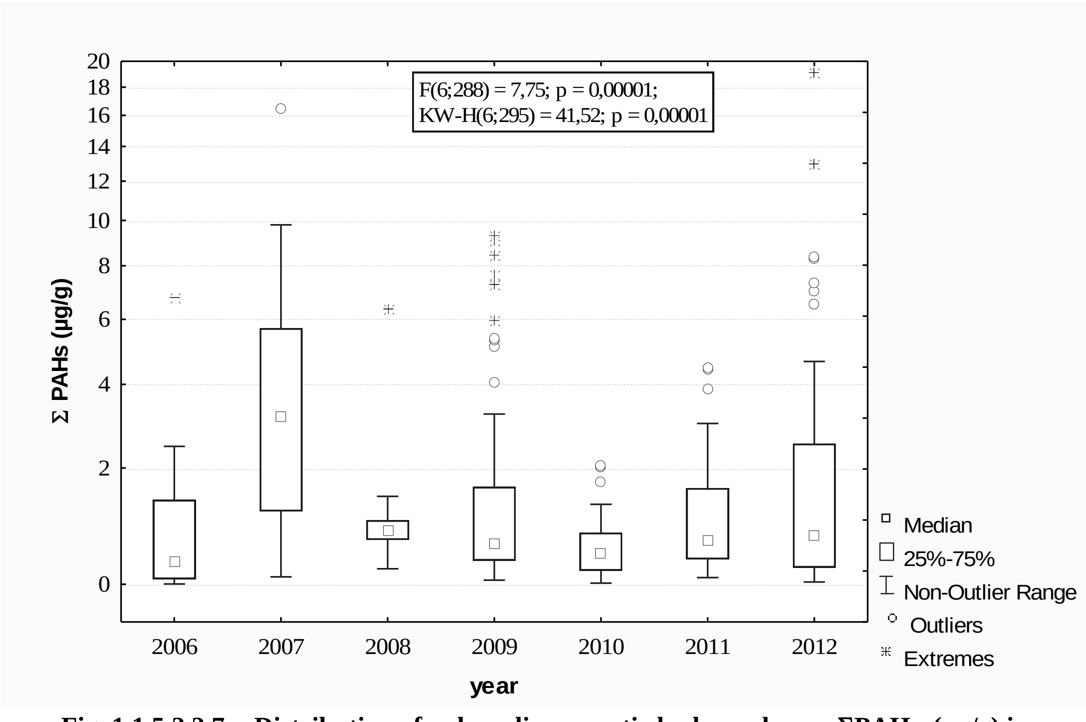


Fig. 1.1.5.2.2.7. - Distribution of polycyclic aromatic hydrocarbons - ΣPAH - (µg/g) in Romanian Black Sea sediments, 2006-2012

1.1.5.3. ORGANOCHLORINE PESTICIDES

The total content of the nine investigated compounds (HCB, lindane, heptachlor, aldrin, dieldrin, endrin, p,p' DDE, p,p' DDD, p,p' DDT) in water and sediment samples frames within the following ranges for the analyzed environmental components: 0.0183 - 0.260 in water (Σμg/l) and 0.0017 - 0.17 in sediments (Σμg/g).

In water, the mean values of the compounds ranged between: 0.002 - 0.027μg/l in coastal waters, 0.002 - 0.025 μg/l in marine waters and 0.003 - 0.062 μg/l in transitional waters.

In 2012, littoral waters were dominated by the occurrence of lindane, for which the highest values were measured in most stations, in transitional, as well as in coastal and marine waters. The highest concentrations of organochlorine pesticides were measures in transitional waters, especially in the Portița area (lindane - 0.2027 μg/l, heptachlor - 0.0760 μg/l, aldrin - 0.130 μg/l, dieldrin - 0.050 μg/l, p,p' DDE - 0.0188 μg/l). However, high concentrations of organochlorine pesticides were also noted in coastal waters between Constanța South and Vama Veche (Fig. 1.1.5.3.1., Fig. 1.1.5.3.2., 1.1.5.3.3.)

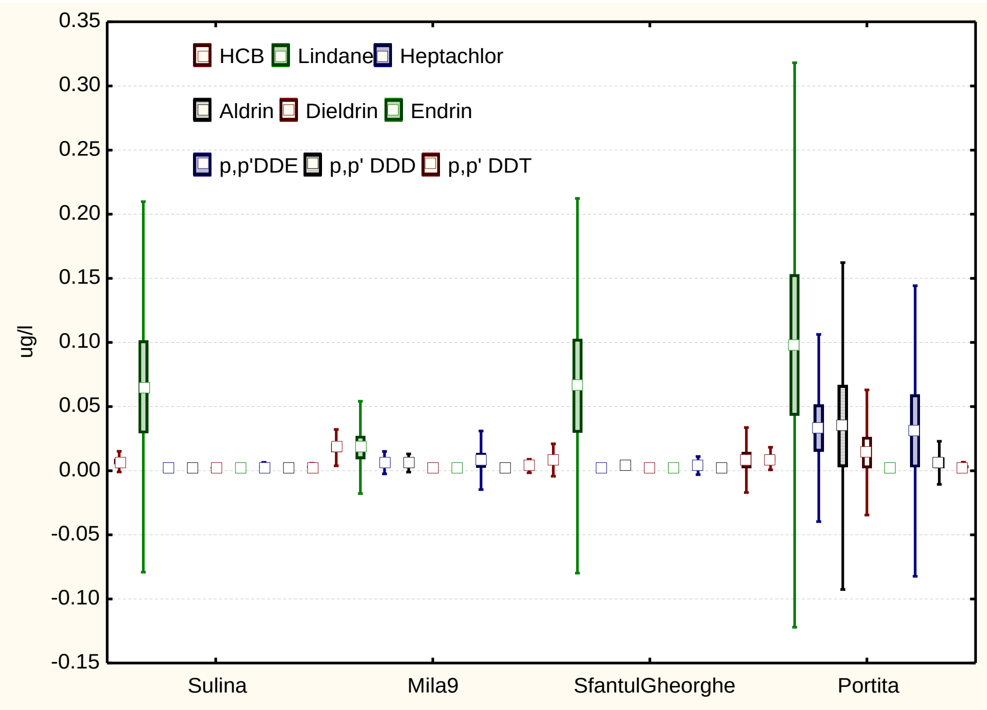


Fig. 1.1.5.3.1. - Mean values, means±SD, means±2SD of organochlorine pesticides in transitional waters in 2012

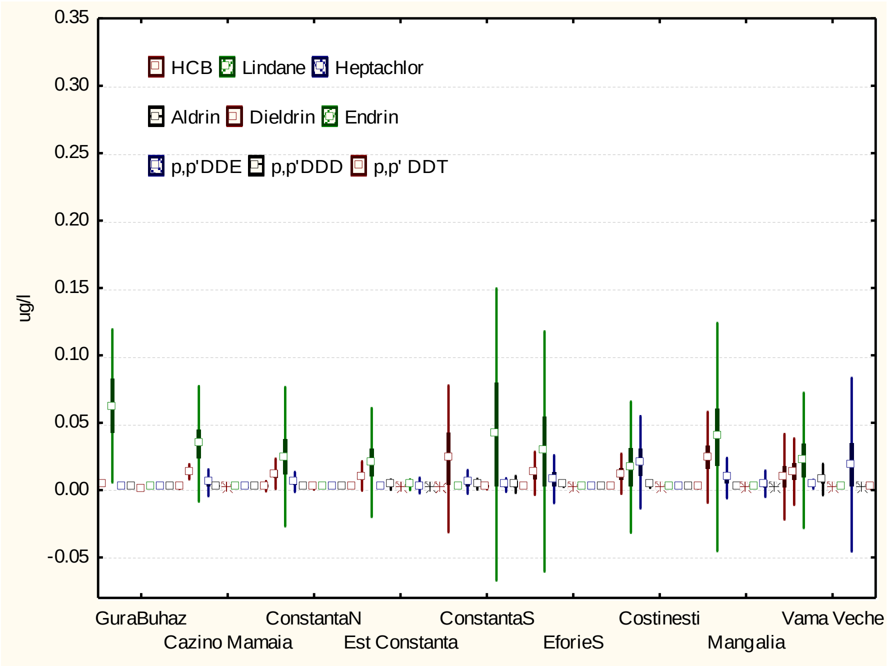


Fig. 1.1.5.3.2. - Mean values, means±SD, means±2SD of organochlorine pesticides in coastal waters in 2012

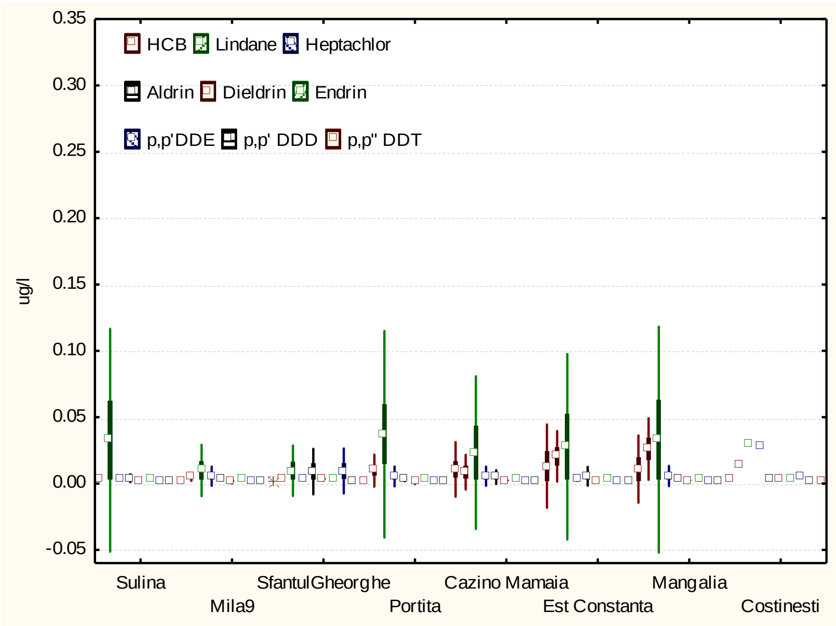


Fig. 1.1.5.3.3. - Mean values, means±SD, means±2SD of organochlorine pesticides in marine waters in 2012

In sediments, the mean values of compounds ranged between: 0.0005 - 0.0048 µg/g in coastal waters, 0.00035 - 0.0041 µg/g in marine waters and 0.0002 - 0.002 µg/g in transitional waters.

In sediments pertaining to transitional and coastal waters, the dominant compounds were lindane, aldrin, p,p' DDT and its metabolites. The highest concentrations were measured in sediments pertaining to transitional waters, in the Sulina area (lindane - 0.0171 µg/g dry sediment; p,p' DDD - 0.0101 µg/g dry sediment), and in sediments pertaining to coastal waters, in the Constanța South area (lindane - 0.0195 µg/g dry sediment; p,p' DDE - 0.0394 µg/g dry sediment; p,p' DDD - 0.0869 µg/g dry sediment; p,p' DDT - 0.0196 µg/g dry sediment) (Fig. 1.1.5.3.4. and Fig. 1.1.5.3.5.).

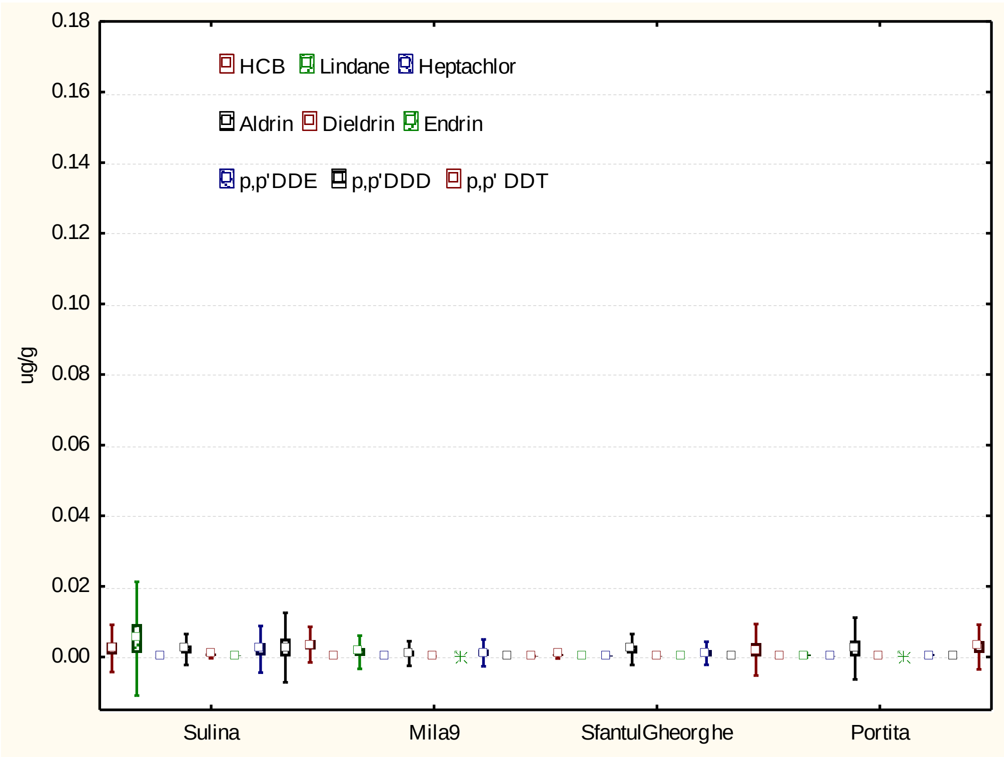


Fig. 1.1.5.3.4.- Mean values, means±SD, means±2SD of organochlorine pesticides in sediments pertaining to transitional waters in 2012

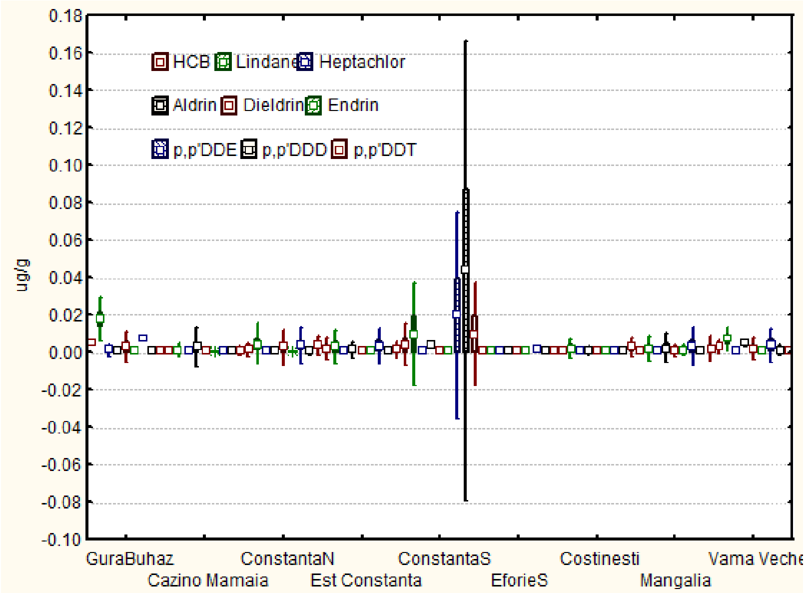


Fig. 1.1.5.3.5. - Mean values, means±SD, means±2SD of organochlorine pesticides in sediments pertaining to coastal waters in 2012

In sediments pertaining to marine waters, there are no dominat compounds, only scattered occurrences of higher concentrations (heptachlor - 0.0593 µg/g dry sediment, in the Sfântu Gheorghe area; lindane - 0.0310 µg/g dry sediment, in the Portiţa area) (Fig. 1.1.5.3.6.).

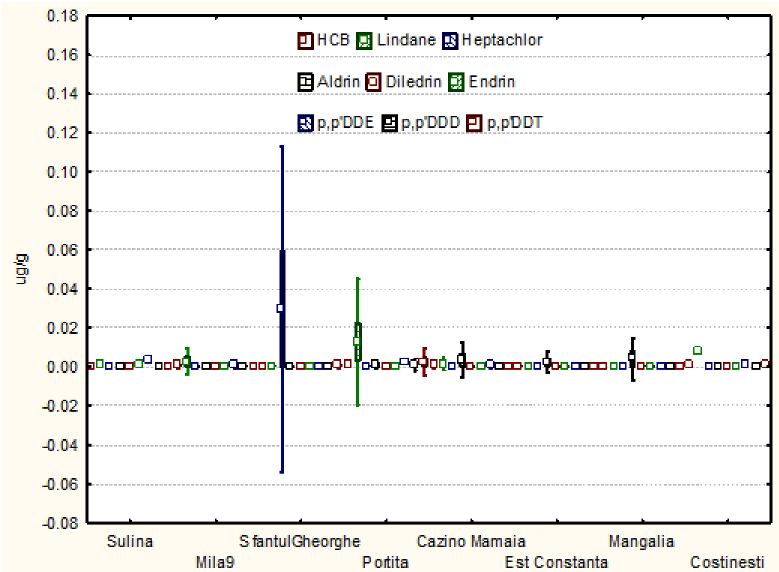


Fig. 1.1.5.3.6. - Mean values, means±SD, means±2SD of organochlorine pesticides in sediments pertaining to marine waters in 2012

In molluscs (*Mytilus*, *Rapana*, *Scapharca*, *Mya*), bioaccumulation was more intense in the species *Rapana* and *Mya*, for most investigated compounds (Fig. 1.1.5.3.7.).

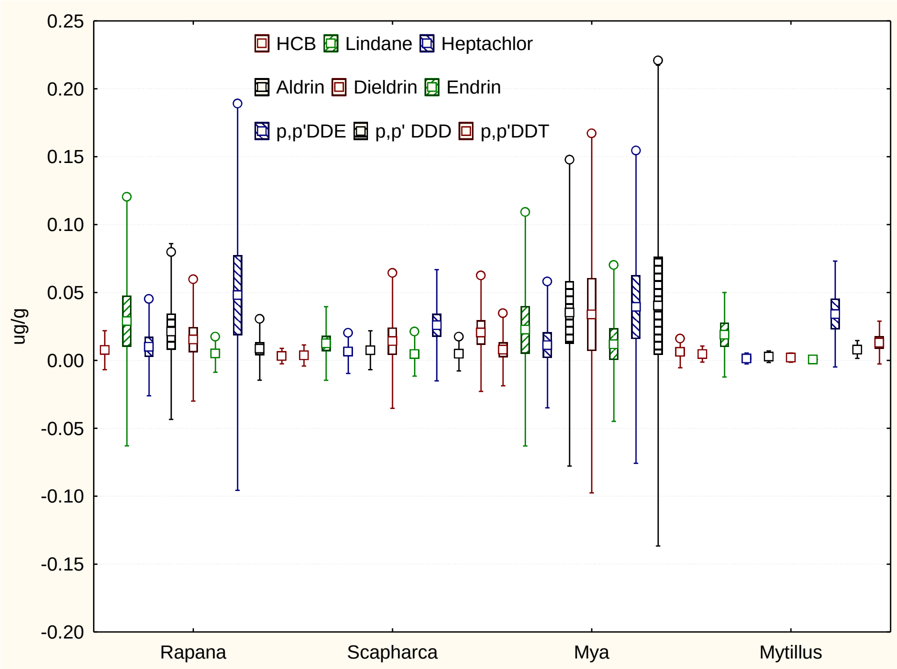
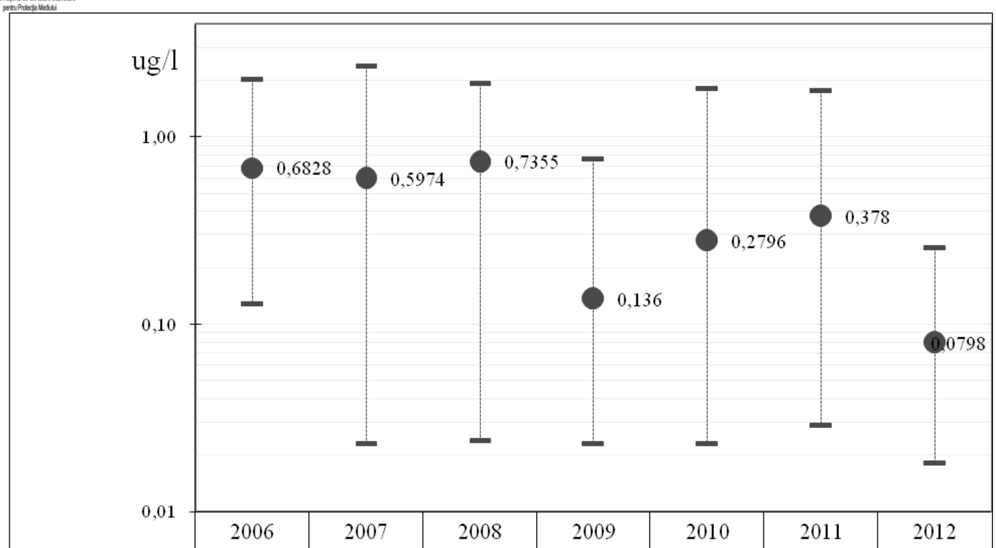


Fig. 1.1.5.3.7. - Mean values, means±SD, means±2SD of organochlorine pesticides in molluscs in 2012

The highest concentrations were measured in the species *Mya* in the Portiţa area (HCB - 0.0347 µg/g dry tissue; lindane - 0.1093 µg/g dry tissue; heptachlor - 0.0581 µg/g dry tissue; aldrin - 0.1478 µg/g dry tissue; dieldrin - 0.1673 µg/g dry tissue; endrin - 0.070 µg/g dry tissue; p,p' DDE - 0.1545 µg/g dry tissue; p,p' DDD - 0.2209 µg/g dry tissue) and in the species *Rapana* in the Mamaia area (HCB - 0.0190 µg/g dry tissue; lindane - 0.1204 µg/g dry tissue; heptachlor - 0.0454 µg/g dry tissue; aldrin - 0.0799 µg/g dry tissue; dieldrin - 0.0599 µg/g dry tissue; endrin - 0.0174 µg/g dry tissue; p,p' DDE - 0.1891 µg/g dry tissue; p,p' DDD - 0.0307 µg/g dry tissue).

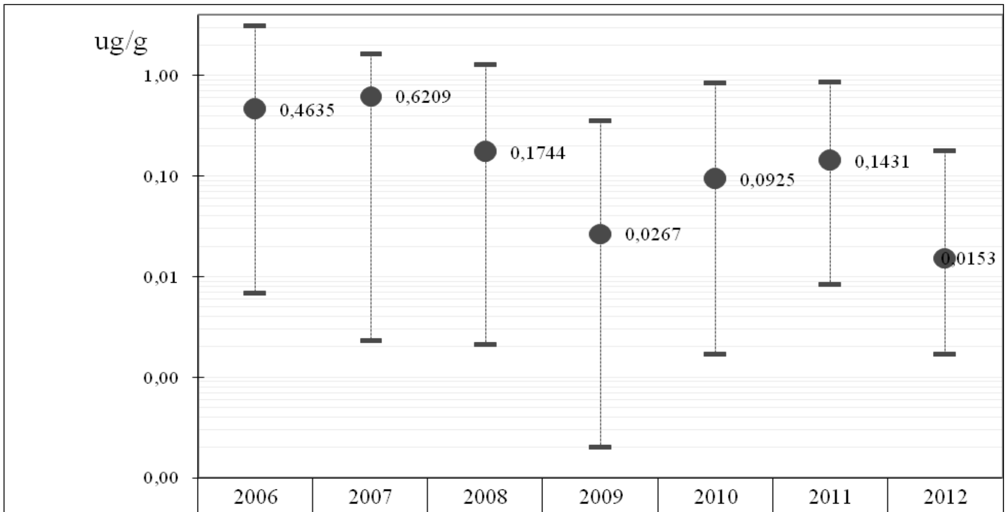
The time series analysis (2006 - 2012) of organochlorine pesticide pollution showed that, in 2012, both in water and in sediments, compared to 2006-2008, the decreasing trend of organochlorine pesticide concentrations of the past years (2009-2011) is maintained, for most investigated compounds (Fig. 1.1.5.3.8. and Fig. 1.1.5.3.9.).

In the biota, the trend is not as obvious, the concentrations remaining within the same variation range of the previous period.



	2006	2007	2008	2009	2010	2011	2012
maximum ug/l	2,0246	2,3715	1,9212	0,76	1,805	1,7517	0,2559
media ug/l	0,6828	0,5974	0,7355	0,136	0,2796	0,378	0,0798
minimum ug/l	0,1279	0,023	0,024	0,023	0,023	0,029	0,0182

Fig. 1.1.5.3.8. - Total organochlorine pesticide content - Σ (μg/l) in water in 2012, compared to 2006-2011, Sulina - Vama Veche area



	2006	2007	2008	2009	2010	2011	2012
maximum ug/g	3,0841	1,6289	1,2894	0,3504	0,8355	0,8497	0,1789
media ug/g	0,4635	0,6209	0,1744	0,0267	0,0925	0,1431	0,0153
minimum ug/g	0,0069	0,0023	0,0021	0,0002	0,0017	0,0084	0,0017

Fig. 1.1.5.3.9. - Total organochlorine pesticide content - Σ (μg/l) in sediment in 2012, compared to 2006-2011, Sulina - Vama Veche area

In conclusion, in 2012, littoral waters were dominated by lindane, in transitional, as well as in coastal and marine waters, while in sediments pertaining to transitional and coastal waters the dominant compounds were lindane, aldrin p'p' DDT and its metabolites. In biota, the bioaccumulation phenomenon was more intense for the species *Rapana* and *Mya*, for most investigated compounds. In 2012, both in water and in sediments, compared to 2006-2008, the decreasing trend of organochlorine pesticide concentrations of the past years (2009-2011) is maintained, for most investigated compounds.

1.1.5.4. MICROBIOLOGICAL LOAD

The microbiological load, a state indicator of contaminants in the marine environment, was good in the southern part of the Romanian Black Sea during 2012; the concentrations of enteric bacteria [total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS)] were generally found varying below the limits of the National Regulations and EC Bathing Water Directive and the values indicating the level of faecal pollution of bathing seawater (Fig. 1.1.5.4.1.).

The frequency of exceeding mandatory and guide values registered in 2011 in some bathing areas (5% for FS) was lower in comparison with the last year (2011), mainly due to not observing the general sanitary-hygienic norms by tourists during the hot summer season of 2011, with high shallow coastal seawater temperature (more than 27°C).

The situation identified during the summer season of 2012 reflects an evolution of bathing seawater quality greatly dependent on the particular hydro-meteorological conditions of the past five years (2008 - 2012), characterized by extremely hot weather in summer, with increased values of shallow coastal seawater temperature.

The maximum values of the analyzed bacterial indicators (>16,000 germs/100 ml) were identified, as in previous years, in areas influenced by waste water discharges, with a potential negative impact on the marine environment and human health.

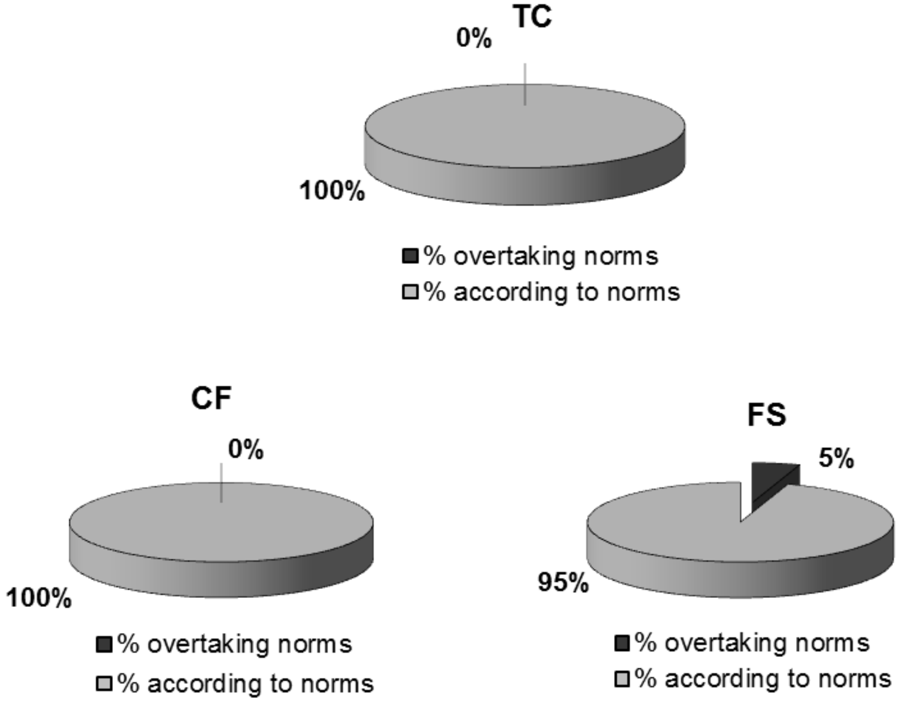


Fig. 1.1.5.4.1. - The percentage (%) of Romanian coastal bathing waters (Mamaia - Vama Veche) overtaking the mandatory and guide values (95 % < 10,000 per 100 ml mandatory value for TC; 95 % < 2,000 per 100 ml mandatory value for FC and 100 per 100 ml reccomended value for FS) of the National Regulations and EC Bathing Water Directive (2008/56/EEC), during April-October 2012

2.1. STATE OF THE MARINE ECOSYSTEM AND MARINE LIVING RESOURCES

2.1.1. PHYTOPLANKTON

The identification of the qualitative and quantitative structure of the phytoplankton component, as an indicator of the eutrophication status, was made as a follow-up of the analysis of samples collected in April and October from the Sulina, Mila 9, Sf. Gheorghe, Portița, Gura Buhaz, Casino, Constanța, Eforie South, Costineşti, Mangalia and Vama Veche transects, along the Romanian coast, on the 5 m, 20 m and 30 m isobaths, as well as of the samples collected twice a week from the Casino Mamaia station.

The composition of the phytoplankton comprised 107 species, with varieties and forms belonging to 7 taxonomic groups (Bacillariophyta, Dinoflagellata, Chlorophyta, Cyanobacteria, Chrysophyta, Cryptophyta and Euglenophyta). The highest number of species were identified in transitional and coastal waters, where diatoms were dominant (31 and 29 species, respectively) (Fig. 2.1.1.1.), followed by dinoflagellates. In marine waters, along with diatoms (35%), the share of the other groups together was equal to diatoms (35%), among these chlorophytes (11%) and chrysophytes (9%) being dominant.

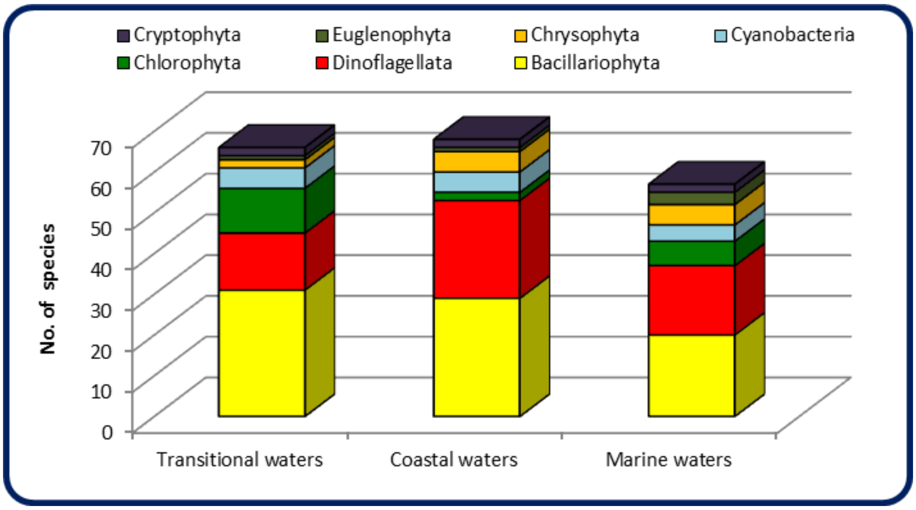


Fig. 2.1.1.1. - Taxonomic composition of the phytoplankton living in the Romanian Black Sea waters, in 2012

The abundance and biomass of phytoplankton in April was characterized by high spatial variability. Phytoplankton densities varied between $6.72 \cdot 10^3$ and $11.2 \cdot 10^6$ $cel \cdot l^{-1}$ and 0.92 and 3420.10 $mg \cdot m^{-3}$. The abundance distribution on water body types (Fig. 2.1.1.2.) shows large variations, up to 5 size orders, between phytoplankton densities and biomasses, the peaks being recorded in transitional and marine waters. Thus, the highest phytoplankton densities in transitional waters were recorded in the Sf. Gheorghe and Mila 9 stations, on the 5 m isobath ($11.2 \cdot 10^6$ and $9.6 \cdot 10^6$ $cel \cdot l^{-1}$), where the biomasses recorded the peaks of this month, too (3.42 and 3.12 $g \cdot m^{-3}$). In marine waters, off the Danube mouths, a high phytoplankton development was found, with values reaching 10 million $cel \cdot l^{-1}$, the peaks being recorded on the 30 m isobaths, off Sulina and Mila 9. Southwards, phytoplankton development was poor in marine waters in about 98% of the cases, only the Constanța offshore station hardly reaching abundances of $150 \cdot 10^3$ $cel \cdot l^{-1}$. Concerning the biomass, the values overtake in most of the stations 1 $g \cdot m^{-3}$, in waters under the direct influence of the Danube, due to the bloom of the diatom *Skeletonema costatum*, characteristic for the spring season.

In coastal waters, the extent of phytoplankton development is much lower compared to transitional and marine waters, the peak of abundances was recorded in the Constanța South station - 20 m isobath - and Mangalia - 5 m isobath ($100.3 \cdot 10^3$ $cel \cdot l^{-1}$ and $168 \cdot 10^3$ $cel \cdot l^{-1}$).

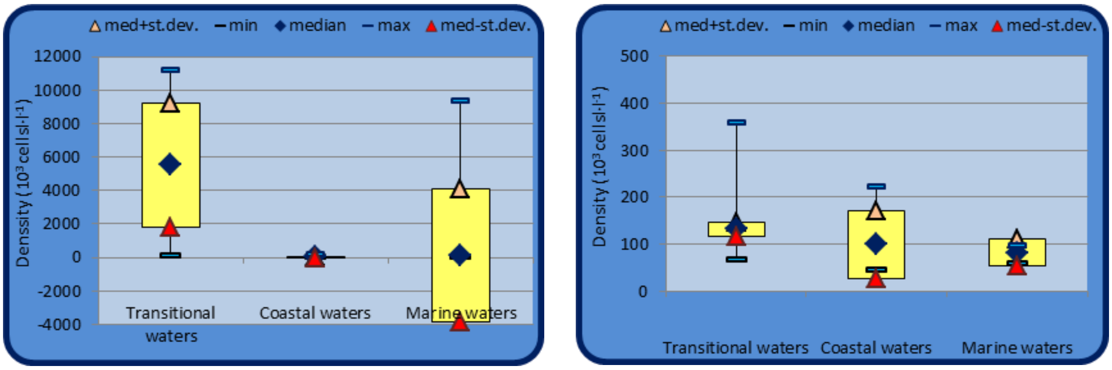


Fig. 2.1.1.2. - Distribution of densities ($cel \cdot l^{-1}$) in Romanian transitional, coastal and marine waters in April (left) and October (right) 2012

Concerning the quantitative structure of phytoplankton in April 2012, diatoms were clearly dominant both as density and as biomass (over 90%) in transitional and marine waters. In coastal waters, non-diatoms were dominant, of which dinoflagellates reached approx. 70% of the biomass and the other groups, especially chrysophytes and cryptophytes reaching approx. 23% in biomass and 37% in density. Among freshwater species encountered in transitional waters, most do not develop greatly in number, vegetating for a limited period of time due to Danube input. Among the dominant fresh-brackish water species, we mention: *Melosira sulcata*, *M. granulata v. angustissima*, *Nitzschia acicularis*, *Diatoma elongatum*, the chlorophytes *Ankistrodesmus arcuatus*, *Scenedesmus quadricauda*, *Crucigenia tetrapedia*, *Actinastrum hantzschii* and the cianobacteria *Dactylococcopsis irregularis*, *Chroococcus minutus*, *Microcystis aeruginosa*.

In waters in the south of the coast, the high diversity of dinoflagellates determined a high biomass and biovolume thereof, among these species mentioning: *Katodinium rotundatum*, *Peridinium quinquecorne*, *Scrippsiella trochoidea*, *Heterocapsa triquetra*, *Peridinium minusculum*, *Gyrodinium fusiforme*.

On the entire studied area, diatoms were clearly dominant, the most significant species being *Skeletonema costatum*, which reached more than 90% in density and biomass. This species recorded the highest densities on the Sf. Gheorghe (5 m isobath - $10.9 \cdot 10^6$ $cel \cdot l^{-1}$), Mila 9 (5 m isobath - $9.4 \cdot 10^6$ $cel \cdot l^{-1}$), Sulina (30 m isobath - $9.3 \cdot 10^6$ $cel \cdot l^{-1}$) transects.

2012 was characterized by a poor development of the phytoplankton community (the mean of phytoplankton amounts in spring $2.85 \cdot 10^6$ cel·l^{-1} and 1.06 g·m^{-3} and in autumn $96.6 \cdot 10^3$ cel·l^{-1} and 0.38 g·m^{-3}), while algal bloom phenomena were absent throughout the year, except for the developments of the diatom *Skeletonema costatum*, characteristic for the marine ecosystem in spring.

Algal blooms

In 2012, three species developed more than 1 million cells per liter, similar to 2011, yet with a decreasing trend compared to the 8 species in 2010 and 6 species in 2009. Among these, the species *Skeletonema costatum* recorded an extensive blooming phenomenon both in shallow waters in Mamaia (33.9 $\cdot 10^6$ cel·l^{-1}) and on the entire Romanian continental shelf, mainly in the north of the coast, in March and April. The other two species with very high densities were the diatom *Nitzschia delicatissima*, in May (peak density - 3.15 $\cdot 10^6$ cel·l^{-1}) (Fig. 2.1.1.3.) and the dinoflagellate *Peridinium quinquecorne*, with a peak of $1.02 \cdot 10^6$ cel·l^{-1} in June.

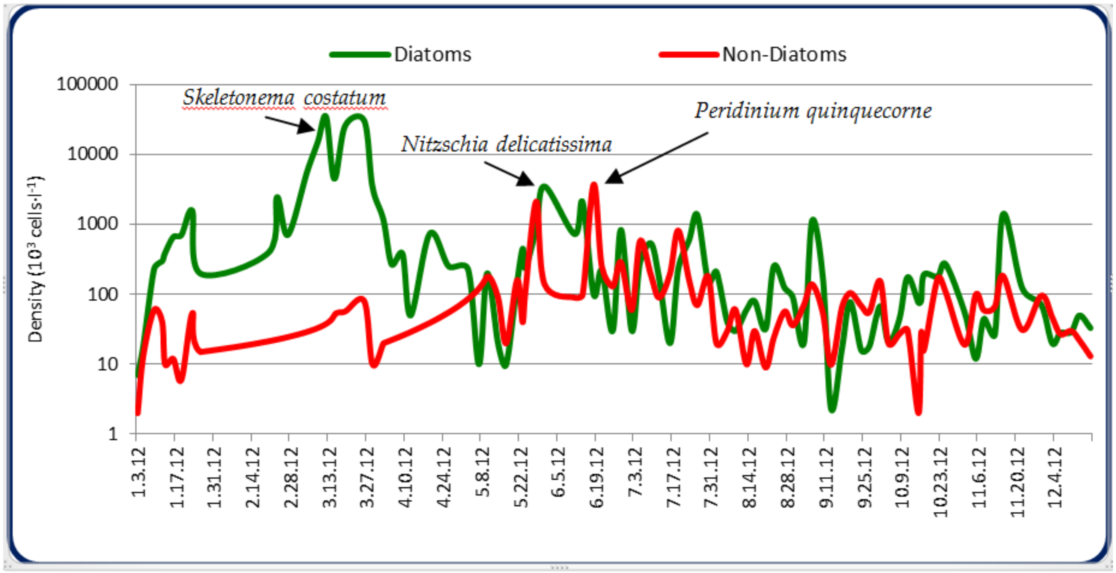


Fig. 2.1.1.3. - Phytoplankton dynamics (10^3 cel·l^{-1}) in the shallow waters of Mamaia in 2012

2.1.2. ZOOPLANKTON

In 2012, the zooplankton was characterized based on two sets of samples collected in April and October. The total zooplankton was dominated during both periods by the fodder component, which, however, recorded mean density and biomass values lower than the previous years (Fig. 2.1.2.1.).

The mean density and biomass of the non-fodder zooplankton recorded lower values compared to previous years also due to the fact that its peak development seasons (summer) was not included (the sea surveys only covered the zooplankton structure in spring and in autumn) (Fig. 2.1.2.2.).

The fodder component recorded its development peak in the coastal area of the southern littoral both in spring and in summer (Fig. 2.1.2.2.)

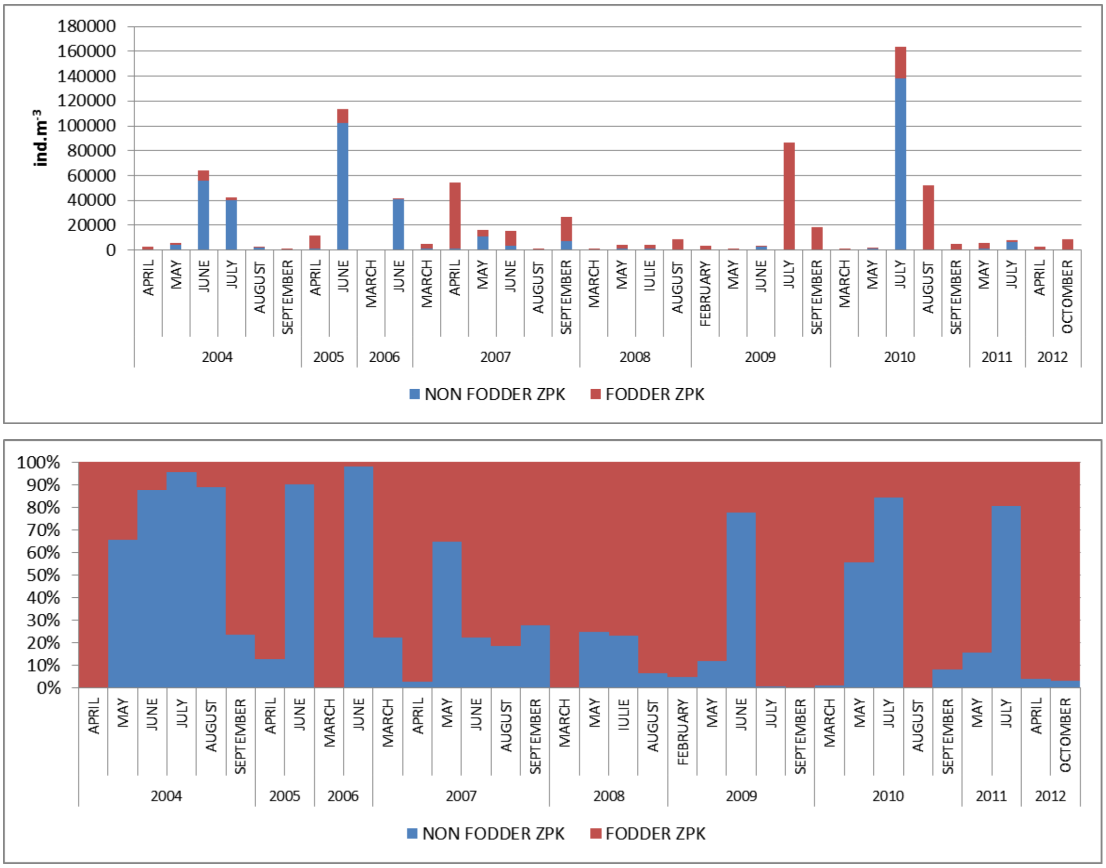


Fig. 2.1.2.1. - Evolution of the density structure (ind./m^{-3}) of the total zooplankton during 2004 - 2012

From the quality composition point of view, in spring the dominant organisms were copepodes, mainly represented by *Acartia clausi* and *Pseudocalanus elongatus.* In autumn, the qualitative structure was dominated by copepodes and cladocerans, mainly represented by *Acartia clausi*, *Centropages ponticusmult*, *Pleopis polyphaemoides* and *Penilia avirostris* (Fig. 2.1.2.2.).

30 taxa, belonging to 12 taxonomic groups, were identified in the qualitative structure of zooplankton, the highest number since 2004 to the present.

The dinoflagellate *Noctiluca scintilans*, the copepods *Acartia clausi*, *Pseudocalanus elongatus*, *Paracalanus parvus* and *Centropages ponticus*, the cladoceran *Pleopis polyphemoides*, the appendicular *Oikopleura dioica* and the chaetognate *Parasagitta setosa* were constantly present in the analyzed samples. In addition, in the north of the Romanian coast, freshwater species were also encountered - *Daphnia cuculata*, *Bosmina longirostris, Podon sp.*, as a follow-up of Danube input.

Among non-indigenous species, the ctenophores *Mnemiopsis leidyi*, *Beroe ovata* and the copepod *Oithona davisae* (erroneously identified in the past as *Oithona brevicornis*) were also reported.

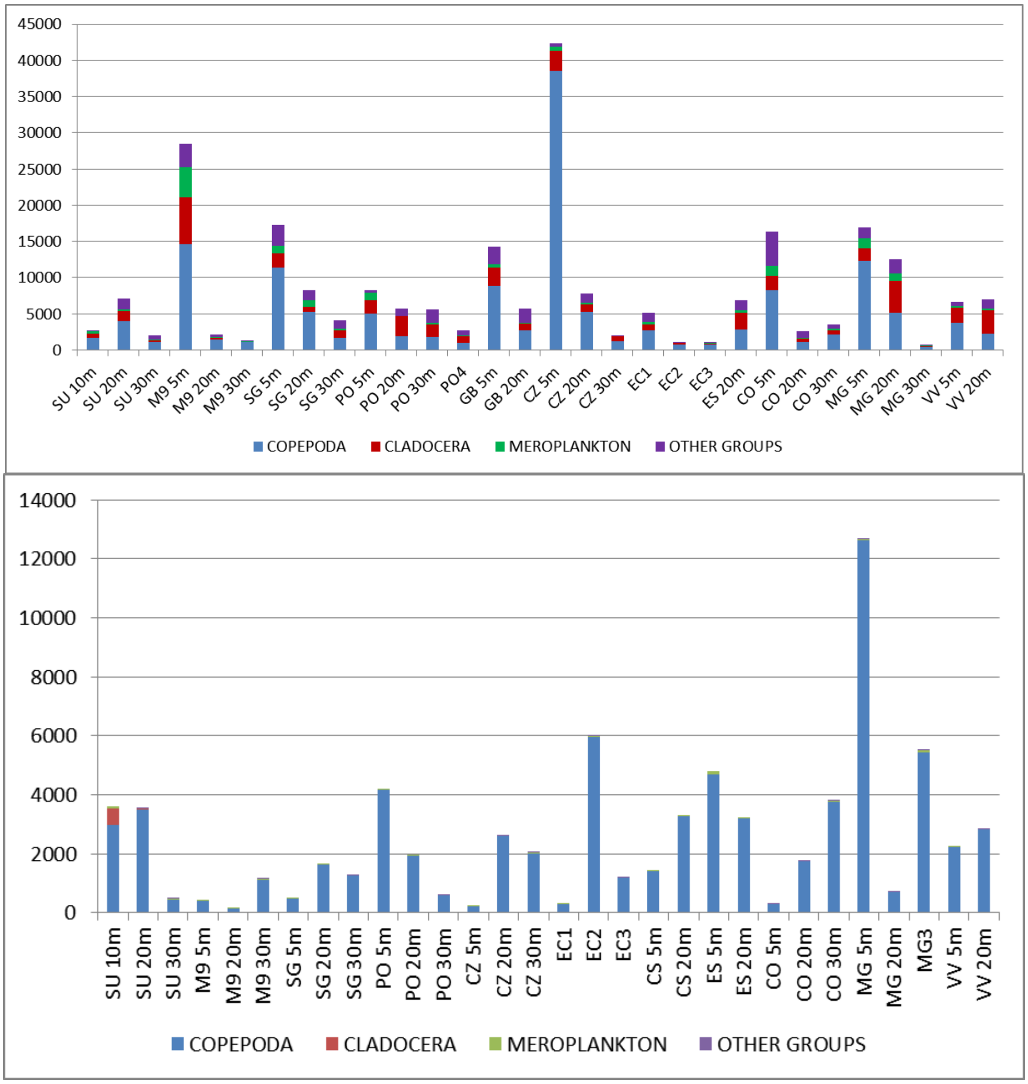


Fig. 2.1.2.2. - Evolution of the density structure (ind./m^{-3}) of the trophic zooplankton in April (up) and October (down) in 2012

2.1.3. PHYTOBENTHOS

For 2012, a qualitative and quantitative analysis of phytobenthic samples was performed, based on a number of 75 samples collected during the summer season. The samples were collected from profiles and stations considered representative regarding the algal flora, following the coastal line: Năvodari, Casino Constanța, Eforie North, Eforie South, Tuzla, Costineşti, Mangalia, 2 Mai şi Vama Veche. Based on the qualitative analysis, in summer 2012, 20 taxa were identified, assigned to phyla as follows: 9 species belonging to phylum Chlorophyta, 1 species - phylum Phaeophyta (*Cystoseira barbata*), 8 species belonging to the phylum Rhodophyta (8 species and one variety, namely *Ceramium rubrum* var. *barbatum*) and 2 phanerogams (*Zostera (Zosterella) noltei* and *Stuckenia pectinata*).

Opportunistic species have developed abundantly in the summer 2012 as a result of favorable environmental conditions (high water temperatures, large amounts of nutrients, a favorable transparency for photosynthesis process - Fig. 2.1.3.1.). Among the green algae, high fresh biomasses were developed by *Cladophora vagabunda* (1800 g/m^2 wet weight) and *C. sericea* (1700 g/m^2 w.w.) and from the red ones - *Ceramium rubrum* var. *barbatum* (approx. 1000 g/m^2 w.w.). These species were identified during the summer season in samples and in shore deposits, especially in the northern part of the Romanian coast; in the southern part predominated the *Ulva* species (*U. lactuca* - 1200 g/m^2 w.w.), *U. intestinalis* - 770 g/m^2 w.w.), as associated species of the existing *Cystoseira barbata* fields in those areas.

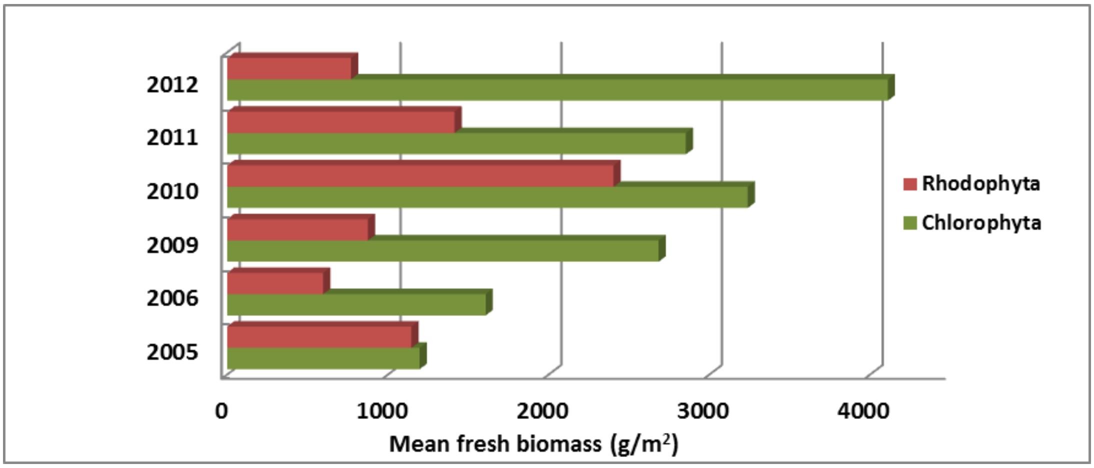


Fig. 2.1.3.1. - Mean wet weight for the dominant groups along the Romanian coast during summer seasons 2005 - 2012

A clear dominance of opportunistic green algae in the northern sector of the Romanian seaside can be noticed and the presence of the brown algae *Cystoseira barbata* at Mangalia, 2 Mai and Vama Veche, where it is known that marine waters have a higher quality that allowed the recovery and the existence of this key species for the marine ecosystem (Fig. 2.1.3.2.). At Mangalia, in summer were observed well-developed thickets of *Cystoseira barbata*, epiphyted by *Cladophora vagabunda*, *Ceramium diaphanum* var. *elegans* and by *Callithamnion corymbosum.* The fresh biomass developed by this species was high (4,300 g/m^2 w.w.), similar to that reported in the previous year (4,700 g/m^2 w.w.), indicating that this species maintains a stable trend of development in this area.

At 2 Mai, on rocky substrate exists a well developed *Cystoseira* field (between 1-3 m depth), with high specimens of *Cystoseira barbata,* epiphyted by small specimens of *Ceramium virgatum* and at the base of the thalli - *Ulva lactuca*, the dominant associated field species identified during summer. On the elastic surface of the thalli, mussels and bryozoa colonies were present, sustaining the importance of this perennial brown algae for the ecosystem, as a species that provide support for the existence of other organisms.

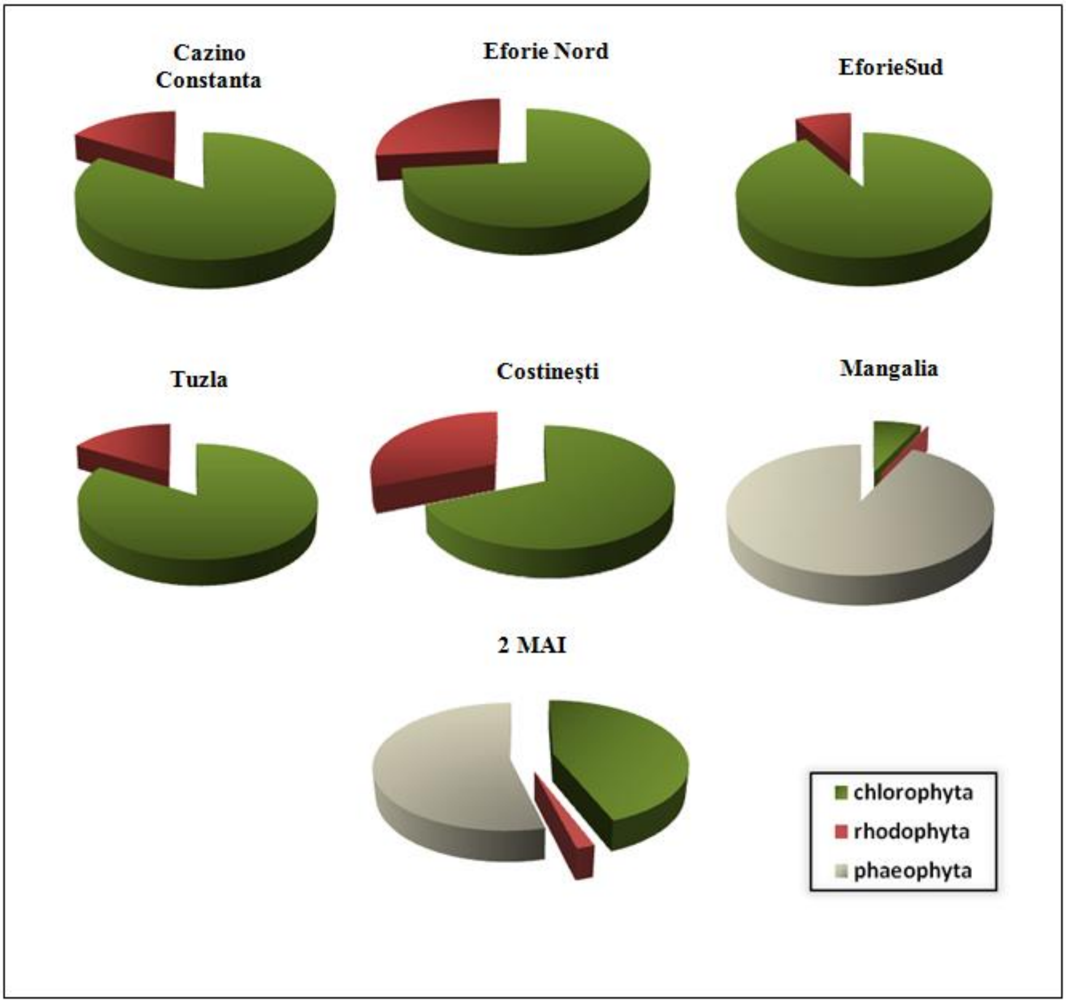


Fig. 2.1.3.2. - The share of phytobenthic species biomasses at the Romanian coast during the summer of 2012

Vama Veche is known from previous studies as the area where *Cystoseira barbata* forms an extended field (between 1-3 m), with mature specimens and a rich associated fauna (Fig. 2.1.3.3.). Also at Vama Veche was observed the presence of the perennial red algae *Corallina officinalis*. In the southern part of the shore the biomasses of the opportunistic species were much lower compared to other analyzed areas (Fig. 2.1.3.3.), in these areas remarking the presence of the perennial species *Cystoseira barbata* and *Zostera (Zosterella) noltei*.

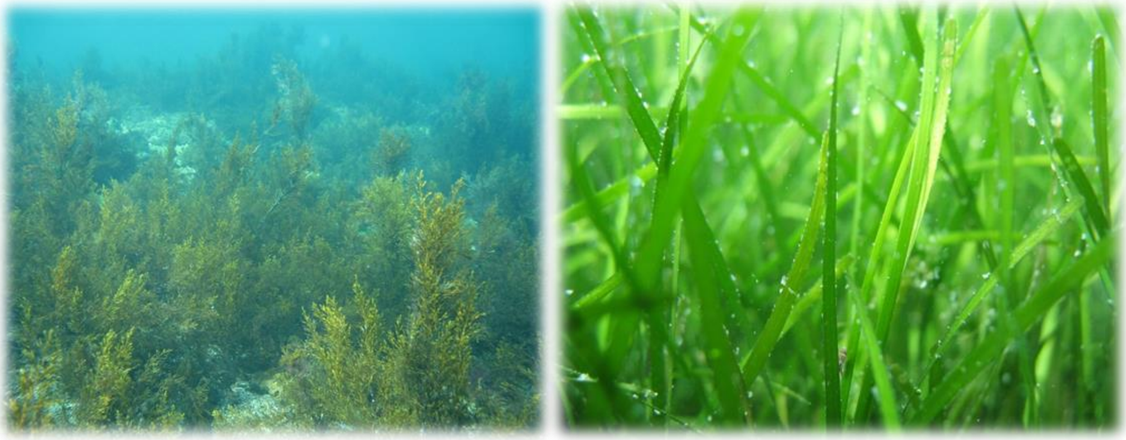


Fig. 2.1.3.3. - *Cystoseira barbata* (Vama Veche) and *Zostera (Zosterella) noltei* (Mangalia) (NIMRD original photo)

Another species with a fundamental role for the marine ecosystem is the marine phanerogam *Zostera (Zosterella) noltei* (between 1-3 m at Mangalia - Fig. 2.1.3.3.), epiphyted by the rodophytes *Colaconema thuretii*, *Callithamnion corymbosum*, *Ceramium diaphanum* var. *elegans*. The fresh biomass for this species is high, similar to the one recorded in the previous year - a sign that the species regeneration is maintained (Fig. 2.1.3.4.) - and increases gradually with the depth, as environmental conditions become more stable (1 m - approx. 2,000 g/m^2 w.w.; 3 m - biomass exceeds 3,500 g/m^2 w.w. - Fig. 2.1.3.5.).

The *Zostera (Zosterella) noltei* meadow from Năvodari, distributed between 1 to 3 m, in association with *Stuckenia pectinata*, present between 0.5 to 4 m (approx. 960 g/m^2 w.w. between 2-3 m) remains in a stable condition without being disturbed by major factors. Besides the ecological role of these species as shelter for the rich associated fauna consisting of bivalves, gastropods, polychaetes, it is mentioned their role in fixing the substrate and improving water quality. In order not to disrupt the recovery rate of the species *Zostera (Zosterella) noltei*, local analysis was non-destructive, consisting only in underwater photos and local observations, excluding sampling.

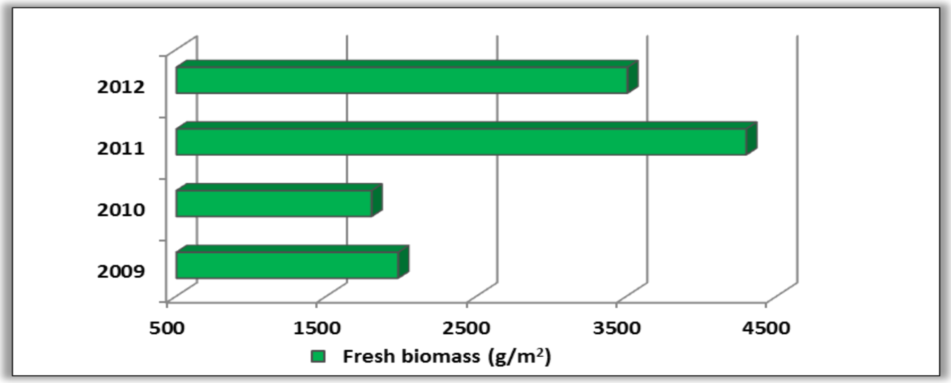


Fig. 2.1.3.4. - Mean *Zostera (Zosterella) noltei* fresh biomass between 2009-2012 (summer seasons)

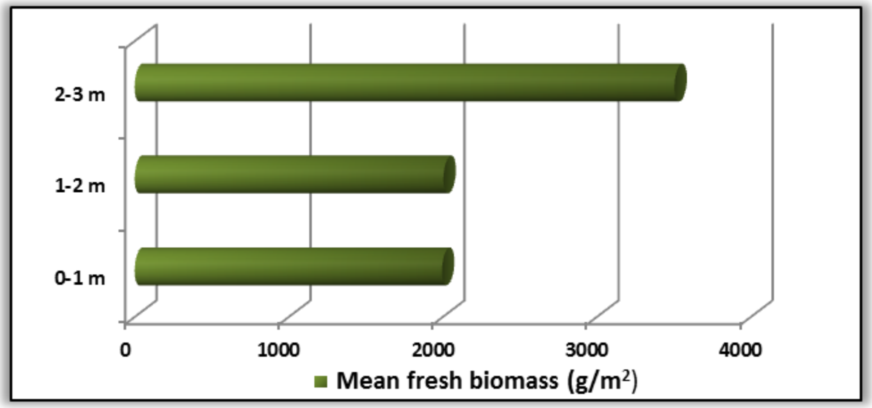


Fig. 2.1.3.5. - Mean *Zostera (Zosterella) noltei* fresh biomass between 1-3 m (summer 2012)

During the summer of 2012, the perennial encrusted red alga *Hildenbrandia rubra* was also identified on rocks in shallow waters, in the northern part (observed at Casino Constanța), and also on the *Rapana* shells. *Hildenbrandia rubra* is a very resistant species to strong waves and currents, due to its strong adhesion to the substrate, supports long periods of exondation and also provides greater complexity to the hard substrate.

2.1.4. ZOOBENTHOS

Zoobenthos, as eutrophication status indicator, still showed a constant evolution, in terms of species diversity. Qualitative assessment in all monitored areas (Sulina- Vama Veche) has led to the record of 52 macrozoobenthic species, the faunistic array keeping the characteristics of previous years.

In 2012, in transitional waters a higher species diversity was recorded, where 43 macrozoobenthic species were identified compared to 2011.

The multiannual evolution in the number of species present in the Romanian water sectors showed a slight, but continuous tendency towards qualitative balancing (Fig. 2.1.4.1.).

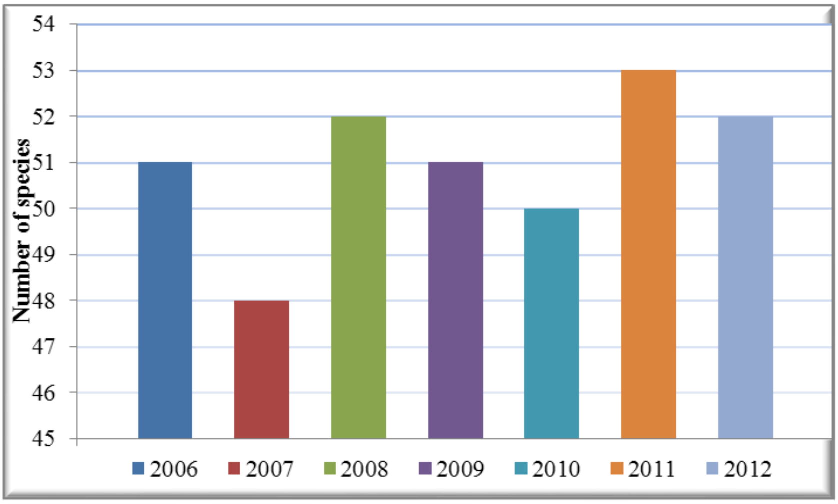


Fig. 2.1.4.1. - The evolution of number of species in the Romanian waters (Sulina-Vama Veche)

In transitional waters (Sulina-Portița profiles), the abundance of macrozoobenthic species was 1.7 times lower than in 2011. Instead, in shallow waters (5-20 m depths), the molluscs bivalve *Lentidium mediterraneum* and *Parvicardium exiguum*, present through well quantitatively structured populations, contributed to the increase of biomasses about 2 times compared to the previous year.

In coastal waters, the mean values of numerical abundance obtained in the Casino Mamaia sector were over four times lower (2.306 ind/m^2), 3 times lower (960 ind/m^2), respectively, in the southern part of the littoral (Costinești - Vama Veche) compared with the quantitative assessments performed in 2011. In 2012, in coastal waters the estimation of macrozoobenthic biomasses (average values ranging from 60 to 119 g/m^2) was close to the assessment made in 2010-2011, with slight increasing variations (1.2 times).

In the marine waters from the East-Constanța sector, the quantitative indicator of density registered an increase over three times higher, which was more evident at 35 m depths, the polychaete worms group dominates numerically.

The assessment of benthic community response to anthropogenic pressure on the marine environment quality was made using the biotic indexes (AMBI and M-AMBI) and the mean values obtained for the water bodies investigated during 2011-2012 showed a moderate quality state, with slight trends towards a good state in the south of the coast, less influenced by eutrophication.

It can be also noted that the sensitive taxa with their tolerance strict adjusted at a certain intensity of environmental factors were present in a proportion of 6.8% in the southern part of the littoral compared to the transitional (Sulina - Portița) and coastal waters (Casino Mamaia), where the maximum presence of the sensitive taxa ranged between 3 and 5%.

For the recovery of benthic communities, there is a stringent need of a longer improved period of environmental conditions, taking into account the fact that species with a low tolerance, the sensitive ones, recover with more difficulty when natural and/or anthropogenic pressures are higher.

2.1.5. BIODIVERSITY INDICATORS

In the past 15 years, in the Romanian marine waters, over 700 species of the main marine groups (phytoplankton, zooplankton, macrophytobenthos, zoobenthos, fish and marine mammals) have been identified. In order to get a more accurate picture of this indicator, we used the number of species identified each year of the main marine biotic components. The values obtained are quite subjective, varying from year to year, conditional on the number of samples and especially on the involvement of specialists in species identification. Between 1996 - 2010, on average, 200 - 300 species were identified annually.

The pressure on biodiversity was expressed by the existence of 29 exotic species (18 of which are listed in the most invasive species in Europe catalogue, established in 2006), 8 species which are exploited commercially (6 fish and 2 mollusks) and 12 types of human activities affecting the conservation status of biodiversity.

The impact on biodiversity was assessed by the ratio between the number of endangered species/the total number of species identified. Due to the fact that the updating of the endangered species lists is made every five years, this indicator shall be calculated after a subsequent update of this list.

2.1.6. ENDANGERED SPECIES

The Red List of macrophyte, invertebrate, fish and mammal species, status indicator for marine biodiversity in the Romanian marine sector, was completely updated in 2008 and only for fish in 2009. It includes 220 species, classified in eight IUCN categories (IUCN categories according to v. 3.0 2003 and their implementing guidelines, 2004 and 2006 versions), namely: 19 macrophytes and higher plants (9%), 56 invertebrates (25 %), 141 fish (64%) and 4 mammals (2%) (Fig. 2.1.6.1.).

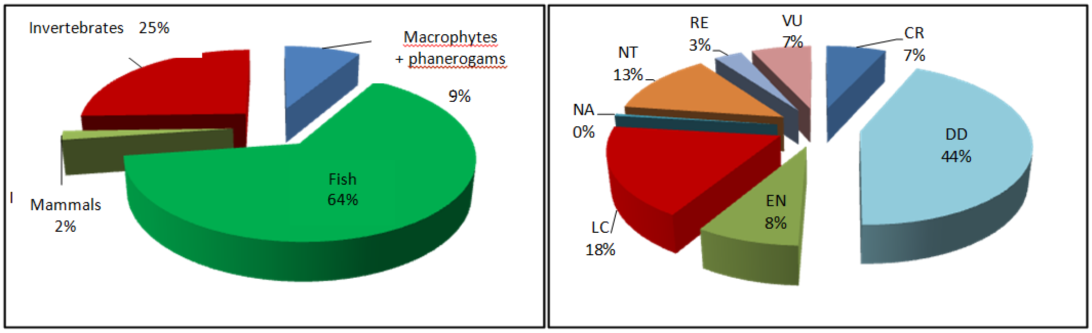


Fig. 2.1.6.1. - The main marine organisms' categories in the Red List (left) and the IUCN categories they are included in (IUCN, v. 3.0, 2003, 2004, 2006)

The classification of fish species in the IUCN categories was modified completely in 2009, the assessment taking into account the categories in which IUCN has rated them worldwide. By applying the methodology for assessing the conservation state regionally, fish were currently rated in only 5 categories: EN, VU, NT, LC and DD, most species (77 - 54%) being widely spread - DD, followed by LC (32 - 23%). The species rated as endangered (EN, VU and NT) are together less than a quarter (23%) of all the species listed. Among the 30 species identified in 2012, 3 are rated Vulnerable VU (*Acipenser stellatus, Trachurus mediterraneus ponticus* and *Alosa pontica pontica*), 13 are rated Nearly Threatened NT, and 6 are Data Deficient (DD). The latter will be rated, in the following yearts, either as endangered (EN) or least concern (LC).

Concerning the marine mammals, in 2012 dolphins were not included in a special monitoring program. 176 stranded dolphins were identified, of which 160 *Phocoena phocoena* individuals, 6 *Tursiops truncatus* individuals and 10 *Delphinus delphis* individuals. We mention that 90% of the stranded dolphins come from illegally set turbot gillnets.

The classification of the three dolphin species *Delphinus delphis*, *Phocoena phocoena* and *Tursiops truncatus* is similar to the previous assessment, namely Endangered (EN) both in the Black Sea and at national level, although in the IUCN Red List only *Tursiops truncatus* is rated Vulnerable (VU), while the other two are listed as Low Concern (LC).

2.1.7. STATE OF MARINE FISHERY STOCKS

In 2012, in the Romanian marine sector, the fishing industry practiced by fishermen was done in two ways: active fishing gear with coastal trawler vessels, made at depths of 20 m, and fixed fishing gear, practiced along the coastline in 18 fishing points, located between Sulina and Vama Veche, in shallow waters (3-11 m trap nets), but also at 20-60 m depths/gillnets and long lines).

The following trends were reported:

2.1.7.1. EVOLUTION OF STATE INDICATORS

● **the stock biomass** for the main fish species (Table 2.1.7.1.1.) indicates:

- for ***sprat***, which usually had a natural fluctuation, almost normal biomass and actually a relatively good stock were estimated, as in the past years, at 60,000 - 65,000 tons, compared to 45,000 tons/2005 and 14,750 tons/2006, when, due to the existence of special hydro-climatic conditions, the species crowded in other areas of the Black Sea;

- for ***whiting***, the biomass was estimated at 6,000 tons, close to the values estimated during 2005 - 2008, but almost three times smaller than the estimates of the past three yeats, when it ranged between 12,000 and 21.000 tons;

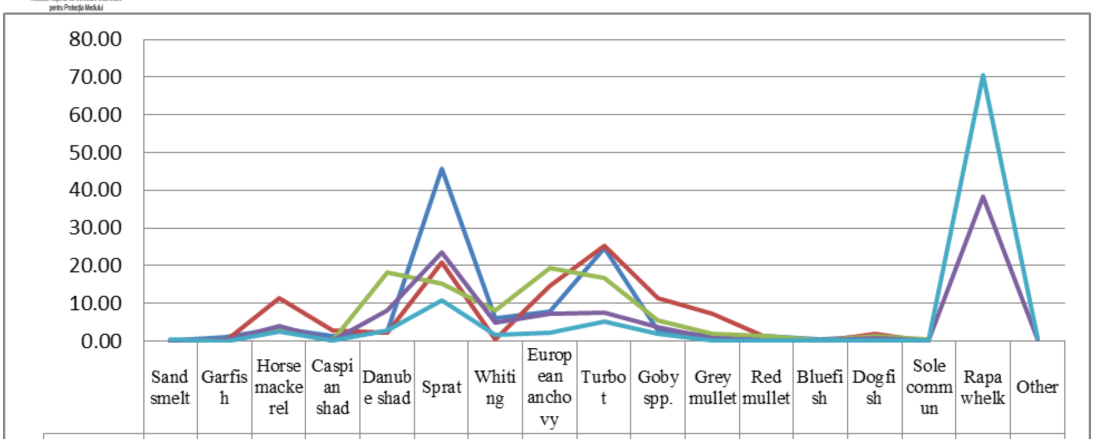
- for ***turbot***, the biomass was estimated at approximately 650 tons, 50% - 70% smaller than the values estimated during the past years, when it ranged between 1,147 t/2011 and 1,750 t/2008;

- for ***dogfish***, there was a 1,500 - 2,000 ton biomass, approximately equal to the one estimated during 2006 - 2009 (1,450 - 4,300 t tons);

Table 2.1.7.1.1. - Stock value (tons) for the major fish species in the Romanian Black Sea

Species	2006	2007	2008	2009	2010	2011	2012
Sprat	14,750	60,000	61,916	60,059	59,643	60,000	68,887
Whiting	7,000	6,000	8,659	11,846	20,948	21,000	5,650
Anchovy	20,000	20,000	20,000	-	-	-	-
Goby	600	600	500	-	500	500	450
Turbot	1,150	1,300	1,750	1,500	1,149	1,147	628
Dogfish	2,000	4,300	1,450	2,500	13,051	10,000	1,550

● the **population structure** indicates, as in previous years, the presence in the catches of a greater number of species (over 20), in which the mainstream belonged to small species (sprat, anchovy, whiting, goby), as well as to the larger ones (turbot and Danube shad). As in previous years, the low share of some species, such as: dogfish, horse mackerel, mullet, bluefish, but also the occurrence as isolated specimens of blue mackerel and bonito were reported (Fig. 2.1.7.1.1.).



	Sand smelt	Garfish	Horse mackerel	Caspian shad	Danube shad	Sprat	Whiting	European anchovy	Turbot	Goby spp.	Grey mullet	Red mullet	Bluefish	Dogfish	Sole commun	Rapa whelk	Other
2008	0.20	1.00	3.40	1.30	2.50	45.60	6.10	7.80	24.80	2.90	1.30	1.20	0.50	1.20	0.00		0.20
2009	0.10	0.00	11.50	2.80	2.30	21.00	0.40	14.80	25.30	11.30	7.20	0.90	0.00	1.90	0.00		0.50
2010	0.20	0.11	2.87	0.10	18.27	15.19	8.14	19.33	16.74	5.43	1.98	1.47	0.03	1.22	0.35		8.57
2011	0.00	0.08	4.07	0.04	8.15	23.56	4.80	7.18	7.61	3.71	0.72	0.29	0.02	0.74	0.10	38.41	0.52
2012	0.34	0.00	2.45	0.18	2.88	10.89	1.77	2.30	5.18	2.05	0.14	0.16	0.21	0.26	0.11	70.49	0.61

Fig. 2.1.7.1.1. - The catch structure (t) of the main fish species in the Romanian marine sector during 2008-2012

2.1.7.2. EVOLUTION OF PRESSURE INDICATORS

● The **fishing effort** continues the trend of reduction reported since 2000. Thus, in 2012, in the case of active fishing (using the mid-water trawl), only one vessel was active and in passive fishing 157 crafts, namely 34 boats (below 6 m), 121 boats (6-12 m), one vessel (12-18 m) and one vessel (18-24 m) were active. In fishing with fixed gear, practiced along the Romanian coast, were used: 22 pound nets, 3,415 turbot gillnets, 585 shad gillnets, 118 goby gillnets, 3 beach seines, 40 mullet gillnets, 160 dogfish gillnets, 252 long liners, 441 cages and 262 handlines;

● after a decreasing trend during 2002-2012, when it dropped from more than 2,000 t, in 2002, to 1,390-1,940 t, during 2003-2006, and below 500 t during 2007 - 2009, reaching a minimum value in 2010/258 t, in the past years the **total catch** has had an increasing trend, namely 568 t, in 2011, and 835 t, in 2012 (Fig. 2.1.7.2.1.).

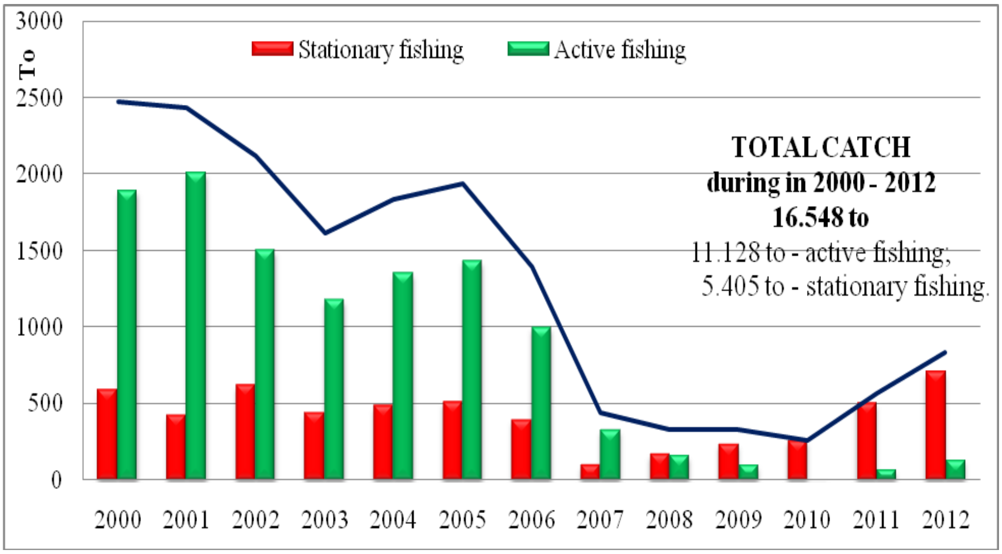


Fig. 2.1.7.2.1. - Total catches (t) made in the Romanian sector of the Black Sea, between 2002 - 2012

The increase of catches during the past years was not due to the fish fauna, but to the emergence of economic operators' interest in the manual harvesting of the rapa whelk (*Rapana venosa*), which was about 67% of the total catch. The low level of catches was still mainly caused by the decrease of fishing effort (drop in the number of coastal trawlers, trap nets and, consequently, of the staff involved in fisheries) and by the influence of hydroclimatic conditions of fish populations, as well as by the increase of production costs and lack of a fishery market.

● the **Total Allowable Catch (TAC)** of the main fish species caught between 2008-2012 remained at the same level (Table 2.1.7.2.1.).

Table 2.1.7.2.1. - The value of the TAC (Total Allowable Catch) for the main fish species in the Romanian Black Sea

Species	TAC (tons)				
	2008	2009	2010	2011	2012
Sprat	10,000	10,000	3,443	3,443	3,443
Whiting	500	500	600	600	600
Goby	100	100	100	100	100
Turbot	50	50	43.2	43.2	43.2
Dogfish	50	50	50	50	50

2.1.7.3. EVOLUTION OF IMPACT INDICATORS

● **the percentage of species whose stocks are outside safe limits** was close to that of previous years, which is nearly 90%. Overcoming the limits of safety is not due only to the exploitation in the Romanian marine sector, because most fish species have a cross-border distribution, which requires management at regional level;

● **the percentage of by-catch species** in the Romanian catches continues to be maintained at a level similar to that in recent years, being 25%;

● **changes in the size class structure (age, length):** compared to the period 2000-2011, except for sprat, which stands a rejuvenation of the schools, due to a very good addition, for the other catches the biological parameters remained almost at the same values;

● **C.P.U.E.** (*catch per unit effort*) for fishing on the Romanian littoral:

- with fixed gear/pound nets, it was 14,748.176 kg/month, 4,022.23 kg/pound net, and 73.132 kg/day, with a fishing effort made by 22 pound nets during 1,210 days and a catch of 88,489 kg;

- with fixed gear/turbot gillnets, it was 12.65 kg/gillnet, 25.23 kg/day and 654.74 kg/boat, with an effort of 3,415 turbot gillnets, 1,713 fishing days, 66 boats and a catch of 43,213 kg;

- with active fishing gear/mid-water trawl, 65.9 t/vessel, 2.91 t/day, 1.25 t/day, 0.56 t/haul and 0.40 t/hour, with an effort made by only one vessel, 53 fishing days, 118 hauls and 166 trawling hours and a catch of 65,992 kg.

2.1.7.4. SOLUTIONS TO CRITICAL ISSUES

► **Nationally**

● **harmonization** of sustainable development strategies in the fisheries sector in the Romanian marine sector by implementing the concept of fisheries management based on the ecosystem approach and the Code of Conduct for Responsible Fisheries through:

- avoidance of creating an excess fishing capacity;
- practice of responsible fishing;
- conservation of biological diversity of marine ecosystems and protection of the threatened species;
- development and use of selective fishing gear and techniques: non-destructive, cost effective, environmental friendly and protecting living marine resources;
- development and diversification of marine aquaculture products;
- elaboration of an integrated plan for the restoration of the fishing fleet closely connected to appropriate human, material and marine living resources available.

► **Regionally**

● regional harmonization of the legal and institutional framework for the sustainable use of living resources;

● improvement of the management of fish stocks through exploitation assessment methodology agreed at regional level;

● development programs/projects to assess the status of fish stocks and to monitor the environmental conditions and biological factors that have influences;

● creation of partnerships between research institutions, governments and producer organizations to develop joint research programs;

● construction of a regional fishery database;

● urgent action against illegal and unregulated fisheries.

CHAPTER 3

3.1. STATE OF MARINE PROTECTED AREAS AND MARINE HABITATS

3.1.1. “VAMA VECHE - 2 MAI MARINE LITTORAL AQUATORY“ (ROSCI0269)

Starting with December 2011, the National Institute for Marine Research and Development “Grigore Antipa“ Constanța is custodian of the Vama Veche - 2 Mai Marine Reserve, handling its management and development. NIMRD had previously been custodian of the Reserve between 2004-2009.

The natural protected area “Vama Veche - 2 Mai Marine Littoral Aquatory“ was established through Decision no. 31/1980 of the Constanța County Council and confirmed as natural protected area by Law no. 5/2000 approving the National Land Arrangement Plan, code 2.345. The natural reserve covers approx. 5,000 ha, along 7 kilometers of coastline, between 2 Mai and the Bulgarian border. By Order no. 1964 of 13 December 2007 and Order no. 2387 of 29 September 2011, amending the Order of the Ministry of the Environment and Sustainable development no. 1964/2007, on the establishment of the natural protected area regime of Community importance sites, the Vama Veche - 2 Mai Marine Reserve was declared site of Community importance (SCI), as integral part of the Natura 2000 European ecological network in Romania.

The priority conservation objectives for the ROSCI0269 Vama Veche - 2 Mai site are reaching a good conservation state for the 1170-10 *Pholas dactylus*, 1170-8 *Cystoseira barbata* and 1170-2 *Mytilus galloprovincialis* habitats, all slightly degraded, including the conservation of the representative species *Cystoseira barbata*, *Pholas dactylus* and *Corallina officinalis*. In addition, the mammal and fish species in Annex II of the Habitats Directive occurring in the site must also be protected: *Tursiops truncatus, Phocoena phocoena*, *Alosa immaculata* and *Alosa tanaica*.

Conservation state of the marine protected area compared to previous years

The state and evolution trends of the marine and coastal environment in the “Vama Veche - 2 Mai Marine Littoral Aquatory“ (ROSCI0269) continued to be monitored in 2012, from the physical, chemical and biological point of view.

The main physical-chemical and state indicators characterizing and regulating the level of eutrophication were analyzed, namely: salinity, pH, dissolved oxigen and inorganic nutrients.

Salinity was measured in situ using the CTD. Dissolved oxygen was determined by the Winkler method. pH was measured using the potentiometric method. Transparency was measured in situ using the Secchi disc. Nutrients in seawater were quantified by analytical spectrophotometric methods, internally validated in the laboratory complying with the quality system pursuant to SR EN ISO/IEC 17025:2005 and using as reference the manual “Methods of Seawater Analysis” (Grasshoff, 1999). The detection limits and the extended relative uncertainties, k = 2, coverage factor 95.45% are given in Table 3.1.1.1. The UV-VIS Shimadzu spectrophotometer, measuring range: 0-1,000 nm, was used to perform measurements.

Table 3.1.1.1. - Detection limits and the extended relative uncertanties for the determination of nutrient concentrations in seawater

Ref. no.	Measured parameter	MU	Detection limit (μmol/dm^3)	Relative uncertainty, U (c), Extended (%), k=2, coverage factor 95.45%
1.	$(NO_3)^-$	µM	0.12	8.4
2.	$(NO_2)^-$	µM	0.03	6.6
3.	$(NH_4)^+$	µM	0.12	7.1
4.	$(PO_4)^{3-}$	µM	0.01	14.0
5.	$(SiO_4)^{4-}$	µM	0.30	3.3

The data were processed using the Ocean Data View version 4.5.3 (Schlitzer, 2013) and Excel 2010 softwares.

Due to lack of rainfall and high temperatures during the warm season, the **salinity** was homogenous, ranging between 17.53 - 18.18 PSU, characteristic value for the brackish waters of the Black Sea. Usually, slightly higher values were reported towards offshore waters, in the water column (Vama Veche station 20 m) (Fig. 3.1.1.1.)

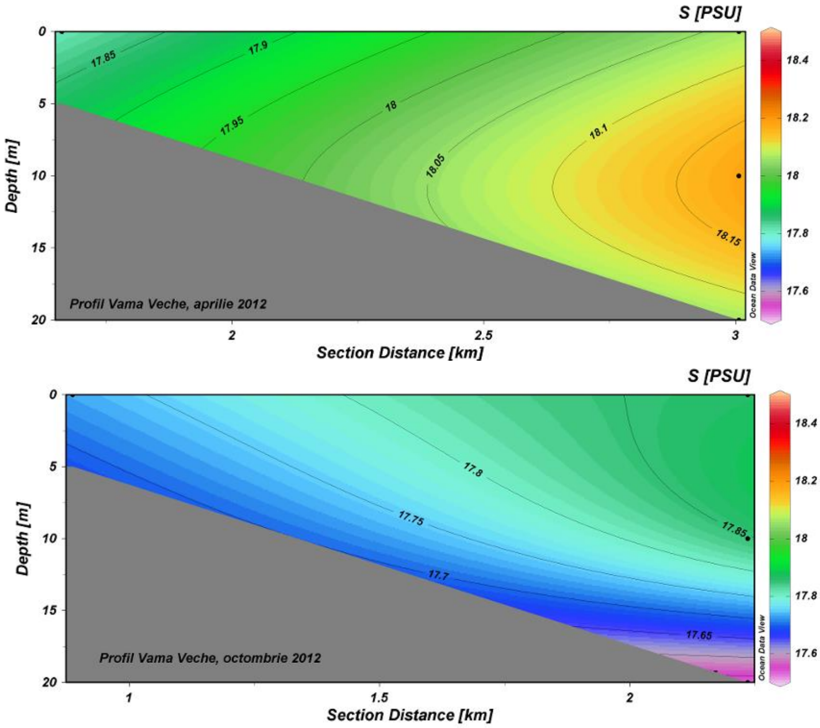


Fig. 3.1.1.1. - Vertical distribution of seawater salinity in April and October 2012 - Vama Veche

The ***pH*** values ranged between 8.00 - 8.14, normal values, which comply with the limits set by Order no. 161/2006 (Regulation for classifying the surface water body quality with the view to establishing the ecological state of water bodies), namely 6.5-9.0.

The waters in the study area had a **good oxygen ratio**. Thus, the values determined ranged between 7.84-10.04 mg/dm^3. A slight layering of water masses was recorded, with lower values at the water-sediment interface, mainly in spring. No hypoxia events were recorded, all values being higher than the limit allowed by Order no. 161/2006, 6.2 mg/dm^3 and 80% saturation, respectively (Fig. 3.1.1.2.).

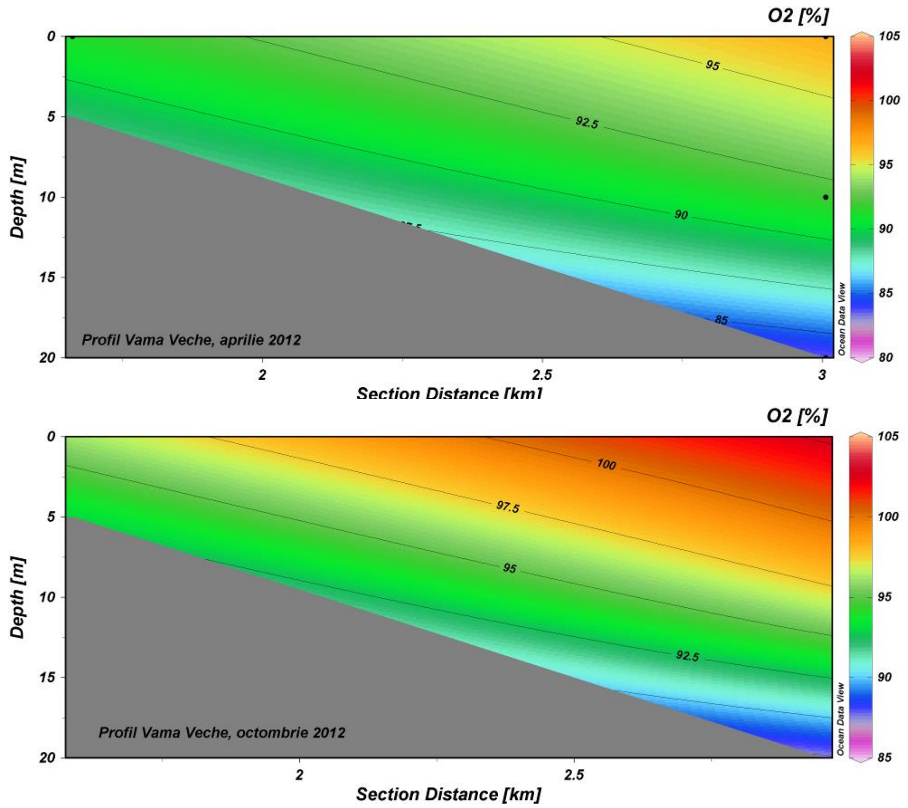


Fig. 3.1.1.2. - Vertical distribution of seawater oxygen saturation in April and October 2012 - Vama Veche

The **phosphate concentrations, $(PO_4)^{3-}$**, recorded values ranging between 0.02 µM and 0.23 µM, low values, comparable with the 1960s, reference period for the good quality status of Romanian Black Sea waters. The higher values in the water column in April were caused by the biological activity, more intense in spring (Fig. 3.1.1.3.).

The biological activity is confirmed by the concentrations of organic phosphorous, which are higher during this season.

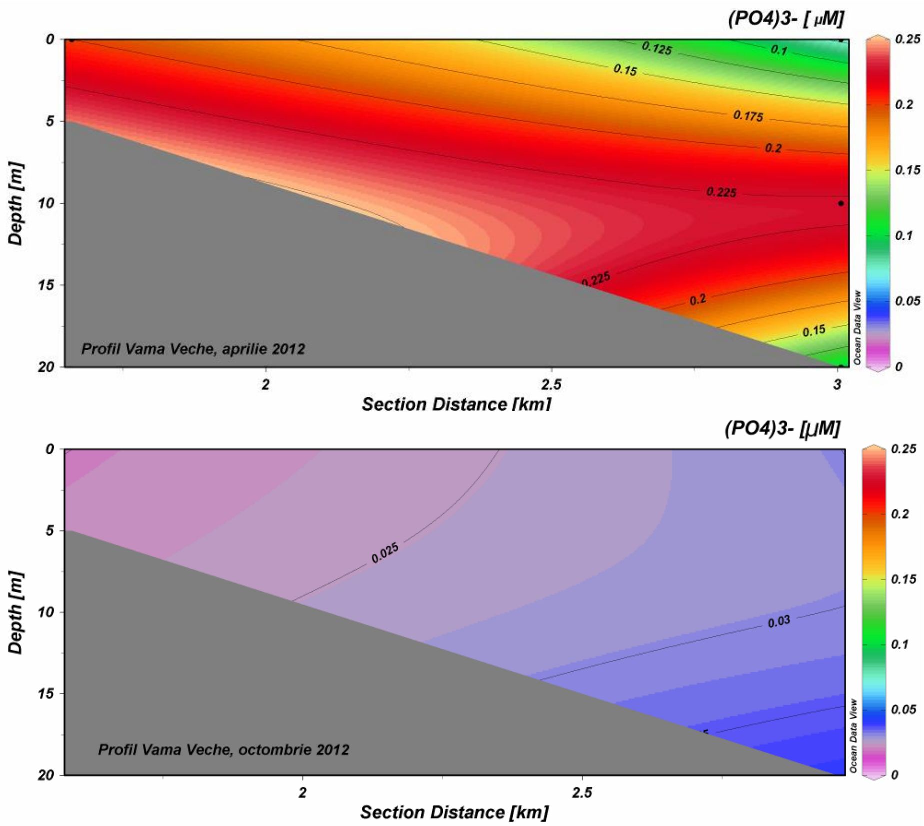


Fig. 3.1.1.3. - Vertical distribution of phosphate concentrations in April and October 2012 - Vama Veche

The **nitrate concentrations, $(NO_3)^-$,** ranged between 1.99 - 3.90 µM, low values, not exceeding the maximum allowed concentration of Order no. 161/2006, namely 1.5 mg/dm^3 (107.14 µM). Generally, a homogenous distribution of nitrates in the water column was reported, with slightly higher values at the surface, in April (Fig. 3.1.1.4.)

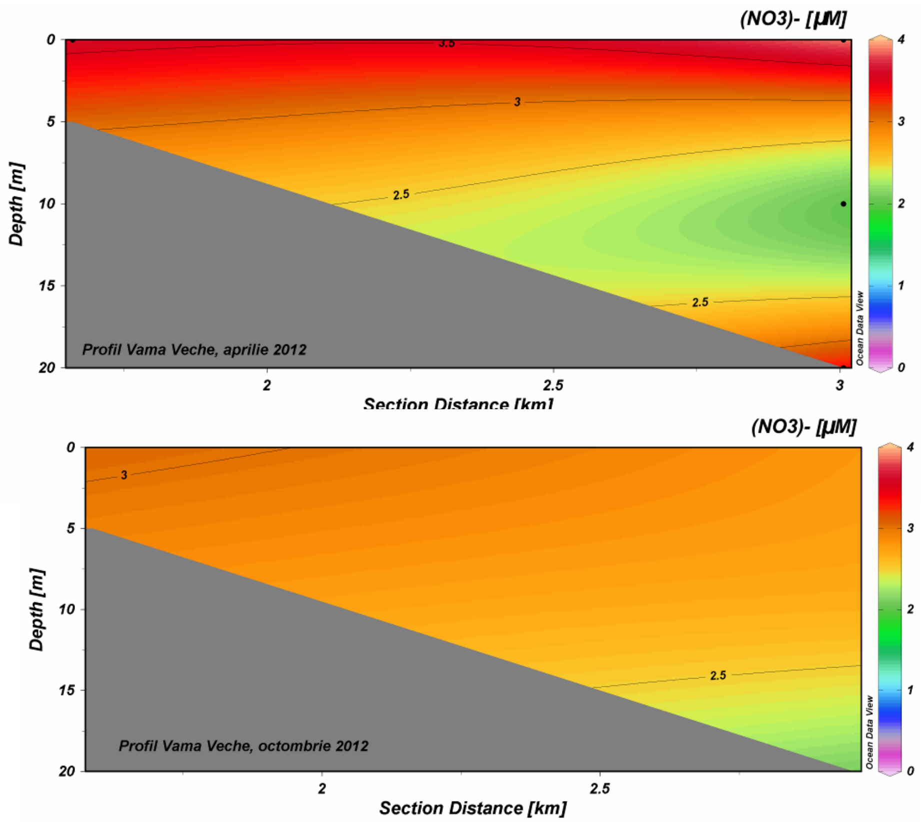


Fig. 3.1.1.4. - Vertical distribution of nitrate concentrations in April and October 2012 - Vama Veche

Nitrites, $(NO_2)^-$, intermediate form in redox processes involving inorganic nitrogen species, recorded low concentrations, ranging between 0.05 - 0.34 µM. All values comply with the maximum allowed limit by Order no. 161/2006, namely 0.03 mg/dm^3 (2.14 µM).

Ammonia, $(NH_4)^+$, the polyatomic ion in which nitrogen holds the maximum oxidation number (+3), is the easiest biologically assimilable inorganic nitrogen form. Its concentrations ranged between 0.67 - 8.21 µM. The maximum value was recorded in October, close to the shore, and overtakes by 0.015 mg/dm^3 the allowed limit both for the ecological state and the area impacted by human activity in Order no. 161/2006, namely 0.1 mg/dm^3 (7.14 µM) (Fig. 3.1.1.5.).

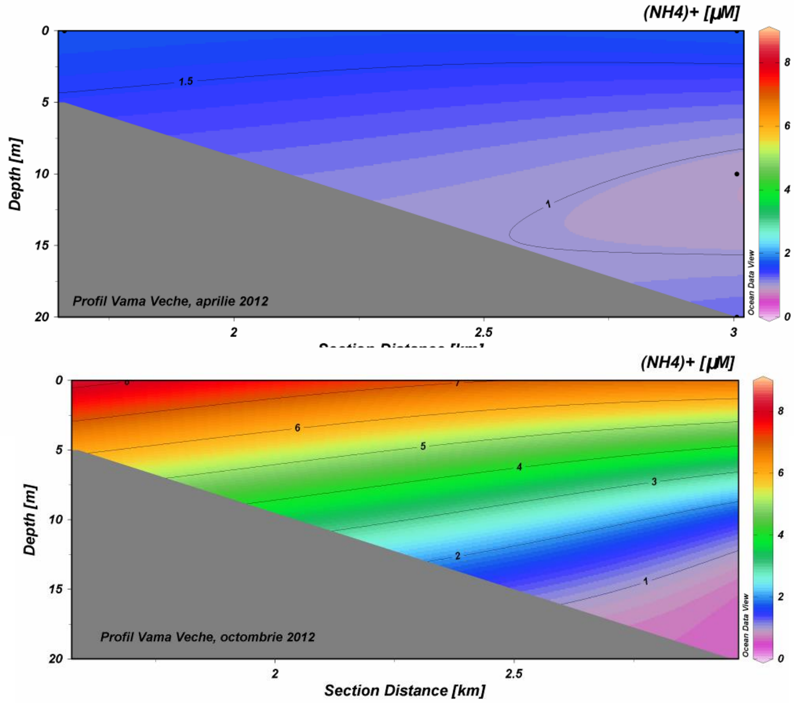


Fig. 3.1.1.5. - Vertical distribution of ammonia concentrations in April and October 2012 - Vama Veche

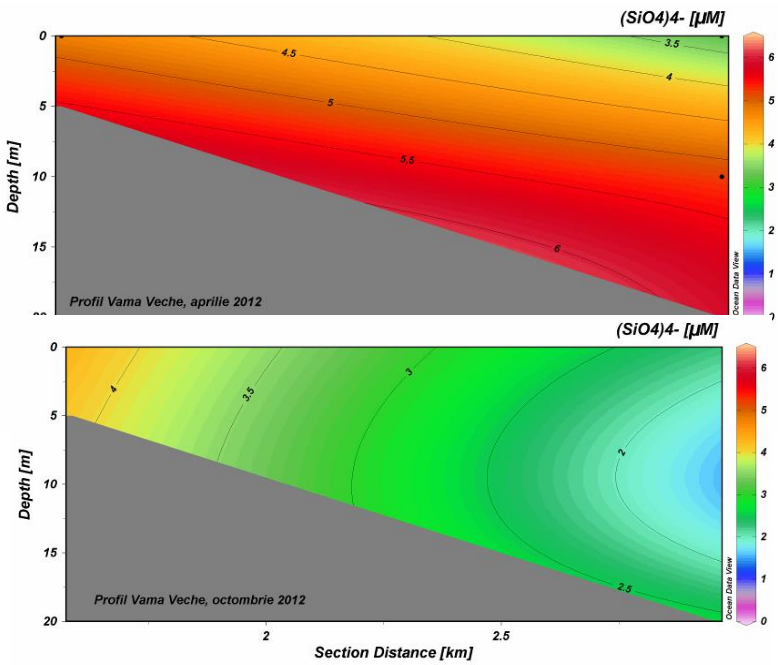


Fig. 3.1.1.6. - Vertical distribution of silicate concentrations in April and October 2012 - Vama Veche

Silicates, $(SiO_4)^{4-}$, recorded low concentrations, ranging between 1.6 - 5.9 µM. The highest values were determined at the water-sediment interface, as a follow-up of the regeneration of the consumed stock by the organic activity characteristic for April (Fig. 3.1.1.6.).

The **microbiological load**, state indicator of contaminants in the marine environment, was good in the bathing area, the concentrations of the enterobacteria reported generally ranging below the limits provided by National Regulations and European Directives.

Algal blooms, as impact indicator of eutrophication on the marine environment, showed a decreasing trend.

The qualitative structure of **phytoplankton** in ROSCI0269 was characterized in 2012 by the occurrence of 102 species, belonging to the 7 algal taxonomic groups. (Bacillariophyta, Dinoflagellata, Chlorophyta, Cyanophyta, Chrysophyta, Euglenophyta and Cryptophyta). Dinoflagellates were dominant, with a 35% share, followed by diatoms, 33%, chlorophytes, 13%, and cianobacteria, 11%, of the total phytoplankton species identified.

Both in 2 Mai and in Vama Veche, the **phytobenthos** array is dominated, from the quantitative point of view, by the genus *Cladophora.* Scarce *Ceramium* specimens were encountered in both stations. The perennial species *Cystoseira barbata* dominates the shallow rough substrate (0-3 m), both quantitatively and qualitatively. Local conditions led to a good development of this species. At the same time, in 2 Mai *Lomentaria clavellosa* was also identified, which forms the association *Lomentaria clavellosa - Antithamnion cruciatum*, which marked, in Romanian coastal waters, the development limit of the fixed macrophyte algal vegetation. The 2 Mai - Vama Veche area shelters two small *Cystoseira barbata* fields, with mature specimens and a rich epiphytic flora, which comprised in summer mostly *Ceramium virgatum* and *Cladophora vagabunda* specimens.

The analysis of **benthos** samples collected from this site showed the occurrence on the 8 m isobath of the community dominated by the bivalves *Mytilus galloprovincialis* and *Mytilaster lineatus*, along with the cirriped *Balanus improvisus*. Among amphipods, *Melita palmata* and *Microdeutopus gryllotalpa* were present, while among decapods *Pachygrapsus marmoratus*. The polychaete fauna was represented on this isobath by 8 species.

As a follow-up of investigations performed in the site, in 2012, 60 **fish species** were identified. In specialized stationary gear fishing (gillnets), mainly in spring, the species *Alosa tanaica* (Caspian shad) and *Alosa immaculata* (Danube shad), listed in Annex II of the Habitats Directive, were caught. For the species *Alosa immaculata*, 4-6 year old individuals are prevalent, which indicates the fact that shads use this area for transit during migration.

In 2012, in the beach area pertaining to the natural protected area, ***14 stranded dolphin individuals***, of the species *Phocoena phocoena,* were reported, most likely accidentally caught in fishing nets located close to the marine protected area. The monitoring of beached dolphins is made by NIMRD “Grigore Antipa“ together with the NGO “Mare Nostrum“ and the Dobrogea-Littoral Water Basin Administration Constanța.

The barren areas represented by the rocky platform in the northern part of the Reserve are undergoing a (slow) natural recovery process and do not require special protection measures, different from the management measures applicable to the entire Zone B (buffer zone) of the Reserve.

Number of permits issued by the Custodian in 2012

The main purpose for which this natural reserve was established was to preserve marine biodiveristy. It is aimed to eliminate and prevent resource exploitation or use which conflict with the preservation purpose, as well as to provide for proper conditions for scientific research, education and leisure activities. Any type of activity likely to alter the habitats and influence the species occurring in the site are strictly forbidden (E.g. natural resource extraction, aquaculture etc.).

As such, no permits for any activities carried-out within the perimeter of the "Vama Veche - 2 Mai Marine Littoral Aquatory" have been requested from or issued by the Custodian.

The monitoring of the reserve: was performed throughout the entire year by regular trips in the area.

During 1 August - 10 September 2012, the Mobile Information Center for the monitoring of the Reserve (NIMRD's trailer) was located on the beach in Vama Veche.

Researcher and technician teams of the Institute provided for permanence during the peak of the summer holiday season, carrying-out, besides research and monitoring activities of the parameters and state of the marine protected area, education and public awareness activities, by lectures and distributing brochures and flyers on the Vama Veche - 2 Mai Marine Reserve and the Marine Environment in general.

Fig. 3.1.1.7. - Mobile Information Center for the monitoring of the Reserve (NIMRD's trailer) (NIMRD original photo, V. Niţă)

The communication and awareness raising activities are one of the Custodian team's pillars. Consequently, information flyers describing the Reserve were created and distributed to tourists visting the area and during various events organized by NIMRD.

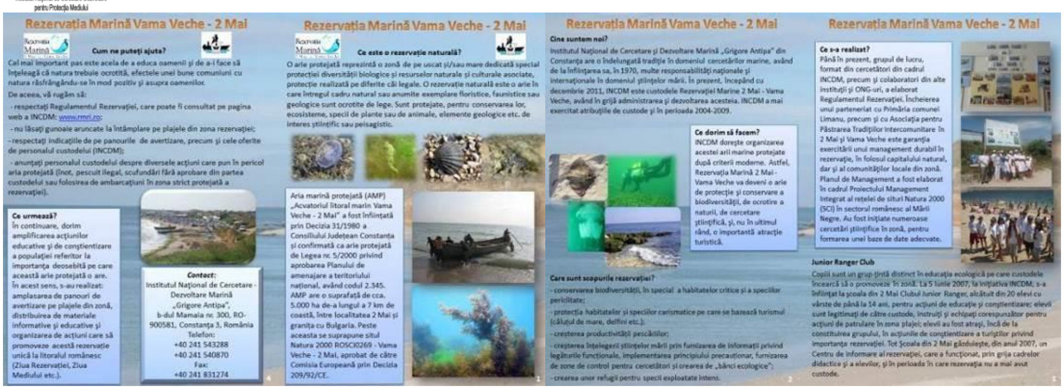


Fig. 3.1.1.8. - Information flyer describing the Vama Veche - 2 Mai Marine Reserve (NIMRD original photo, M. Nenciu)

To sum up, pursuant to the provisions of the Order of the Minister of the Environment and Forests no. 2387/2011, amending the Order of the Minister of the Environment and Sustainable Development no. 1964/2007, as well as to European Directives 79/409/EEC and 92/43/EEC, the following natural protected areas are established in the Romanian marine zone:

1. ROSPA0076 Black Sea: site of Community importance, according to the 79/409/CEE Birds Directive, directly nominated Special Protected Area - SPA - through GD no. 1284/2007 regarding the declaration of avifaunistic protected areas as an integrating part of the Natura 2000 European ecological network in Romania - 147,242.9 ha (Custodian SC EURO LEVEL);
2. ROSCI0269 - Vama Veche - 2 Mai: Site of Community Importance, according to the 92/43/EEC Habitats Directive, adopted through 2009/92/EC Decision, which overlaps the Vama Veche - 2 Mai Marine Reserve, natural protected area of national importance - 5,272 ha (Custodian NIMRD);
3. ROSCI0094 - The Sulphur Seeps in Mangalia (362 ha): site of Community importance, according to Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 362 ha (Custodian NIRD GEOECOMAR);
4. ROSCI0197 - Submerged beach from Eforie North - Eforie South: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 141 ha (Custodian SC EURO LEVEL);
5. ROSCI0273 - Marine area from Cape Tuzla: site of Community importance, according to the Habitats Directive 92/43/CEE, established by Decision 2009/92/EC - 1,738 ha (Custodian NIRD GEOECOMAR);
6. ROSCI0237 - Submerged methanogenic carbonate structures Sf. Gheorghe: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 6.122 ha (Custodian NIRD GEOECOMAR);
7. ROSCI0066 - Danube Delta - marine zone: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/CE, overlapping the marine area of Danube Delta Biosphere Reserve -

natural protected area of national and international importance - 121.697 ha (Custodian DDBRA).

8. ROSCI0281 - Cape Aurora: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Order of the Minister of the Environment and Forests no. 2387/2011 (No custodian).
9. ROSCI0293 - Costineşti - 23 August: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Order of the Minister of the Environment and Forests no. 2387/2011 (No custodian).

3.1.2. MARINE HABITATS

In 2012, research was performed aimed at identifying and inventorying the marine habitats in the two newly established marine sites at the Romanian coast, namely *ROSCI0281 Cape Aurora* and *ROSCI0293 Costineşti - 23 August*.

As a follow-up of field trips, observations made and considerations on habitat distribution, an inventory of the European interest habitats in the two sites was performed.

Habitat identification and classification in *ROSCI0281 Cape Aurora*

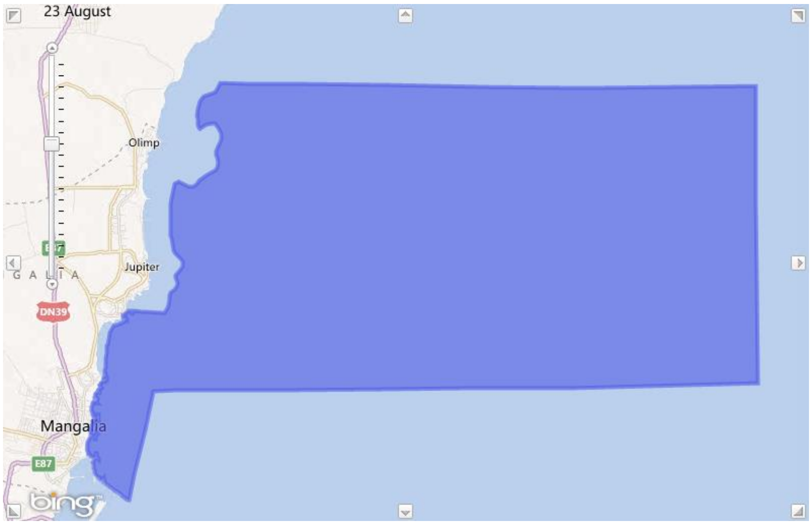


Fig. 3.1.2.1. - Location of ROSCI0281 Cape Aurora
(http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=ROSCI0281#2)

2 elementary Natura 2000 habitat types: 1110 and 1170, with 8 subtypes, are present:

1110-3 Shallow fine sands

The substrate comprises fine earthy (flinty) or biogenic sands, mixed with shells and pebbles, from the shore down to the 5-6 m isobath. This habitat shelters the biocoenosis with *Donax trunculus*, characterized by abundant populations of this bivalve. Due to the increased hydrodynamism, the associated fauna is not very diverse: the gastropod *Cyclope neritea*, the crustaceans *Liocarcinus vernalis* and *Diogenes pugilator*, yet it can be abundant.

1110-4 Well-sorted sands

This habitat is located immediately after shallow fine sands, from 5-6 m down to 10-15 m deep. The substrate comprises homogenous granulometry sands, less affected by wave movement. The silt content of the sediment increases with depth. The typical species are the molluscs *Chamelea gallina, Tellina tenuis, Anadara inaequivalvis, Cerastoderma glaucum, Cyclope neritea, Nassarius nitidus*; the crustaceans *Liocarcinus vernalis* and *Diogenes pugilator*, the fish *Gymnammodytes cicerelus, Trachinus draco, Uranoscopus scaber*.

1110-7 Shallow sands bioturbated by *Arenicola* and *Callianassa*

At the top (4-5 m), the habitat is contiguous with 1110-3, from which it extends up to 7 m deep. The sand is bioturbated to a depth of 1 m and the sediment surface is marked by the characteristic funnels and mounds typical for *Callianassa truncata* and the debris cones of *Arenicola marina*.

1110-8 Sandy muds and muddy sands bioturbated by *Upogebia*

The substrate is riddled with numerous galleries of the thalassinid decapod crustacean *Upogebia pusilla*, which penetrate 0.2-1.0 m deep, depending on the consistency of the sediment. This species feeds by filtering plankton and organic suspensions in the water current, which is continuously pumped through its galleries. Bivalve mollusc density is low in this habitat due to food competition and planktonic larvae and postlarvae predation by *Upogebia*. Other species, particularly commensals living in *Upogebia* galleries, are facilitated.

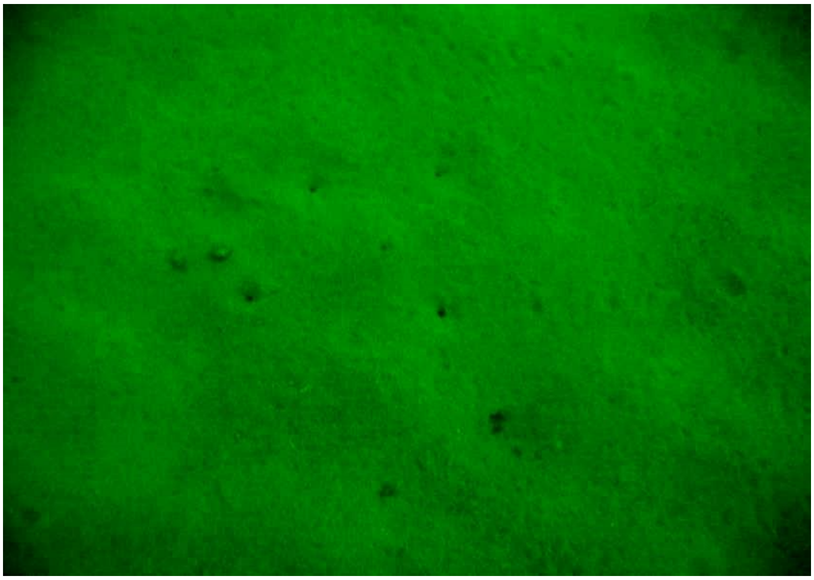


Fig. 3.1.2.2. - Sandy muds and muddy sands bioturbated by *Upogebia* in the site *ROSCI0281 Cape Aurora* (NIMRD original photo, V. Niţă)

1170-2 *Mytilus galloprovincialis* biogenic reefs

Mytilus galloprovincialis biogenic reefs are built up on mussel banks whose shells accumulated in time, forming a hard substrate, protruding from the surrounding sediments (mud, sand, gravel or mixtures), on which live mussel colonies attach themselves. Among all sedimentary substrate habitats of the Black Sea, this particular habitat shelters the highest species diversity, due to its expansion at various depths and the great number of micro-habitats in the mussel reef matrix, offering living conditions for a large number of species.

This reef type is unique for the crucial ecological role of mussel banks in self-cleansing the ecosystem and performing the benthic- pelagic interconnection, by the existence here of several threatened species, by its socio-economic significance as habitat and fishing ground for many commercial species.

1170-3 Shallow hydrothermal sulphur seeps

Sulphurous underground waters, of karst continental origin, surface by means of fault lines and Sarmatian limestone channels, whether it is exposed or covered with a sediment layer. The seeps are easily located by round yellow-whitish halos formed by thiophyle bacteria that thrive around them. The algal flora does not stand close to the source, but flourishes in its vicinity. The fauna consists of few species tolerant to hypoxia, which can be very abundant. Sulphurous seeps occur in the Cape Aurora - Mangalia area, between 0 and 15 m depth, on rocky or sandy substrate.

1170-8 Infralittoral rock with photophylic algae

This habitat begins immediately below the lower midlittoral, where emersion is accidental, and extends down to the lower limit of distribution of photophylic algae. Between these boundaries the rocky substratum is covered with dense and varied photophylic algal turfs. Among these, the highest conservation value is held by coastal belts formed by the perennial brown alga *Cystoseira barbata*. They only grow in areas with clear, clean water and relatively sheltered from waves. The *Cystoseira* thalli are solid, durable, elastic and form true thick “forests“ whose structural and permanent complexity allows for the development of a rich and diverse fauna, including many rare or threatened species.

Fig. 3.1.2.3. - Infralittoral rock with photophylic algae in the site *ROSCI0281 Cape Aurora* (NIMRD original photo, V. Niţă)

1170-9 Circalittoral rock with *Mytilus galloprovincialis*

The mussel banks covering the rocky substrate become dominant starting with10-15 m, continuing as a compact cover to the lower distribution limit of the rocky substrate (30-35 m deep). The fauna is highly diverse, including numerous sponge, hydrozoan, polychaete, mollusc, crustacean and fish species, characteristic only for this type of habitat, some of them being rare or protected. It has the essential role in the biofiltration of surrounding coastal waters, ensuring their quality.

Fig. 3.1.2.4. - Circalittoral rock with *Mytilus galloprovincialis* in the site *ROSCI0281 Cape Aurora* (NIMRD original photo, V. Niţă)

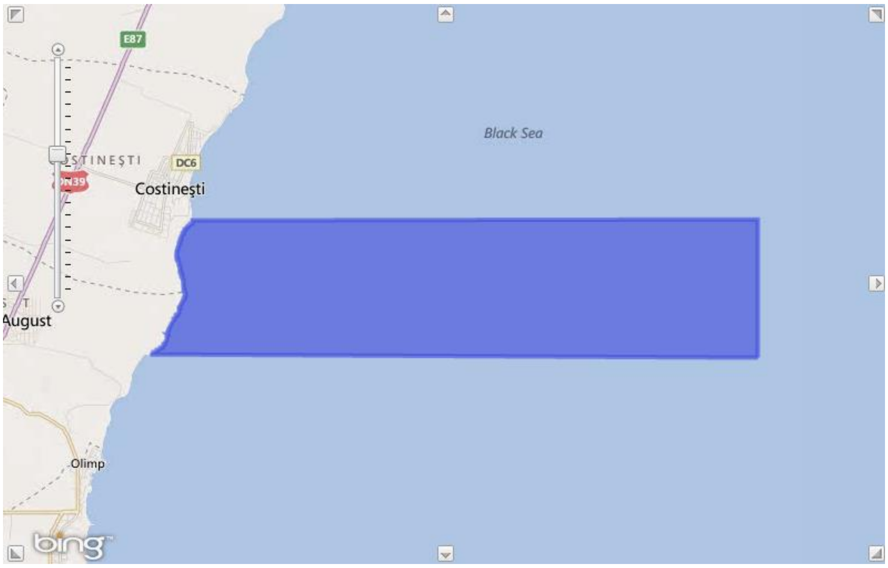


Fig. 3.1.2.5. - Location of ROSCI0293 Costineşti - 23 August (http://natura2000.eea.europa.eu/Natura2000/SDFPublic.aspx?site=ROSCI0293)

The site is more diverse than the previous one, with 3 elementary Natura 2000 habitats: 1110, 1140 and 1170, and 9 subtypes:

1110-3 Shallow fine sands

The substrate comprises fine earthy (flinty) or biogenic sands, mixed with shells and pebbles, from the shore down to the 5-6 m isobath. The molluscs *Mya arenaria, Cerastoderma glaucum* and *Anadara inaequivalvis*, the crustaceans *Crangon crangon, Liocarcinus vernalis* and the fish *Platichthys flesus* and *Pegusa lascari*s are typical.

1110-4 Well-sorted sands

This habitat is located immediately after shallow fine sands, from 5-6 m to 10-15 m deep. The substrate comprises homogenous granulometry sands, less affected by wave movement. The typical species are the molluscs *Chamelea gallina, Anadara inaequivalvis, Cerastoderma glaucum*; the crustaceans *Liocarcinus vernalis* and *Diogenes pugilator*, the fish *Uranoscopus scaber, Pomatoschistus* sp.;

1110-5 Wave-lashed coarse sands and fine gravels

Encountered in natural rocky coves of natural exposed coasts and do not exceed a few tens of centimeters deep. They are narrow submerged beaches, composed of coarse sand and gravel derived from the degradation of rock, continually remodeled by waves.

1140-3 Midlittoral sands

The habitat covers the shore sand, on which the waves break. Depending on the sea choppiness, the portion may be wider or narrower, but in the Black Sea it is limited by the low tide. The sand is compact and mixed with shell remains and gravel.

Fig. 3.1.2.6. - Midlittoral sands in *ROSCI0293 Costineşti - 23 August* (NIMRD original photo, V. Niţă)

1170-5 Supralittoral rock

Is situated above the water level and is sprayed by waves of flushed during storms. The vertical extent depends on wave regime, solar exposure and slope. Harsh conditions make this habitat suitable only for a few hardy species: the lichen *Verrucaria*, isopod crustaceans, the crab *Pachygrapsus marmoratus* etc. In areas with organic pollution it can be covered by a slippery film made of epi- and endolitic cyanophytes.

1170-6 Upper midlittoral rock

It is located in the upper part of the swash zone is not permanently covered by water, being intermittently wetted by taller waves. The most typical fauna element is the cirriped crustacean *Chthamalus stellatus*, rare at the Romanian coast.

1170-7 Lower midlittoral rock

Located in the lower part of the swash zone and covered by water most of the time. Submersion, strong wave action and bright light are the main factors here. The encrusting corallines *Lithophyllum incrustans*, articulated corallines *Corallina officinalis*, *C. elongata* and ephemeral macrophytes like *Ulva compressa*, *Enteromorpha* sp., *Cladophora* sp. and *Ceramium* sp. algae make up the algal cover. The fauna is characterized by the crustacean *Balanus improvisus*, the bivalves *Mytilaster lineatus* and *Mytilus galloprovincialis*, bryozoans, amphipod and isopod crustaceans, the crabs *Pachygrapsus marmoratus* and *Eriphia verrucosa*.

Fig. 3.1.2.7. - Lower midlittoral rock in the site *ROSCI0293 Costineşti - 23 August* (NIMRD original photo, V. Niţă)

1170-8 Infralittoral rock with photophylic algae

This habitat begins immediately below the lower midlittoral, where emersion is accidental, and extends down to the lower limit of distribution of photophylic algae. Between these boundaries the rocky substratum is covered with dense and varied photophylic algal turfs. Among these, the highest conservation value is held by coastal belts formed by the perennial brown alga *Cystoseira barbata*. They only grow in areas with clear, clean water and relatively sheltered from waves. The *Cystoseira* thalli are solid, durable, elastic and form true thick "forests" whose structural and permanent complexity allows for the development of a rich and diverse fauna.

Fig. 3.1.2.8. - Infralittoral rock with photophylic algae in the site *ROSCI0293 Costineşti - 23 August* (NIMRD original photo, V. Niţă)

1170-9 Circalittoral rock with *Mytilus galloprovincialis*

The mussel (*Mytilus galloprovincialis*) banks covering the rocky substrate in the previous habitat become dominant starting with 10-15 m, continuing as a compact cover to the lower distribution limit of the rocky substrate (25-35 m deep). The fauna is highly diverse, including numerous sponge, hydrozoan, polychaete, mollusc, crustacean and fish species.

Fig. 3.1.2.9. - Circalittoral rock with *Mytilus galloprovincialis* in the site *ROSCI0293* Costineşti - 23 August (NIMRD original photo, V. Niţă)

CHAPTER 4
4.1. SOCIAL ENVIRONMENT

4.1.1. MARITIME SPATIAL PLANNING

Maritime Spatial Planning (MSP) is considered part of the Integrated Coastal Zone Management (ICZM) and a sustainable development tool. From 2008 to the present, the definition of this concept has undergone significant changes. Due to ambiguities in the nomenclature of the maritime spatial planning process, there were different expressions of MSP synonyms, such as: marine spatial planning, maritime spatial planning, "off-shore" planning, maritime spatial development.

In 2011, the European Commission organized a public consultation for MSP (March to May), to know the opinion of stakeholders in Member States.

In March 2011, the ICZM Protocol on integrated management of the coastal zone entered into force. The protocol was enforced especially in Member States neighboring the Mediterranean. Within the FP7 project PEGASO, the study of the implementation and dissemination of this protocol was conducted. As a partner in this project, Romania (by NIMRD and DDNI) actively contributed to this objective, including by its periodic reports and collaboration with the Black Sea Commission. In 2012, in Brussels, a special meeting dedicated to MSP was organized.

In 2012, ICZM and MSP definitions changed again and currently they are both tools for the sustainable development of the coastal zone, as follows:

- ICZM - is a tool for the integrated management of the coastal area, and
- MSP - is a tool and public process for analyzing and planning the spatial and temporal distribution of human activities in the maritime area.

The **major difference** between **land spatial planning** and **maritime spatial planning** derives from **different ownership** types: the marine area is of a public nature, is open to everyone and to changes and all modes of use, while the land area, better structured and known, is divided into public property, private and state property.

So far, NIMRD contributed to the first inventories of human activities on which the primary elements of maritime spatial plans were established.

In 2012, the informational support (documentary and imaging) required to demonstrate that some of the important activities and marine uses, such as fisheries, can be seen as part of maritime spatial planning (Project PN-NUCLEU 09-320302/2009-2012) was developed. The following were planned in 2012:

- Identification of the Common Fisheries Policy aspects;
- Inventory of European legislation, harmonization and implementation to Romanian conditions;
- Study of the Exclusive Economic Zone (EEZ), the role of zoning and reporting of legal issues, conflicts (essential components of MSP) on the application of environmental legislation for the protection of marine areas and exploitable resources at the Romanian coast and across borders.

It was also found that, in our country, NIMRD has a long line of historical and current data recorded in marine fisheries and fishing. According to their commercial and environmental importance, such assessments are subject to specific studies and some essential prognoses of fisheries and the obligations assumed by Romania as a Member State of the European Union and the Black Sea basin. The recorded data are also used in controversial situations, such as overexploitation of species with high economic value, foreign vessels from countries neighboring Romania and the Black Sea entering territorial waters, border areas (illegal, unregulated and unreported fishing).

Socio-economic pressures are particularly high. Member States (including European maritime states) often reach conflicts about fishing rights in territorial waters. Taking into account the situation of natural stocks reaching alarmingly low levels, sustainable fisheries remains a core priority. In this regard, the issues of concern to marine fishery in the Romanian Black Sea waters, access to Community waters, implementing conventional European regulations, identifying fishing areas and protecting the capitalizable fishery resources are essential elements in implementing the Integrated Maritime Policies and the obligations assumed by Romania to develop marine strategies (Fig. 4.1.1.1.).

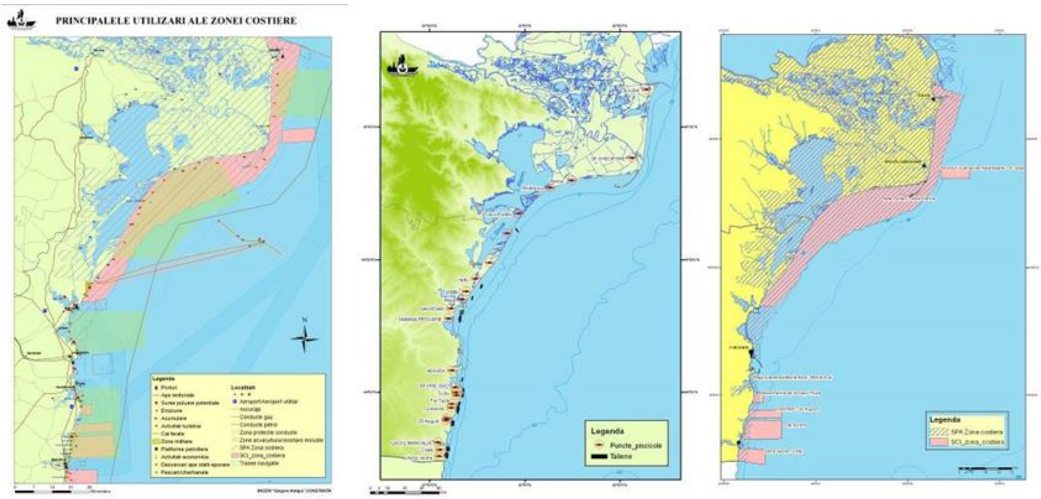


Fig. 4.1.1.1. - Integrated maps of the maritime and coastal area:
a. Main uses (update);
b. Coastal map of fisheries;
c. Marine Protected Areas (MPAs)

In 2012, the following outcomes concerning MSP were reached:

- Initiation of a legislative framework in the field of fisheries, adaptable and easily updated, including laws, government decisions, decrees, public administration orders, regulations, decisions, emergency ordinances, republished laws, along with other specific documents: agreements, protocols, addenda, contracts, addresses, statutes;
- Identification of international legislation harmonized to national conditions, developed and/or under implementation in Romania, with the possibility of permanent updating;
- Initiation of the integration of marine fisheries and fishing in the field of Maritime Spatial Planning;
- Identification of specific situations related to some conflicting issues (national and international) and pointing-out support issues on solving case studies.

Cartographic and photographic images of the main coastal activities in the marine and terrestrial protected areas, thematic and integrated marine uses - in fisheries - and the distribution of some of the most important species in the Romanian and Bulgarian marine zone (Fig. 4.1.1.2, Fig. 4.1.1.3.).

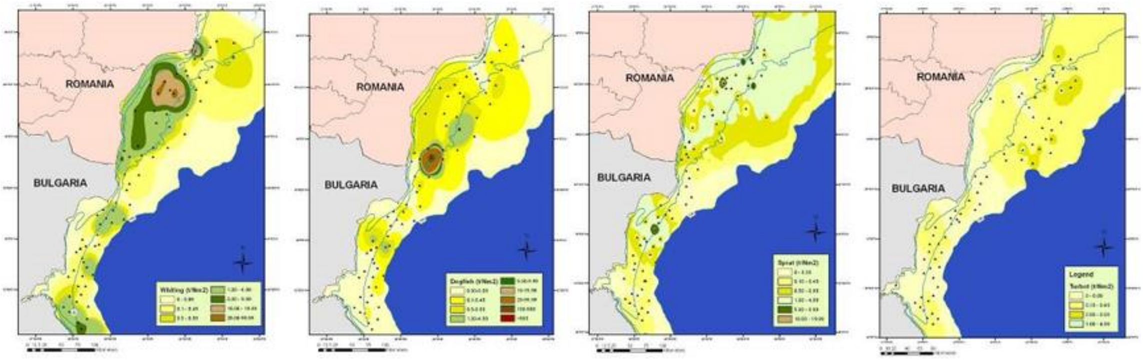


Fig. 4.1.1.2. - Cross-border distribution maps (Romania - Bulgaria) of marine species stocks (whiting, dogfish, sprat, turbot)

With the view to fully understand and integrate marine fisheries into MSP, the following were studied:
- "Code of Conduct for Responsible Fisheries" - FAO;
- Community fisheries policy and the "Habitats" and "Birds" Directives;
- Zoning of marine protected areas;
- Cross-border issues on the appointment and management of protected sites;
- ICZM Protocol and the Protocol on Special Protection Areas and biological diversity in the Mediterranean.

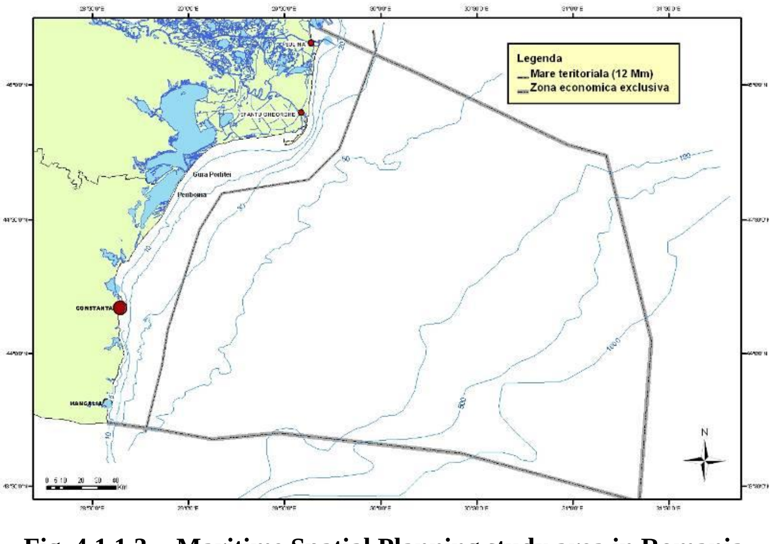


Fig. 4.1.1.3. - Maritime Spatial Planning study area in Romania

The results obtained in 2012 can be summed-up as follows:

- In the waters of seas and oceans, including the Black Sea, fish and other aquatic organisms are renewable exploitable natural resources that can be caught in terms of durability if rational policies are implemented.
- Through MSP, the exploitable natural stocks will not be reduced by future exploitation and overuse, the urgent moral duty of this generation is to advocate for conservation and operation policies in accordance with the carrying capacity of ecosystems.
- European policies recommend governments and their citizens to apply global and integrated policies on the long term and short term, to maintain stocks for a long time.
- Currently, we deem it is necessary to: 1. Nominate the authority responsible for MSP; 2. Develop national norms; 3. Harmonize the European legislation and implement EU directives to national/local conditions; 4. Involve NIMRD in making plans and activities in marine, coastal and cross-border areas, as national multidisciplinary marine research institute; 5. Cooperate with other institutions involved in marine component inventory and spatial plan development; 6. Develop the capacity of translating data into GIS format.

4.1.2. INTEGRATED COASTAL ZONE MANAGEMENT

International cooperation within an EU context in the frame of sharing knowledge and experiences is a great help in the development of the Romanian ICZM programme and the preparation of an adaptive coastal response to anticipated impacts of climate changes.

ICZM at European Union level

The European Commission has launched a review of the EU ICZM Recommendation, with a view to a follow-up proposal by the end of 2012. An impact assessment was conducted in conjunction with the assessment of possible future action on Maritime Spatial Planning. In order to address the issue further, the Commission is currently tendering a service contract on sharing of best practices on ICZM in a context of adaptation to climate change in coastal areas. One of the objectives is to provide up to date and well-targeted information aiming to increase, share and disseminate Member States' knowledge about Integrated Coastal Zone Management and the linkages with Maritime Spatial Planning in this context of climate change adaptation. The findings of the analysis of existing policies and measures could be the basis for a guidance document on concrete actions.

The European Environment Agency (EEA) organized on 11-12 September 2012 the first Joint EIONET and Member State Expert groups on Maritime Spatial Planning and Integrated Coastal Zone Management (ICZM). The workshop focused on the links between ICZM and MSP and increasing general awareness for the need to coordinate both policies in order to come to sustainable coastal management and marine planning in particular land-sea-interface issues.

ICZM at regional level

The Advisory Group on the Development of Common Methodologies for Integrated Coastal Zone (AG ICZM) is an integral part of the Black Sea Commission institutional structure and constitutes its subsidiary body, which gives advice to the Black Sea Commission on proper management of the coastal zone and elaboration and implementation of regionally coordinated integrated coastal zone management strategies, methodologies and instruments in the context of sustainable development *(Annex I, Black Sea Strategic Action Plan, 1996)*. The 16th ICZM Advisory Group Meeting was organised according to the Work Programme of the Black Sea Commission on 4-7 December 2012. Therefore were presented the National Reports of the Black Sea riparian countries, as well as the *Black Sea CASEs progress - Romania CASE; Ukraine CASE; Georgia CASE*. The role of the PEGASO CASEs (pilot sites) was to test and validate some of the tools developed during the project at various spatial scales. All the Black Sea CASEs are currently working on the methodological fact sheets and indicators. Thus, the Georgia CASE (Guria Coastal Region) adapts the progress indicators for use at national level, the Ukraine CASE (Sevastopol Bay) tested water quality and pollution indicators and the Romania CASE (Danube Delta) applied biodiversity indicators for species, habitats, fragmentation etc. and tested LEAC (Land and Ecosystem Accounting) methodology in the protected area. The results of the work carried-out within pilot sites will contribute to the regional assessment with respect to the ICZM process in the Black Sea.

A stock-taking for Integrated Coastal zone Management (ICZM) is being undertaken for Mediterranean and Black Seas within the EU 7th Framework Programme (FP7) PEGASO Project and in the spirit of the Shared ICZM Governance Platform promoted by PEGASO for these two regional sea basins. The purposes of the questionnaire are focused on the following main directions:

(a) to perform the policy, legal and institutional stock-take as the basis for the future implementation of the ICZM;

(b) to build on existing capacities and develop common novel approaches to support integrated policies for the coastal, marine and maritime realms of the Black Sea Basin in ways that are consistent with and relevant to the development of the ICZM Guidelines for the Black Sea.

ICZM at national level

The Romanian ICZM legal framework consists of the main legislative documents:

- **Governmental Emergency Ordinance no. 202/2002** regarding coastal zone management **approved with further modifications and amendments through Law no. 280/2003**;
- **Government Decision no.1015/2004** regarding the Regulations of the organization and operation of the National Committee of the Coastal Zone;
- **Government Decision no.749/2004** for establishing of the responsibilities, criteria and the delineation manner of the land stripe close to the coastal zone to preserve the environment, patrimonial and landscape values close to the shore;

- **Government Decision no. 546/2004** regarding the approval of the methodology for delineation of public state domain in the coastal zone.

Fig. 4.1.2.1. The 14th Session of the National Committee of Coastal Zone organized by NIMRD (20 september 2012) (NIMRD original photo)

The National Committee of the Coastal Zone (NCCZ) was established in June 2004 by Government Decision no. 1015/2004 in order to ensure an integrated coastal zone management. As prescribed by Law no. 280/2003 and approved by Government Emergency Ordinance no. 202/2002 on integrated coastal zone management, representation in NCCZ encompasses about 40 central, local and regional authorities, institutions and stakeholders, NGOs and is responsible for the endorsement of all subjects related to integrated coastal zone management.

The National Institute for Marine Research and Development “Grigore Antipa” (NIMRD) is responsible for the Permanent Technical Secretariat (PTS) activities. Under the National Committee, Working Groups (WG) consisting of key experts from relevant authorities and research institutes providing advice and guidance on specific topics such as monitoring and control of the coastal environment, coastal spatial planning, coastal erosion, action planning and strategy development etc. were set.

On 20 September 2012 the 14th Session of the NCZZ was held, organized by NIMRD. The meeting was attended by 32 representatives of 40 institutions currently involved in NCCZ.

Public participation is one of the key factors believed to drive ICZM. Participation means the involvement and collaboration of the private sector, NGOs, citizens’ groups and other non-institutional organizations or individuals interested in or affected by the management of the coast. Coastal resource planning and management requires the highest level of stakeholder and public participation possible.

Relevant coastal zone projects:

A. National projects

- Plan on the rehabilitation of the Romanian coastal zone against erosion (2010 - 2012);
- Cliff rehabilitation works;
- Preparation of the Informational Support and the Updating of the Database Aiming at the Elaboration of the Integrated Maritime Spatial Planning Strategy;
- Characterization of the Marine Ecosystem and the Promotion of the Sustainable Development.

B. International projects

- EC/FP 7: European Marine Observation and data Network - EDMODNET (2009 - 2012);
- EC/FP7: People for Ecosystem based Governance Assessing Sustainable Development of Ocean and coast - PEGASO (2010 - 2014);
- EC/FP 7: Option for Delivering Ecosystem-Based Marine Management - ODEMM (2010 - 2014);
- EC/FP 7: Pan-European infrastructure for Ocean & Marine Data Management SeaDataNet II (2011 - 2015);
- EC/FP7: Coordinating research in support to application of Ecosystem Approach to Fisheries (EAF) and management advice in the Mediterranean and Black Seas - CREAM (2011-2014);
- EC/FP7: Towards COast to COast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential - CoCoNet (2012-2016);
- EC/BS-ERA.NET - FP7: Radiation background of Black Sea coastal environment (2011- 2014);
- EC/BS-ERA.NET - FP7: Molecular Approaches for rapid and quantitative detections of Cyanobacteria and their toxins from coastal Black Sea (2011-2014), *ENV- 1.2 Water pollution prevention options for coastal zones and tourist area;*
- ESA: Application for the Western Black Sea - Ocean Color (2010 - 2013);
- Joint Operational Programme “BLACK SEA BASIN 2007-2013”: Strengthening the regional capacity to support the sustainable management of the Black Sea Fisheries - SRCSSMBSF (2011 - 2013)
- Joint Operational Programme “BLACK SEA BASIN 2007-2013” Industrial Symbiosis Network for Environment Protection and Sustainable Development in Black Sea Basin - SymNet (2011 - 2013);
- 2nd Call for Proposals Joint Operational Programme “BLACK SEA BASIN 2007-2013” Improvement of the Integrated Coastal Zone Management in the Black Sea Region, ICZM (2012-2014).

4.1.3. ANTHROPOGENIC PRESSURES

Pressures in the coastal zone

The current period, following the 1990s, is regarded as a period of relaxation of human pressure, in particular in relation to the economic collapse of the socialist block countries, which led to the abandonment of many polluting activities in agriculture, industry, urban development.

It should be noted that, by 2007, the so-called anoxic "dead zones" in the Western Black Sea disappeared, the frequency of hypoxia conditions decreased, the biomasses of the fodder zooplankton species increased and the invasive species abundances dropped.

However, the ecological state of the Black Sea ecosystem has continued to be a concern due to the loss of biodiversity caused primarily by the socio-economic pressures, namely eutrophication, overfishing, even if the fishing fleet has disappeared in the highest proportion, pollution by oil and hazardous substances, introduction of new invasive species, coastal erosion, transportation and tourism in the wider climate change context.

Thus, various provisions of the legislation in force contain many references to marine pollution, however not adequately quantifying and including in the regulations/rules of good practice and national or European regulations the action of the various pressures exerted by the socio-economic environment, such as biodiversity loss and degradation, habitat loss, overfishing, eutrophication due to certain gaps which lie in insufficient funding of research programmes and projects, lack of expertise and advanced research equipment.

However, many of the parameters and indicators analyzed in environmental state reports (such as, for example, nutrients, hazardous substances, biodiversity, fish stocks etc.) are already in direct accordance with the requirements of the Marine Strategy Framework Directive (MSFD).

It will be necessary to extend the MSFD for indicators of hydro-morphological changes crucially impacting especially in coastal areas, namely the rates of shoreline retreat, rising sea levels, changing the topography and bathymetry of shallow areas as a result of extending various coastal protection constructions which cause changes in the annual and seasonal velocity regime of currents modified by exposure to wave action, inducing changes in the mixing characteristics, turbidity (optical regime change), residence time etc. and changes in habitat distributions in areas which deserve special attention due to their characteristics, location or strategic importance, respectivley, by undergoing extreme/specific pressures, for areas requiring special protection regime.

In 2012, environmental monitoring conducted at the Romanian coast emphasized the improvement of the conservation state of all biotic components, including phyto/zooplankton and fish fauna. One reason for this improvement is considered to be the decrease of environmental pressure exerted by the different populations of invasive species, such as *Mnemiopsis* and *Pleurobrachia rhodopis*.

Also, the distribution and dynamics of phytoplankton abundances showed significant spatial and temporal variations under the influence of natural and anthropogenic conditions, especially represented by the area of the Danube outflow influence and/or the effects of various anthropogenic pressures on shallow areas of the southern coastline. Benthic invertebrates are often used as indicators of environmental change detection and monitoring with a rapid response to stress caused by the natural and/or man-made pressures, their presence or absence may reflect, in time, spatial changes in ecosystems and their temporal evolution footprint.

Information resulting from investigations on heavy metals as a basis for the characterization of Romanian marine ecosystems in terms of the levels of heavy metal pollution showed some signs of recovery of the marine ecosystem quality during research in recent years. However, the distribution of heavy metals in the Black Sea marine ecosystem components highlights the differences between the various sectors of the coastline. Generally slightly increased concentrations are found in the waters under the influence of the Danube and in the southern sector in certain areas subject to different anthropogenic pressures (harbors, wastewater discharges).

Thus, it can be stated that, in the year 2012, the ***main anthropogenic pressures identified in the Romanian coastal zone*** result from the pronounced development of various socio-economic activities in the coastal zone natural space: tourism and leisure, buildings/holiday homes in tourist areas, expansion and modernization of existing tourist marinas, harbors and navigation, marine fisheries, agriculture and food industry, petrochemical industry, refineries etc.

As a result of these pressures, the Romanian coastline faced significant problems regarding **habitat destruction, coastal erosion, water pollution and depletion of natural resources**. The rapid population growth in residential areas, in previously tourist areas and the rapid development of the related infrastructure have led to severe degradation and decline in the quality of the Romanian coastal zone, along with the large-scale exploitation of natural resources.

In addition, **maritime traffic**, including leisure boats traffic, with high incidence in summer, involves multiple pressures on the Black Sea biodiversity, including the discharge of nutrients, production of underwater noise, oil leaks and spread of non-indigenous, exotic organisms.

Also, the **urban sprawl/coverage of beach areas with constructions** and extending vertically/raising the old historical buildings/terraces on the beach by running multiple stories above them (Mamaia area), and the uncontrolled development of temporary tourist constructions and tourist, recreation and leisure activities over the carrying capacity of the coastal environment led to the additional pressures exerted by tourism on the environment, in terms of population doubling during the summer season, becoming significant, linked to increasing/doubling the amount of domestic wastewater requiring treatment, increasing/doubling car traffic and recreational boating, with subsequent increases in emissions and noise level.

Local pressures generating organic substances/pollutants are concentrated in the southern part of the Romanian Black Sea coast, as this area is more developed from the industrial and urban point of view.

The main anthropogenic pressures identified in the Romanian coastal zone result from the pronounced development of various socio-economic activities in the coastal zone natural space: tourism and leisure, buildings/holiday homes in tourist areas, expansion and modernization of existing tourist marinas, harbors and navigation, marine fisheries, agriculture and food industry, petrochemical industry, refineries etc.

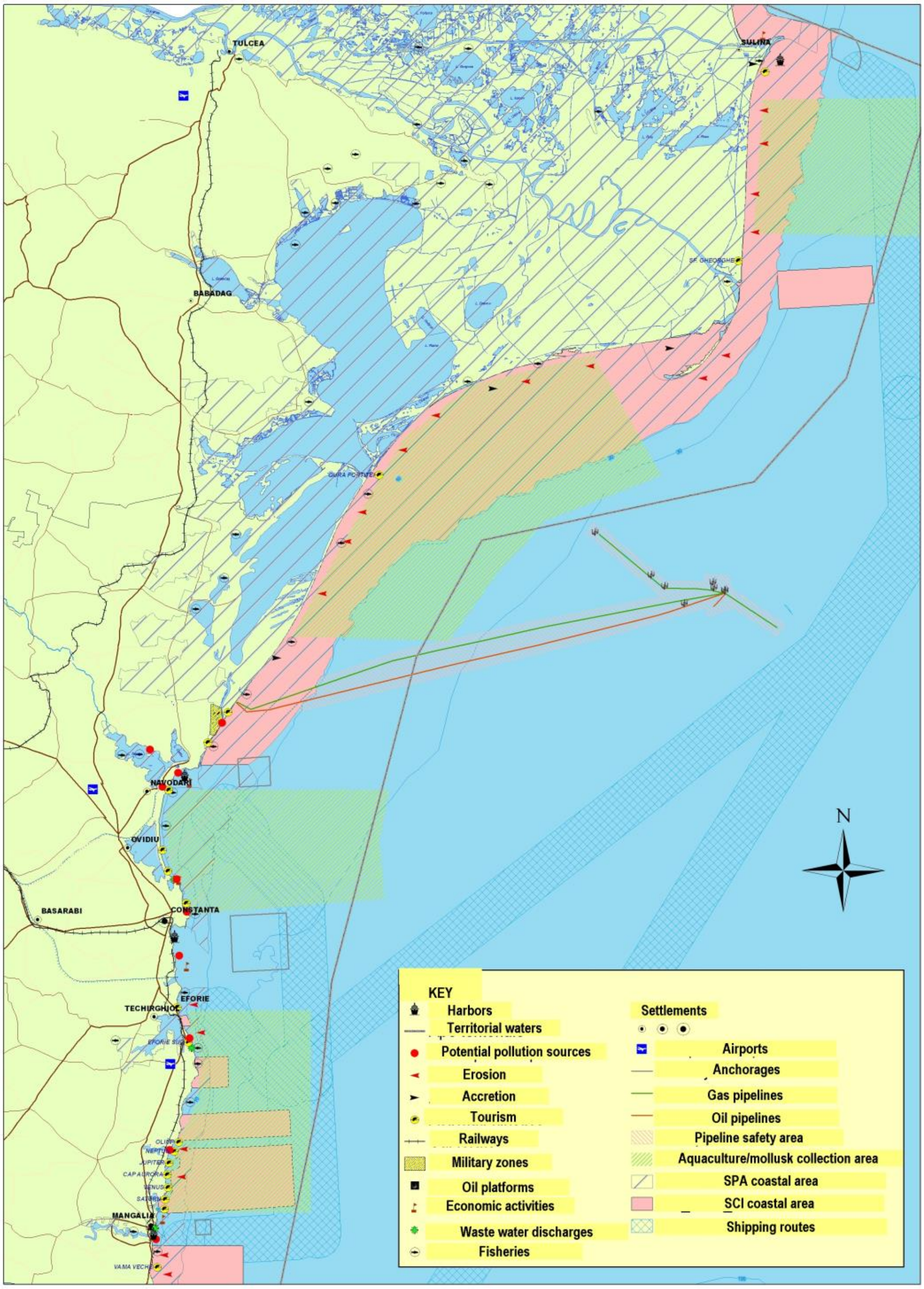


Fig. 4.1.3.1. - Main uses of the Romanian coastal zone

The pressures described above are those identified in the *"Analysis of the main pressures and impacts, including those caused by human activities, influencing the ecological state of Romanian marine waters"*, provided for in Art. 8 b of the Marine Strategy Framework Directive, drawn-up by the Romanian Waters National Agency and NIMRD "Grigore Antipa". This report can be accessed online following this link http://www.mmediu.ro/beta/stiri-si-anunturi/evaluarea-initiala-a-mediului-marin-2/.

In this document, the main pressures and impacts were analyzed, including those resulting from human activities, which influence the environmental state of Romanian marine waters in accordance with the requirements of Marine Strategy Framework Directive. This is a brief outline of the main findings of the report.

Impact of maritime traffic

Maritime traffic entails multiple pressures on the Black Sea biodiversity, including the discharge of nutrients, production of underwater noise, oil leaks and spread of non-indigenous, exotic organisms.

Nutrient input: Maritime and inland river transport have contributed to the eutrophication of the Black Sea through nitrogen oxide emissions and discharges of nitrogen and phosphorus contained in waste from vessels. Also, the salts of nitrogen emitted into the air are deposited either directly on the surface of sea water or in its catchment area, from where a part is driven in the sea by rivers.

Oil spills: Accidental oil spills from vessels cause cascade effects on the marine ecosystem, from phytoplankton to the top of the food chain. Though little known, it is assumed that even these minor discharges are harmful, given the decreasing availability of food and increased bioaccumulation of toxic substances.

The transportation of petroleum products with Romanian tankers dropped immediately after 1990. In 2010, the last of the six Romanian tankers which sailed under Romanian flag, the "Histria Topaz", was sold for scrap. The quantities of petroleum products detected in harbors or coastal waters come from small illegal or accidental spills. However, we must bear in mind the negative cumulative effect of these minor spills. The species that suffer the most are seabirds and cetaceans, that may suffer from hypothermia and intoxication, which can cause the death of animals, especially birds.

Other effects of maritime transportation, especially in shallow waters, are physical in nature. Vessels generate water mass movements, leading to coastal remodeling, change the circulation of nutrients in the water column, boosting eutrophication.

Even some structural changes and the drop of coastal fishing stocks may be caused by maritime traffic, coastal erosion, increase of sedimentation and eutrophication. Maritime traffic may also lead to increased quantities of marine litter. Fouling, as well as ballast water and sediments carry exotic organisms and chemical antifouling paints used for painting the hull may cause acute effects on organisms, especially on species from lower trophic levels of the food chain.

Noise: Although maritime traffic causes a considerable increase in noise levels, both at surface and in the water mass, it seems that it does not cause acute damage to marine animals, but may cause disturbances especially on the ceatcean species *Phocoena phocoena* (harbor porpoise).

Hydrotechnical works at the Romanian coast

One of the disturbance factors which acted at the Romanian coast and which, along with other negative influences, has led, over time, to a decrease in biodiversity, have been erosion and coastal hydrotechnical works and structures, many of them meant to prevent erosion. Among the hydrotechniacl works with negative balance of the past decades, we mention:

- Hydrotechnical works for river landscaping (dams, derivatives, water supply, anti-erosion works etc.);
- Works related to navigation (construction and expansion of the jetties for the Sulina branch on a distance of approx. 9 km) and coastal protection (groynes, dams etc.);
- Construction of maritime harbors.

The consequences were the changes in shoreline morphology and bottom slope, changes in the structure of the substrate, increase in the organic content in the water and sediments, increasing turbidity. This led to the installation of less favorable conditions, actually to a degradation of living conditions for all plant and animal organisms, both in the water mass (planktonic), but especially for those related to substrate (benthic bodies). An example of the loss of biodiversity, due mostly to this negative factor, is the evolution of the algal macroflora of our coast.

Impact on macrophytes: The driving of large quantities of suspensions, which, once in the water, reduce the permeability of light, on the one hand, and, on the other hand, cause the clogging of the substrate and prevent the fixation of spores, further germination and growth of algae. Increasing suspensions have reduced transparency and hence the limit of algal macroflora development dropped, the germs and juvenile stages of red and brown algae, especially sensitive, being muffled. The *Cystoseira* fields used to have an important role in damping shock waves and their reduction entailed driving large quantities of suspensions in the water.

As a follow-up, of the 122 macrophyte species described at the Romanian coast, in 1980 only 70 species were reported, of which only approx. 20 species in more significant amounts, and in 1982 only 24 taxa were listed.

The brown algae belt of the genus *Cystoseira*, which once was characteristic for the southern part of the coast (north of Tuzla to Vama Veche, at 0.5 - 2 m depth, 150-200 m wide belt), with a special ecological role, has reduced progressively.

The assessments in 1971 determined 5,600 tons, in 1979 only 120 tons, while in 1980 only isolated tufts were reported.

The reduction and subsequent disapperanace of the *Cystoseira* perennial algae fields, which were a favorable environment for a rich associated fauna, caused the reduction or disappearance of benthic invertebrate species living in the algal thicket (amphipod, gastropod, shrimp, crab species) and the reduction of the distribution, feeding and shelter areas for many fish species, mainly *Bleniidae* and *Labridae*. The *Cystoseira* facies, which was an extremely significant ecological niche for marine life in the infralittoral zone, is today extinct.

A similar evolution had *Zostera marina* (eelgrass), the only marine phanerogam species, which used to form “green islands“ in shallow waters in the sedimentary zones of Midia, Agigea and Mangalia and which is currently almost extinct. Along with it, some co-

coenosis indwellers - animals living in the thickets formed by *Zostera* grasses - disappeared (especially shrimps, which were abundant here, and fish species from the family *Sygnatidae* (sea pony - *Hippocampus microstephanus* and the snouted pipefish - *Syngnathus argentatus*).

Impact on the sandy mid-littoral and intestitial supralittoral: Changes in mid-littoral sediment texture and advanced clogging in certain areas of the coast have negatively affected the life of interstitial organisms. Research in the past 4-5 years, when research in this living environment was resumed, showed an alarming depletion of wildlife, both as species diversity and density as compared to the situation recorded in the period 1960-1970. The trend of environmental degradation of the two biotopes - sandy mid-littoral and interstitial supralittoral - was determined by the circulating of increasing amounts of particulate and dissolved organic matter through the endopsamic micropores, up to clogging them and causing the reduction of sediment permeability, often leading to anaerobic conditions. Thus, the great species diversity of these biotopes in previous decades is now much diminished. Some dominant species in the past, such as the association of the bivalve *Mesodesma corneum* and the polychaete *Ophelia bicornis,* characteristic for the mid-littoral in the south, have been conspicuously absent in recent years.

Oil and gas prospection and survey activities

In an attempt to change the downward trend in the level of oil production in the country, in 1990 the Romanian Government decided to encourage private investment and access to new technologies by issuing licenses for oil and gas prospecting in the continental shelf of the Romanian Black Sea (Fig. 4.1.3.2.). There are two ways of seismic prospection, namely seismic exploration prospecting and exploration by drilling. Seismic prospection precedes prospecting by drilling and aims at acquiring seismic images of the seabed geology. The seismic profiles are then interpreted, and interpretations are used in preparing geological maps to assist in the exploration of hydrocarbons. The energy source for obtaining the sounds is represented by *air guns*.

Relating to both types of prospecting, several pollution sources were identified, impacting on the environment in a different manner.

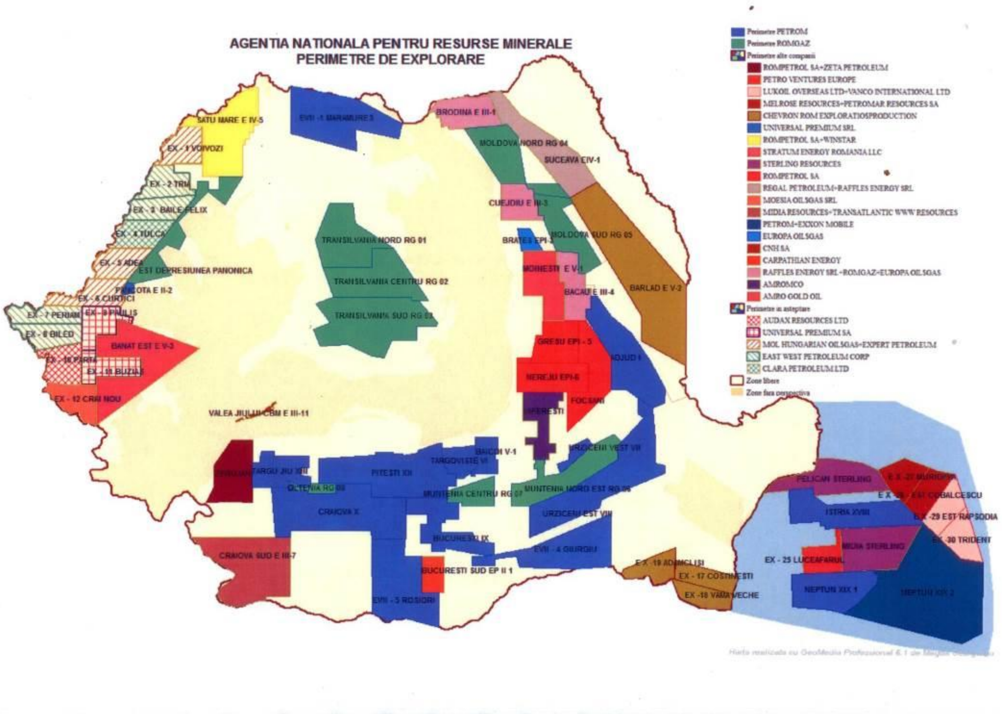


Fig. 4.1.3.2. - Map of oil and gas exploitation fields in Romania ***(http://www.namr.ro/map_petrol/)***

I. Pollution sources

1. *Cuttings, detritus* or *drill solids* - result as a follow-up of the cutting of the substrate rock and may vary in size (15-338 µm), and the total amounts thereof vary in relation to depth, cross-section diameter etc. Part of the drill solids may remain on the seabed and part may reach the surface, on the drilling platfrom, from where they will be discharged. The cuttings discharged will sink to the seabed and their dispersion depends on the particle size and distribution, water depth and currents.

2. *Drill mud* or *sludge* is a mixture of several chemicals (e.g. bentonite, sodium hydroxide, sodium ash, gelplex, floplex, and the like) and seawater.

3. *Air emissions* are generated from the combustion of diesel in power generators on the platform and support vessels. They contain many more compounds, including heavy metals, dioxin, HCB and suspended particulate materials, substances which, although in infinitesimal quantities, some of them are very dangerous to human health and the environment.

4. *Underwater noise* is produced by the activities on the platform, cranes, support vessels, the helicopter making the crew change and so on, when exploration is made through drilling, or by air guns, for seismic prospections.

5. *Accidental oil spills*, caused either as a follow-up of a transfer from the fuel supply vessel to the bulk storage room of the platfrom (rare and in small amounts) or by an accident (collision), when the entire hydrocarbon stock can get into the sea.

II. Impact on the marine environment

The drill cuttings and the drill mud are the first two pollutant categories resulting from drilling activities, which may impact both on the quality of water and sediments on the site, but also implicitly on the plant and animal species.

- *Increasing the amounts of suspensions in the water*: drill cuttings with mud residues and chemicals in its composition will produce increased quantities of suspensions both in water and on the sediment, which will cause a decrease in transparency and increased turbidity.
- *Clogging and death by suffocation of monocellular organisms:* Decreased transparency will have a direct and immediate impact on photosynthetic unicellular organisms (phytoplankton) and indirect on the phytoplankton eating zooplankton; the increasing quantities of suspensions will cause the clogging of the respiratory apparatus of zooplankton species, causing their death by suffocation. The highest impact will occur on benthic organisms and primarily on those that feed by filtering the water suspensions, such as molluscs, clams.
- *Underwater noise*: may have pathologic, sometimes even lethal consequences on all organisms (phytoplankton, zooplankton, benthic invertebrates, fish), yet the highest impact is felt by dolphins. The assessment of noise impact on cetaceans is mostly based on assumptions. Being extremely active animals, marine mammals are able to avoid vessels and, in addition, some species, among which the three species in the Black Sea, have behavioral skills and competencies by means of which they can reduce their vulnerability to the negative effects of man-made noises. However, it is considered that noise and vibrations may have a direct or indirect, aggregated and synergic impact on dolphins, by causing behavioral changes, leaving the feeding, breeding and nursing areas.

Leisure and tourism

The Romanian coast of the Black Sea concentrates 43% of the country’s tourism potential. Located at the confluence of several pan-European transport corridors and benefiting from the proximity of the Black Sea, Constanța can develop a range of tourism products, such as summer tourism, spa tourism, rest and recreation, tourism and water sports, business tourism and cruise and itinerary tourism (EPA Constanța Report, 2005).

The tourist resorts are located in the southern and central part of the coast; we mention Mamaia, Eforie North, Eforie South, Costinești, Olimp, Neptun, Aurora, Venus, Jupiter, Saturn, as well as the villages south of Mangalia, 2 Mai and Vama Veche.

In July 2008, there were 249 Romanian seaside hotels. Every summer it is estimated that over 1 million tourists visit the Romanian littoral (1.3 million in 2009). Basically, during summer, the population of the Constanța County doubles.

At the Romanian coast there are three leisure harbors (marinas) (the Mangalia Tourist Harbor, the Tomis Constanța Harbor and the Eforie Marina). In Mamaia, a walkway allowing the access of visitors to a marina for leisure boats was put into service in the summer 2012. This is part of the future Mamaia Marina. It is planned to build a new marina, which will be the largest marina in the Black Sea Basin and will be called *Marina di Eforie*. The harbor will cover 200 hectares, between the Constanța South Agigea Harbor and Eforie North.

Recreational/sports fishing at the Romanian seaside is carried-out both on the beach and piers, as well as in boats. It is possible to rent boats for fishing offshore in most sea harbors, Sulina, Sf. Gheorghe, Gura Portiţei, Midia, Tomis Marina, Eforie North, Mangalia.

Impact of leisure activities

Doubling the population in summer makes the tourism pressures on the environment significant. First, it doubles the amount of domestic wastewater requiring treatment, it doubles traffic, thus leading to duplication of emissions and increase of traffic noise.

Among the most important tourist activities are bathing, sailing large and small boats, some of them private property, and recreational/sports fishing. These activities have a great negative impact potential on the ecosystem, through the release of nutrients and microbiological agents, marine waste, physical damage and natural resource extraction.

Leisure boat activities are conducted mainly in marinas that contribute to the fragmentation of the coastal zone and are associated with negative impacts of dredging during construction. Privately owned boats (rowing boats and motor boats, cutters and sailing boats) and related activities, such as fishing, cause multiple impacts on the marine environment. Some of the boats allow spending the night at sea. Larger vessels have toilet waste collection facilities on board, but in many leisure boats there are no such facilities, so they are discarded at sea or stored on the land.

A continuous impact is represented by the holiday homes that contribute to pollution, with large amounts of nutrients and microbiological agents, since many are not connected to the municipal sewer system.

Toilet wastes (from boats and holiday homes not connected to sewers), and the uncivilized behavior of tourists in bathing waters pose a risk of pollution and are a source of nutrients, impacting on the biodiversity.

The Public Health Directorate monitors in 49 points both the microbiological indicators (total coliforms, faecal coliforms, faecal streptococci, *Salmonella*, enteroviruses) and physical-chemical indicators (temperature, pH, mineral oils, phenols, transparency, dissolved oxygen, degree of saturation, BOD5). These monitoring points are located in 15 bathing areas - Năvodari Beach - children's camp, Mamaia Beach, Modern Beach - Constanţa, Eforie North Beach, Eforie South Beach, Constineşti Beach, Olimp Beach, Neptun Beach, Jupiter Beach, Cape Aurora Beach, Venus Beach, Saturn Beach, 2 Mai Beach, Vama Veche Beach, Techirghiol Beach. This type of monitoring was made during 2012, as well.

Wastes on beaches: The numerical identification and inventory of wastes present on Romanian beaches was conducted the NGO "Mare Nostrum", within the ***Coastwatch*** Project, since 1995. In 2011, observations were conducted during the period 19 September to 1 November in 32 locations both in the Constanța County, on the coast between Corbu and Mangalia, and in the Tulcea County, on the beach adjacent to the Sf. Gheorghe commune.

After centralizing data from the field, the wastes amounted to a total of 45,369, of which 29,882 are plastic wastes (66%), 8,815 paper wastes (19%), 4,392 metal scrap (10%) and 2,264 glass wastes (5%).

The resort with the largest quantity of waste was Mamaia, followed by Constanța and Neptun. The cleanest resorts, with very little waste, were Cape Aurora, Saturn and Tuzla. However, from the sector between Melody Bar and the Azur Terrace in Mamaia the smallest amount of waste plastic (only 55 pieces) was collected. The other extreme is the beach of the Neptun resort, where 6,872 plastic wastes were counted.

The number of *plastic wastes* (comprising PET packaging, plastic caps, cups and plates, packaging of various food and non-food products, bags and plastic sacks) increased very little compared to 2010, with a rate of only 3%, but was over 63% higher than October 2009. The following types of plastic wastes were found: lighters, disposable cutlery, straws, toys, lounger debris, plastic crates, boxes of medicines, fragments of other objects. The highest percentage of plastic wastes is held by the PET and plastic caps, summing-up 30% and 24%, respectively, of the total.

Paper wastes. The amount of waste paper (packaging of various food and non-food products, paper cups and plates, “tetra pack“ boxes, carton, bags and paper sacks, napkins, magazines, newspapers, pieces of paper) increased allamingly compared to October 2010, with a share of almost 42%. Also, compared to the same period of 2009, this amount increased by 59%. The cleanest sector was Cape Aurora, where no waste in this category was found, and the largest number of paper wastes were counted in Olimp - 1,808. The highest percentage is the packaging (54%), followed by disposable cups and plates (12%) and the lowest percentage (7%) represents the various types of waste paper.

Metal scraps, represented by metal beverage cans, tins, caps, rods, wires, pipes, tubes, plugs, accounted for only 10% of the total and *glass wastes* only 5%. The latter increased by 12% compared to October 2010 and by over 60% compared to October 2009.

On the beach areas monitored were also found in very small numbers textile wastes or wood wastes. Also, construction materials, in different quantities, and piles of trash bags were counted (“Mare Nostrum“ Report, 2011).

To identify the wastes reaching the sea, during research expeditions with the survey trawl (bottom trawl) for demersal fish stock assessment, the monitoring of wastes (solid or emulsion) reaching the sea from various sources (vessel traffic, oil wells, fisheries, tourism etc.) was also carried-out in two consecutive years, 2011 and 2012.

In 16 and 24 hauls of the overall 40 made, in the retention area of the trawl (sack) plastic wastes (bags, sacks, drums etc.), metal scraps, oil, textiles, rubber, fishing gear, pieces of wood or other materials were identified, and the amounts varied from one haul to another. The percentages relative to the total amount of waste collected were 683.43 and 531.18 kilograms, respectively.

The largest quantity of waste was the waste oil, ranging between 24 and 48% and waste wood (with percentages of 35.8 and 38.9%). They were followed by waste rubber (much more in the first survey, when they reached 12%). Dominant in frequency were plastic wastes (bags, sacks, drums etc.), but they accounted for only 1.4 and 2.3%, respectively.

Other harmful effects are gaseous emissions from motor boats, in particular carbon monoxide (CO) and hydrocarbon emissions. This is because a large part of the leisure boats have two-stroke engines with inefficient combustion.

Motorboats are a source of disturbance to marine mammals and birds life by generating noise; collisions between these boats and marine mammals are rare.

Finally, antifouling paints containing zinc, copper and organotin compounds (tributyltin) adversely affect marine organisms.

Fisheries

Fisheries can produce a number of effects on cetaceans, including the change (decrease or increase) of the possibilities of feeding, behavior changes, alteration of distribution, migration and reproductive ability of cetaceans.

Pelagic and coastal fisheries may affect cetacean populations by the overexploitation of fish species that are their source of food.

Combined with eutrophication, over-fishing has led to a substantial reduction in the stocks of some species (anchovy, horse mackerel, sprat etc.).

On the other hand, the introduction of the Asian mullet *Mugil so-iuy* is an example of a positive influence on cetaceans, as it has already been included in their diet.

Fishing activity can alter dolphin behavior and fishing strategy, as they are often seen near fishing vessels, active trawlers or near passive gears (seines, gillnets) and inside harbor aquatories (Fig. 4.1.3.3.).

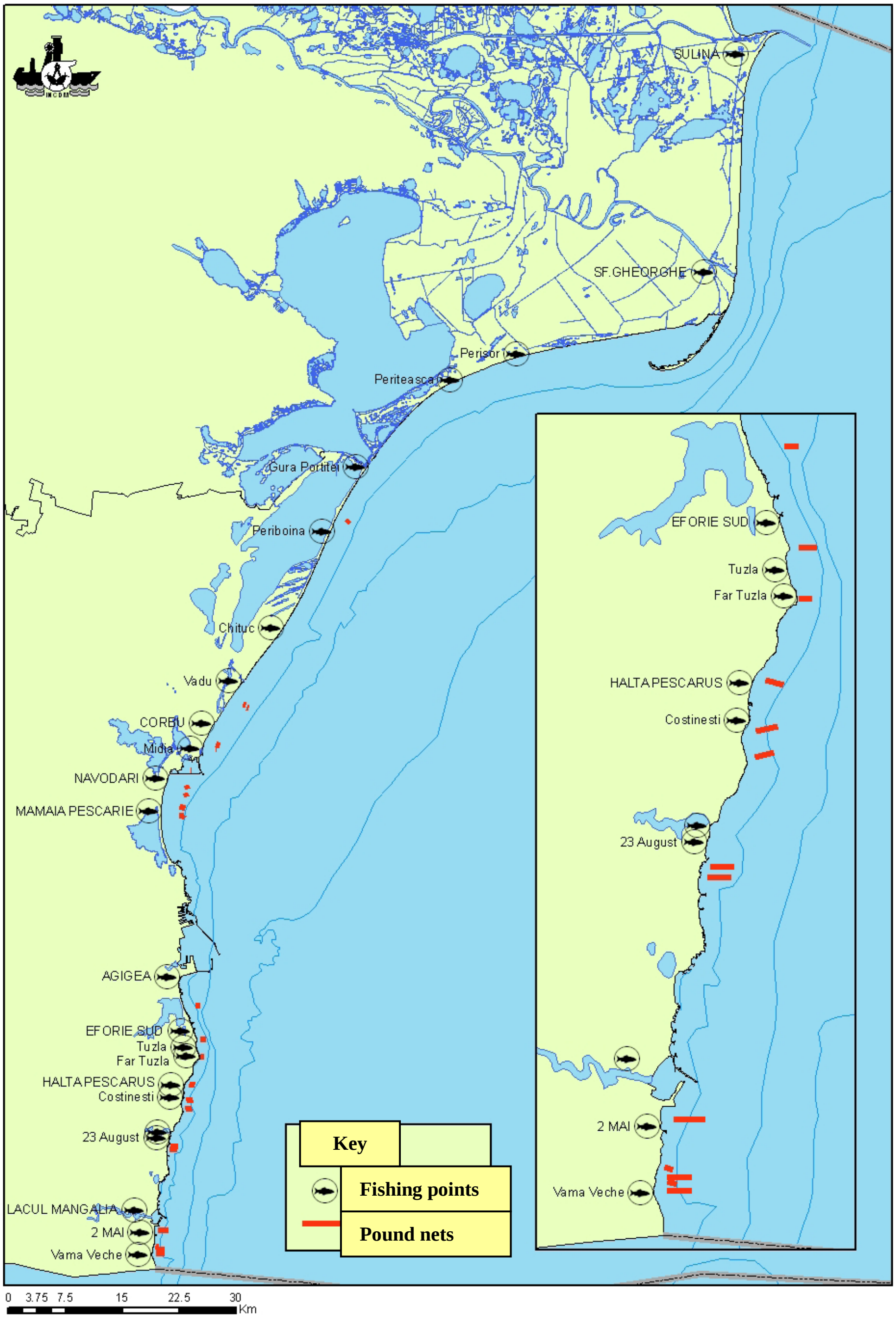


Fig. 4.1.3.3. - Map with the locations of fishing gears along the Romanian coast

Dolphin habitat damage by fishing can be done in several ways:

- The large number of fixed gear, seines, gillnets, and so on, reduce the area of existence of dolphins, increasing the chances of entangling in them;
- Mid-water trawl fisheries, armed in the demersal variant, have an indirect impact on cetaceans by destroying the benthic fauna and eliminating important links in the food chain;
- Also, mid-water trawl fisheries can also have a direct impact on cetaceans by capturing them in the cone net during trawling operations.

However, the most dangerous for dolphins remain turbot gillnet gears. Turbot gillnets do not generate adverse functional effects on benthic biocoenoses (used for food or refuge for fish) and their specific habitats. Instead, the data and information that we have revealed that gillnets are the most dangerous for dolphins which travel to get food in areas where these gears are installed.

Each year, at the Romanian Black Sea coast are recorded accidental dolphin catches and thus fatalities caused by them (strandings), especially in the small species *Phocoena phocoena*, which proved to be the most vulnerable to this type of fishing. This vulnerability can be attributed to the small size of the body in relation to mesh size/yarn fineness, that is a reaction force smaller than large species when they get in a position to cling and entangle in the mesh network of this type of gear.

Also, an imminent threat to dolphin populations are the lost or abandoned fishing nets (as a result of observations, they remain functional and continue to retain dolphin individuals that cross them). Field investigations revealed that over 95% of dolphins stranded on the Romanian coast of the Black Sea are by-caught in this type of gear.

The information of economic operators practicing specialized turbot fishing revealed that at the Romanian coast the average number of dolphin by-catch in turbot gillnets with mesh size ϕ = 200 mm, with a check carried-out periodically (4-5 days, period conditional, however, on the weather), is about 1-2 dolphins at 30-40 gillnets (Table 4.1.3.1., Table 4.1.3.1.).

If in the past gillnetting was not representative, now, both because of low catches taken by trawl and pound net gears and high operating costs, fisheries started targeting this type of fishing. The fishing effort with this kind of gear has come to occupy an important place for boats in the classes 6-12 m and <6 m. At the moment, the gillnet fishing gear effort, with boats smaller than 6 m and 6-12 m, respectively, has come to represent 97% of the total fishing capacity.

Table 4.1.3.1. - Structure of dolphin by-catches at the Romanian coast during 2002 - 2012

YEAR	SPECIES			TOTAL
	Phocoena phocoena	*Delphinus delphinus*	*Tursiops truncatus*	
2002	20	-	-	20
2003	7	-	-	7
2004	-	-	-	-
2005	-	-	-	-
2006	20	2	-	22
2007	70	1	-	71
2008	8	-	1	9
2009	11	-	1	12
2010	15	-	2	17
2011	54	-	-	54
2012	-	-	-	-

Starting with 2008, the gears which increased in number are gillnets, mainly turbot gillnets, which sum-up 20 - 40% (for 0 - 6 m long boats) and 40 - 50% (for 6 - 12 m long boats) of the total number of gillents used in fisheries. This trend can be explained by the price 2-5 times higher for one kg of turbot compared to the other species.

Table 4.1.3.2. - Monthly structure of dolphin strandings at the Romanian coast during 2002 - 2012

Year/ Month	II	III	IV	V	VI	VII	VIII	IX	X	XI	TOTAL
2002	-	1	7	39	4	1	2	2	-	-	56
2003	-	-	5	18	3	83	10	-	-	-	119
2004	-		5	4	7	-	1	1	-	-	18
2005	-	-	3	13	2	18	3	2	-	-	41
2006	-	6	9	30	20	35	1	3	-	-	104
2007	1	-	1	1	2	2	3	-	-	-	10
2008	1	-	4	5	9	2	2	-	-	-	23
2009	-	-	7	3	5	1	2	-	-	-	18
2010	-	-	6	3	3	25	3	2	-	-	42
2011	-	-	3	34	5	7	3	-	-	-	52
2012	-	-	2	24	38	82	20	7	1	2	176

Literature reports that at the Turkish coast the mean catch is 1-2 dolphin individuals at 33 gillnets. Ukraine reports officially 0.9 dolphin individuals/10 km of gillnets for flat fish and 1-2 dolphin individuals/10 km of dogfish gillnets.

Both literature and own research showed that turbot gillnets are the most dangerous gears for dolphins and any effort enhancement with this kind of gear would lead directly to increasing the share of dolphin catches. This explains the fact for which there is a large number of dolphins caught accidentally or stranded during the formation of turbot breeding agglomerations (April - May) and also during the dispersion after breeding (in the second half of June).

Therefore, sizing the fishing effort and ensuring the selectivity of fishing based on allowable catch assessment is the only way to prevent overfishing situations with unfavorable implications.

Contamination by hazardous substances

Introduction of synthetic compounds

Synthetic compounds can reach the marine environment in various ways, the main ones being: wastewater discharge by point sources of pollution on shore and Black Sea tributary input.

Point sources of pollution

The main point sources of pollution existing at Romanian coast of the Black Sea are: the industrial clusters and the Danube River.

In order to identify significant point sources of pollution generating nutrients, the following criteria in accordance with the Water Framework Directive 2000/60 were selected and applied:

a. Urban clusters (identified in accordance with the requirements of the Urban Wastewater Treatment Directive - Directive 91/271/EEC), with more than 2,000 population equivalent (p.e.) with wastewater collection systems with or without treatment plants and discharging into water resources; also agglomerations <2,000 p.e. are considered significant if they have centralized sewerage system; also, urban clusters with sewer system that does not have the ability to collect and purify the mixture of wastewater and storm water during periods of intense rainfall are considered significant sources of pollution;

*b. Industry***:** i. Installations covered by the Directive on integrated pollution prevention and control - 96/61/EC (IPPC Directive) - including units that are inventoried in the Emitted Pollutants Register (EPER) that are relevant to the environmental factor - water; ii. Units discharging hazardous substances (List I and II) and/or priority substances above the legislation in force (in accordance with the requirements of Directive 2006/11/EC which replaced Directive 76/464/EEC on pollution caused by hazardous substances discharged into the aquatic environment of the European Community; iii. other units discharging into water resources and not conforming to legislation on the environmental factor - water;

River input to the marine environment - substances and synthetic compounds

Besides loads of pollutants discharged from point sources of pollution on shore, another way to transport and discharge pollutants into the marine environment is represented by natural river tributaries.

The Romanian coast of the Black Sea is not rich in natural tributaries, the main path of pollutant transportation being the Danube River, by means of its three branches: Chilia, Sulina and Sfântu Gheorghe and the Danube-Black Sea Canal with its two branches: Danube-Black Sea (DBSC) and Poarta Albă-Midia-Navodări (PAMNC).

All the pressures mentioned above are considered in detail in the *Initial Assessment of the Marine Environment*, pursuant to Article 8 of the MSFD, made in 2012 by NIMRD "Grigore Antipa", available at http://www.mmediu.ro/beta/stiri-si-anunturi/evaluarea-initiala-a-mediului-marin-2/.

As such, within this initial assessment, the following economic activities, users of the marine environment, acting directly on it, were identified (Table 4.1.3.3.):

Table 4.1.3.3. - Economic activities impacting directly on the marine environment

Pressure	**Economic activity**	**Sub-activity/Marine water use**
Biological disturbances	**Fisheries**	**Living resources catches Fish/Molluscs**
Damages to the physical environment (from geological and geomorphological point of view, as well as constructed shoreline/infrastructure)	**Anthropogenic origin structures (including the construction stage)**	**Coastal protection & protection against flooding**
		Harbor operation
		Emplacing and operating offshore structures (other than those producing energy)
		Oil/gas extraction
Other disturbances of the physical-chemical environment	**Transportation**	**Maritime transportation**
		Marine litter
	Tourism	**Tourism and leisure, including sailing, swimming**
	Vessel construction	**Pollution with solid wastes/noise/fumes**
Nutrient and organic substance enrichment	**Human settlements/Industry/ Agriculture**	**Waste water discharges from industry/emissions; Waste water discharges from municipalities; Nutrients discharged by the Danube**
Hazardous substances contamination	**Industry**	**Hazardous substances discharge by the Danube**

The development of coastal bathing water management involves technological development and increase of standards of wastewater treatment, to reduce the negative effects on water quality in water bodies of the catchment and due to various pressures and factors represented by socio-economic activities associated with large coastal clusters. An example is oil pollution from automobiles/ATVs/old watercrafts, entering and being fueled directly on the beach, and sea water pollution by continuing testing operations and reconstruction/optimization of the wastewater discharge pipes of the Constanța North and Eforie South Treatment Plants/overflow pipe arrangement in places close to bathing areas highly frequented by a high density of tourists, the state of coastal bathing waters at the Romanian littoral being influenced by local point sources of pressure (clusters and industry) located on the Romanian Black Sea coast.

* * *

Addressing the complexity of the interdependence of different anthropogenic pressures requires, however, an assessment of the estimated costs of measures to help restore and prevent marine environment degradation in relation to the pressures and the activities that generate such pressures, and this approach must be made to define a reference state, a normal range of variability for different parameters/status indicators associated to coastal processes. All of these measures for which it has been possible to assess the amount/degree of impaction can be analyzed in relation to the related pressures.

To reduce and control the problems at the Romanian coast, we suggest the optimization of coastal management activities and conducting related studies on the risks and hazards in existing conditions or reconsidering emergency situations management: accidental oil spills, earthquakes, flood management, coastal ecosystem response to toxic waste spill, the impact of insecticides, biotechnological hazard impact on the community, chemical hazard on the community in times of drought, desertification, land degradation, climate change, risk assessment of landslides/slope of the cliff, intense storms, marine waterspouts etc.

OVERALL CONCLUSIONS

The state and evolution trends of the Romanian marine and coastal environment were monitored in 2012 from the physical, chemical and biological point of view, compared to the reference period of the 1960s and more recent data. The state of the marine and coastal environment in 2012 confirms the general trend of slight improvement of the monitored parameters. The synthesis of data for 2012, compared to historical data, on the state and evolution trends of the Romanian coastal and marine environment is part of the "Romanian Environmental Factors State Report".

During the winter of 2012, as a follow-up of low temperatures during January-February along with an exceptional storm, specific ice structures - ice pegs, grouped in ridge steps - developed on the entire area of the beach, continued by ice belts. For the northern sector of the coast, the accumulated areas covered ~74 ha, while the eroded areas covered ~153 ha. The shoreline advancement by >10 m was reported on ~12% of the total length, shoreline retreat by >10 m on ~52%, the rest of the coast being in dynamic balance - the shoreline retreated or advanced by less than +/- 10 m.

Sea level showed in 2012 three distinct fluctuation stages in relation to the monthly multiannual means (1933-2011). Thus, during January - April, the level was below the monthly multiannual means, during May to September the values exceeded slightly the monthly multiannual means for these months. In September and October, the monthly multiannual means were almost equal to the monthly multiannual means for these months, while during November and December the monthly multiannual means were again exceeded.

Marine water temperature in 2012 was 1.57°C higher compared to the reference period (1959-2011). For the western part of the Black Sea, three characteristic water masses were pointed out: the upper quasi-homogenous layer (UQL), the intermediat cold layer (ICL) and the seasonal thermocline. In autumn (October), the intermediate cold layer reaches depths beyond 25 m. The sea choppiness degree is due to the frequency of waves higher than 1 m. From this point of view, the maximum height of 6.00 m was reported in February, while the predominantly calm, wavy and rippled sea periods were reported in March, June and October. The frost phenomenon occurred in the winter of 2012 in the last decade of January and the first decades of February, when littoral zone temperatures dropped below freezing point (-0.8°C). During summer, three upwelling phenomena were recorded in the coastal area (May and June), caused by the dominant western and south-western winds.

The transparency value distribution points-out the high variability range of marine waters, which, in the northern area, are still under the influence of river input. The salinity of surface waters framed within the typical variability range of waters in the Romanian Black Sea coast, being influenced mainly by river input, lower in 2012.

During the studied period, the waters in the surface layer of the Black Sea coast were well oxygenated in all three water bodies. In the water column, there were some values below the allowed limit (80%) both for the ecological state and the human activity impact area in Order 161/2006. No annoxia phenomena were reported in 2012. The pH of of Romanian Black Sea waters ranged within normal limits.

All maximum values of phosphate concentrations were reported at the surface, in stations under the influence of Danube input or of the Constanța urban area. With 93% of the values below 0.60 µM, phosphate concentrations at the Romanian coast showed, during the studied period, values close to the reference period of the 1960s. In 2012, the multiannual mean monthly concentrations of nitrates (April and October) recorded the lowest values measured since 1976. Nitrites also recorded low values, ranging between 0.02 (LOD) - 1.68 µM (mean 0.28 µM). Ammonia concentrations recorded values ranging between 0.31 - 46.47 µM (mean 4.40 µM). The mean annual concentrations of silicates in seawater in Constanța ranged between 6.7 µM (1993) - 66.3 µM (1972) and, in 2012, it recorded the lowest value of the past 20 years, namely 7.7 µM. In 2012, the mean annual content of chlorophyll *a* in coastal waters recorded a value close to 2011 (3.67 µg/l compared to 4.91 µg/l), but below the annual mean calculated for the period 2001-2010 (6.27 µg/l), thus confirming the recovery tendency of the ecological state of the Black Sea costal ecosystem.

Heavy metal contamination of coastal areas may be directly correlated with urban or industrial sources, such as factories, thermo-electric plants, ports, water treatment plants. River influence on the coastal area is significant, being a major source of metals, mainly as particulates, extreme hydrological events (floods) enhancing such an input. The distribution of metals in waters and sediments from the transitional, coastal and marine areas highlighted the differences between different sectors of the coast, generally being reported slightly elevated concentrations in some coastal areas subject to different anthropogenic pressures (harbors, sewage discharges), but also in the marine area under the influence of the Danube. The concentrations of most heavy metals in water, sediment and biota generally framed within the variation range of mean multiannual values (2007 - 2011).

In 2012, low values (<200 µg/l) of the total petroleum hydrocarbon content - TPH (µg/l) were determined in water samples. The distribution of concentrations on water body types did not point-out any significant differences between the means of the three water bodies, yet the highest values were recorded in marine waters. The petroleum hydrocarbon pollution level of 2012 is significantly lower compared to the period 2006-2009. In 2012, the decreasing trend of hydrocarbon concentrations in investigated environmental components recorded lately (2010-2011) was continued. In 2012 the analysis of polycyclic aromatic hydrocarbons (PAH) pointed-out high values for the following pollutants: pyrene, fluoranthene, anthracene, phenanthrene and benzo[a]anthracene. The mean values were within similar variation ranges compared to 2006-2011.

Concerning pesticide contamination, in 2012, littoral waters were dominated by lindane, for which the highest values were measured in most stations, both in transitional, coastal and in marine waters. The highest organochlorine pesticide concentrations were measured in transitional waters, mainly in the Portița area. However, high organochlorine concentrations were reported, though, in coastal waters between Constanța South and Vama Veche. In sediments pertaining to transitional and coastal waters, the dominant compounds were lindane, aldrine, p,p' DDT and its metabolites. The highest concentrations were recorded in sediments pertaining to transitional waters in the Sulina area. In biota, the bioaccumulation phenomenon was more intense for the species *Rapana* and *Mya*, for most investigated compounds. In 2012, both in water and in sediments, compared to 2006-2008, the decreasing trend of organochlorine pesticide concentrations of the past years (2009-2011) is maintained, for most investigated compounds.

With reference to the microbiological load, the situation identified during the 2012 summer season pointed-out an evolution of marine water quality depending directly on exceptional hydrological and weather conditions of the past five years (2008-2012), characterized by heat waves in summer, with very high temperatures of shallow marine waters. The maximum values of the analyzed bacterial indicators (>16,000 germs/100 ml) were identified, as in previous years, in areas influenced by waste water discharges, with a potential negative impact on the marine environment and human health. In 2012, only the faecal streptococci exceeded regulated values.

2012 was characterized by a poor development of the phytoplankton community (the mean of phytoplankton amounts in spring 2.85•106 cel•l^{-1} and 1.06 g•m^{-3} and in autumn 96.6•103 cel•l^{-1} and 0.38 g•m^{-3}), while algal bloom phenomena were absent throughout the year, except for the developments of the diatom *Skeletonema costatum*, characteristic for the marine ecosystem in spring.

The mean density and biomass values of non-fodder zooplankton recorded lower values compared to previous years, also due to the fact that its maximum development season (summer) was not sampled (the surveys performed only reflect the structure of zooplankton in spring and autumn). The fodder component recorded the maximum development values near the shore, in the southern part of the coast, both in spring and in autumn. 30 taxa belonging to 12 taxonomic groups were identified in the qualitative structure of zooplankton, the highest number since 2004 to the present.

In the summer of 2012, 20 macrophyte algae taxa were identified, divided as follows: 9 species belonging to the Chlorophyta phylum, 1 species - Phaeophyta phylum (*Cystoseira barbata*), 8 species of the Rhodophyta phylum (7 species and one variation, namely *Ceramium rubrum* var. *barbatum*) and 2 phanerogames (*Zostera (Zosterella) noltei* and *Stuckenia pectinata*). The dominance of green opportunistic algae was reported in the northern sector of the Romanian coast and the occurrence of the brown alga *Cystoseira barbata* in Mangalia, 2 Mai and Vama Veche, where it is known that marine waters have a better quality.

In 2012, 52 macrozoobenthos species were identified, the fauna array maintaining the features of previous years. In 2012, a higher species diversity was reported in transitional waters, where 43 macrozoobenthos species were identified, comparable to 2011. The multiannual trend of the number of species identified in the Romanian Black Sea waters showed a slight, but continuous tendency of qualitative balancing. The assessment of benthic community response to anthropogenic pressure on the marine environment quality was made using the biotic indexes (AMBI and M-AMBI) and the mean values obtained for the water bodies investigated during 2011-2012 showed a moderate quality state, with slight trends towards a good state in the south of the coast, less influenced by eutrophication.

The state of biodiversity - defined by the occurrence of 300 species, compared to 200-300 identified during the past 15 years (700 sp. throughout the entire period): 26 endangered species of the 48 in the Red List. The pressure - expressed by 29 alien species, 8 commercially exploited species (2 molluscs and 6 fish) and 12 anthropogenic activities.

In 2012, the industrial fishery activity in the Romanian Black Sea sector was made in two ways: active gear fishing, with coastal trawler vessels, up to 20 m depths, and fixed gear fishing, practiced along the coast in 18 fishing points, between Sulina - Vama Veche, in shallow waters, 3 - 11 m/trap nets, and also at 20 - 60 m depths/gillnets and longlines.

The population structure shows, as in previous years, the occurrence in catches of a great number of species (more than 20), of which the most significant are small-sized species (sprat, anchovy, whiting, horse mackerel, gobies), as well as larger species (turbot and Danube shad). We point-out the low share of dogfish, garfish, mullet and bluefish, and also the occurrence of isolated individuals of the blue mackerel and bonito. After a decreasing trend during 2002-2010, when catches dropped from more than 2,000 tons in 2002 to 1,390-1,940 t, during 2003-2006 and below 500 t during 2007-2009, reaching a minimum value in 2010/258 t, in the past 2 years the catches recorded an increasing trend, namely 568 t, in 2011, and 835 t, in 2012.

Since December 2011, NIMRD took again into custody the marine protected area "Vama Veche - 2 Mai Marine Littoral Aquatory" for a period of five years, by Agreement no. 306/13.12.2011, concluded between MEF and the Institute. Researchers and technicians from the Institute provided permanence during this peak summer season period, carrying-out, besides research and monitoring the parameters and state of the marine protected area activities, ecological education and awareness raising activities, by lecturing and distributing brochures and flyers with information on the marine reserve and the marine environment in general. In 2012, research aiming at identifying and classifying the marine habitats in the two newly designated marine sites at the Romanian coast were performed, namely ROSCI0281 Cape Aurora and ROSCI0293 Costinești - 23 August.

In 2012, the following results were obtained in the field of MSP: setting-up the legal framework in fisheries, adaptable and easy to update; identifying the international legislation harmonized at national level, drawn-up and/or under implementation in Romania; setting-up the integration of marine fisheries in the field of maritime spatial planning; identifying the specific situations concerning conflicts (national and international) and pointing-out support-issues to solve case studies; creating maps, photographs of the main coastal activities in land and marine protected areas, the thematic and integrated marine uses - in the field of fisheries, as well as the distribution of the most important species in the Romanian and Bulgarian maritime area.

Concerning the Integrated Coastal Zone Management activities, at EU level, during 11-12 September 2012, NIMRD was part in the Joint EIONET and Member State Expert groups on Maritime Spatial Planning and Integrated Coastal Zone Management, organized by the European Environment Agency - Copenhagen (EEA). At regional level, a stock-taking for ICZM is being undertaken for Mediterranean and Black Seas within the EU 7th Framework Programme Pegaso Project. During 4-5 December 2012 meeting of the Advisory Group on the Development of Common Methodologies for ICZM in Istanbul, preliminary results were presented in the direction of institutional and legal developments for ICZM in the Black Sea region. At national level, the 14th National Committee for Coastal Zone Meeting convened on 20 September 2012 and projects in the coastal zone were debated.The main anthropogenic pressures were dealt with in extenso in the Initial Assessment of the Marine Environment State, pursuant to Article 8 of the Marine Strategy Framework Directive. Thus, at the Romanian Black Sea coast, several economic activities and users of the marine environment, acting directly on it, were identified. The local pressures generating organic substances/pollutants are concentrated in the southern part of the Romanian Black Sea coast, this area being the most developed from the industrial and urban point of view.