

Biology and Biodiversity Aspects from Black Sea, New Challenges for International Cooperation

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Abstract: *This paper reflects the importance of cooperation and treaties of good proximity in order to solve the environmental problems occurred in the Black Sea. Ten years ago, an accident discharged a major amount of oil in the coastal area of Turkey. The attempts of remediation changed the local water chemical composition. This led to the emergence and overgrowth of some invasive species. Many European studies and specially created commissions analyze the possible solutions to solve the problem affecting Romania, Bulgaria, Turkey, Ukraine, and Russian seaside. The present paper structured into five parts presents some aspects registered along the Black Sea coastal shore into the south part of Romania, near the Bulgarian border. There are mentioned some major physical modifications, appeared in the last decade, due to uncontrolled erosion and several collapses of the cliffs. Further, there are presented some measurements and samples collected, during three consecutive years. The Black Sea represents a key interface between the European Union and the former Soviet countries and a direct connection by the Turkish Channel with the Mediterranean Sea. Thus, a healthy environment of the Black Sea represents a priority for the entire Europe. A special paragraph shows the endangered species because of the different modifications of the water quality and the new environmental conditions. Some measurements regarding the regulation of the international fishing regime, and the exploitation of the infrastructure developed (gas pipeline which traverses the Black Sea) are also mentioned. Conclusions and references finish the article.*

Keywords: *Bio-degradation; Endangered species, BSC-Black Sea Convention, MSFD-Marine Strategy Framework Directive, WFD- Water Framework Directive*

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I. Introduction

During the last decades, the Black Sea was confronted with an unexpected increase of small earthquakes in deep water, followed by changes of the seashore forms, uncontrolled erosion and several collapses of the cliffs, sometimes more than 10 m, especially into the south part of Romania, near the Bulgarian border. Consequently, many farmlands were affected and many households, pensions, and even hotels from the seaside have been removed. Moreover, new ecological and social problems appeared especially because of unsustainable development and inadequate freshwater resource management of the main rivers (Danube and Dnieper), of wastewater and solid waste, of industrial activities, inadequate land management, and improper agricultural practices. Ordinarily, they generate several direct consequences: pollution of surface and groundwater water, eutrophication, accelerated erosion and degradation of the biodiversity.

For local population, the main sources of income are the tourism during the summer season, agriculture, and fisheries in the rest of the year. Any change in the ecological balance affects the standard of living in the area. Accordingly, to reducing of the beaches of Eforie, Mangalia, 2 Mai, Vama Veche greatly reduced the number of tourists, who are turning more and more to outbound tourism. Decreased specific fund ordinarily let to less fishing marine, necessary to the national economy. The Black Sea has distinctive natural conditions, with over 90% of its deeper water volume consisting of anoxic water. The interaction between the oxygen-rich surface waters and the Black Sea's deeper areas tends to be limited. This leads to a layering structure, which affects the diversity of the organisms within the Black Sea.

Consequently, due to natural factors, the diversity of species of Black Sea fauna is approximately three times smaller, compared with that of the Mediterranean Sea. Conversely, the specific features of the Black Sea make it vulnerable, at the disturbances of its environment and ecosystems. In the last decade, marine currents have changed their directions, the pollution has increased consistently, the sand shoals are moving, and the coastal area is continuously modifying. These aspects, have as immediate results, a permanent change in the local equilibrium of the marine bio-system, leading to a slowly, but continuously bio-degradation, affecting permanently the local social life.

Nevertheless, large areas were affected; massive quantities of dead fish and jellyfish appeared on the sea surface followed by a huge amount of destroyed marine vegetation. In Romania, the beaches were impossible to be used in 2005 and 2007, in Mamaia, Mangalia, and near Bulgarian border, for more than three weeks in full season, during summer, because of some large quantities of vegetation, and dead seafood. Nevertheless, even after cleaning the beaches the tourists preferred to go outside Romania to other countries as Bulgaria, Greece, and Turkey. Since 2005, the number of tourists constantly decreased on Romanian beaches, which ordinarily affect the local communities.

The Black Sea region has become an area of particular interest to the European Union (EU) because it is a transit area for oil and gas resources from Russia and the Caspian Sea. Partly because of its strategic importance, the area is a subject to political conflicts and tension, as currently observed in Ukraine, in Crimea. The Black Sea area covers two EU Member States, Romania, and Bulgaria, a candidate state, and others countries non-members of EU. Consequently, Russia, Ukraine, Georgia, Armenia, and Azerbaijan must respect the treaties of good proximity and the regulatory environment conditions, to maintain the regional balance and social prosperity of the countries involved in the Black Sea region.

II. Structured Data base, measurement, and registered data

The Black Sea ecosystem represents nowadays a subject of intense discussions. Changes to its ecosystem during the last 50 years clearly indicate its vulnerability to the anthropogenic effects. Marine resources in the Black Sea have declined due to over-fishing, due to an unplanned development of the coastal zones and of the intense maritime traffic. Due to the economic interests of entire Europe, was created a Commission of the Black Sea, in order to permanent monitor it [5]. This committee reports in real time, the wind direction and speed, temperature, and the possible areas of risks, depending on the sea currents. Such report is presented in Figure 1.



Figure 1. Hourly data, monitored by the Commission of the Black Sea

In line with the international good neighborly relations was created a panel of international experts from Bulgaria, Romania, Turkey, named CP-BSP, Commission on the Protection of the Black Sea against Pollution [6]. Part of it, are specialists from The National Institute for Marine Research and Development “Grigore Antipa” Constanta, NIMR [7], and National Research and Development Institute for Marine Geology and Geo-Ecology [8], but also and the author of this article, from the University Politehnica of Bucharest, Department of Hydraulics and Environmental engineering. Its purpose is to perform additional measurements and to create a database necessary for subsequent numerical modeling. Measurements are stored and reported monthly. Such a database is shown in Figure 2, for temperature, humidity, and precipitations, wind velocity, and direction.

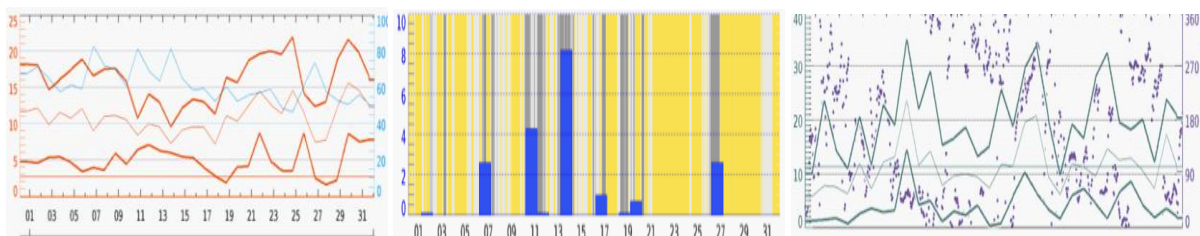


Figure 2. Monthly data base registrations

For understanding the chemical modifications, sand samples were taken from the shore zone, at different depths. Moreover, the Commission, in some particular places, considered economic and socially important, collected material samples at different dates. Ordinarily, the grain size and its composition varied. Each sample was subjected to optical measurements and analysis, as it is mentioned in Table 1.

In 2000, when were recorded the first significant changes in the sea shore length, and in the seawater composition, was created this commission. Consequently, the early measurements consistent in biological, physical and chemical samples, and were made all along the Black Sea. Nevertheless, until 2012 constantly, there was registered an increase in eutrophication, more pronounced after 2009, as consequence of the accident registered on the Turkey coast. Nowadays some signs of recovery have been observed, but some problems remain.

Table 1. The Sand characteristics measurements

Probes	Sand (%)	Silt (%)	Clay (%)
P1 (21-25 cm)	38,79	54,7	6,51
P2 (54-78 cm)	30,6	58,9	10,5
P3 (160-200 cm)	48,3	47,1	4,6

Problems encountered significantly affect the social life of the local community, basically, dependent on the fishery and of the seafood collected. Consequently, it requires permanent monitoring of the Black Sea water composition, to control the eutrophication effects as mentioned in the next paragraph.

III. Accidents and the nitrification process

The main disturbance appeared during the last two decades, especially in years 1997, 2007, and 2009, with oil spills. Consequently, they were followed by some chemical and biological modifications. In Figure, 3-a is presented the amount of oil spilled in the Black Sea, 1996-2001 as a result of accidents or to some faulty handling in the shipyards, reported by the EEA-European Environment Agency [9]. Since 2002, the satellite monitoring is registered, even the size of oil slicks. An example is shown in Figure 3-b, the oil dispersion as result of the accident on the Turkish coast, in 2009, realized by the same Agency.

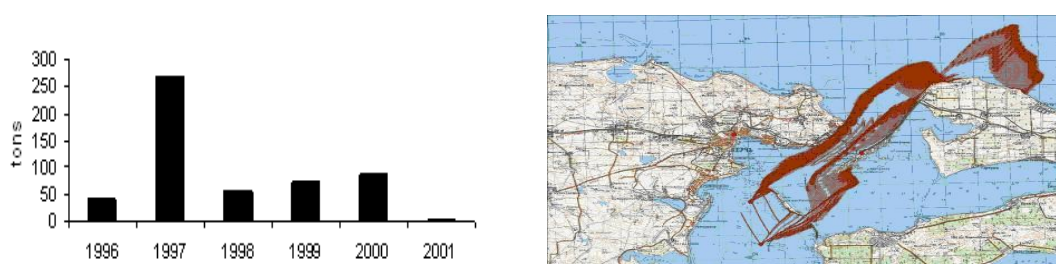


Figure 3. Main oil spills appeared in last decade

Consequently, the oil spills produce an increase in nutrients from the water, a problem recognized as one of the major causes of the eutrophication of the Black Sea. All these aspects affected the social life of local communities; oil spills on the sea have removed the tourists, killed the fishes, the birds, the jellyfishes, and the seashells.

Starting 1995 is constantly realized a permanent registration of the main parameters of the Black Sea water. In 2016, in conformity to European Environment Agency is reported:

- Chemical oxygen necessary 0.8 -17.6 mg/l; average 6.96 mg/l
- Dissolved oxygen 5.36 - 10.28 mg/l; average 7.66 mg/l
- Nitrates 0.03-7.40 mg/l; average 1.25 mg/l
- Total organic carbon 0.05 - 3.15 mg/l; average 0.23 mg/l

The maximum values for nitrates were reached in 1997 and 2009.

In the Romanian coastal waters, in period 2014-2016, was registered a slight decrease in the concentrations of nitrogen. The cause is the decrease in the application of fertilizers in last decade and the effective enforcement of the EU Nitrate Directive in the countries of the Danube basin.

One of the most negative consequences of the elevated inputs of nutrients and of the eutrophication is a disturbance of the oxygen regime followed, ordinarily, by further hypoxia and anoxia phenomena. The development of the hypoxia phenomenon, the river discharges, the hydro-chemical, and the biological conditions are all interrelated. Consequently, the area, where the oxygen content of the water is reduced, registered in the N-W Black Sea after 2009, gradually has expanded and larger areas were covered. In the worst scenario, consequently, the hypoxia and the mass vegetable mortality in the N-W Black Sea areas might cover over 30-40 Thousand km². The areas where the hypoxia and the anoxia were registered are characterized by anomalous marine conditions: temperatures of 15oC, vertical gradients of density 6 conventional units, salinity

6 % per 1 m. A characteristic feature of nutrient distribution is the absence of zero values in the surface water layer. However, in the early summer of 2016, the pH level on the surface reaches 9.25 and is oversaturated with oxygen, 170 %. In the bottom layer, the pH level of the water decreases to 7.8. Consequently, an intense development of a destructive process is observed: BOD₅, Biochemical Oxygen Demand value reaches 2-4 mg/l and the constant of organic matter oxidation speed exceeds by 3 -5 times.

All these changes recorded in the composition of the water made the fish move away from shore, to a registration of reduction of the fish number and an increase in the number and the sizes of the jellyfish. The year 2016 was for the Romanian sea-fishing one of the lowest quantity, recorded in the last 20 years.

IV. Invasive and endangered species

Consequently, to the previous mentioned parameters, the Black Sea is now confronted with some invasive species. As the eutrophication from the Black Sea evolved, the number of the saprophytic bacterial plankton sharply increased, particularly, the cocci and bacilli, because of the high levels of dissolved particles of the organic matter. This one is a source for nutrition for saprophytic microorganisms. The Bacteria populations, particularly pathogenic organisms, have reacted to the changing of the marine conditions, by increasing from the organic matter from the water column and in the bottom sediments. In Figure 4 are shown pictures from the satellite above the Black Sea, recorded from the Steering Committee of the Black Sea [10]. Accordingly, may be observed the affected areas of the growth of the saprophytic bacterial plankton. In Figure 4- b, c are shown images with the development of the cocci and bacilli algae. The most favored species in eutrophic conditions is the plankton, of small size such as Dinoflagellates, Coccolithophores, and Euglenoids. Currently, the phytoplankton species composition is represented by 148 species and subspecies. The unfavorable conditions, such as solar radiation from summer 2001, have provoked a recurrence of a massive development of algae. In Figure 4- d, e, are presented images made by the CP-BSP, in 2001.

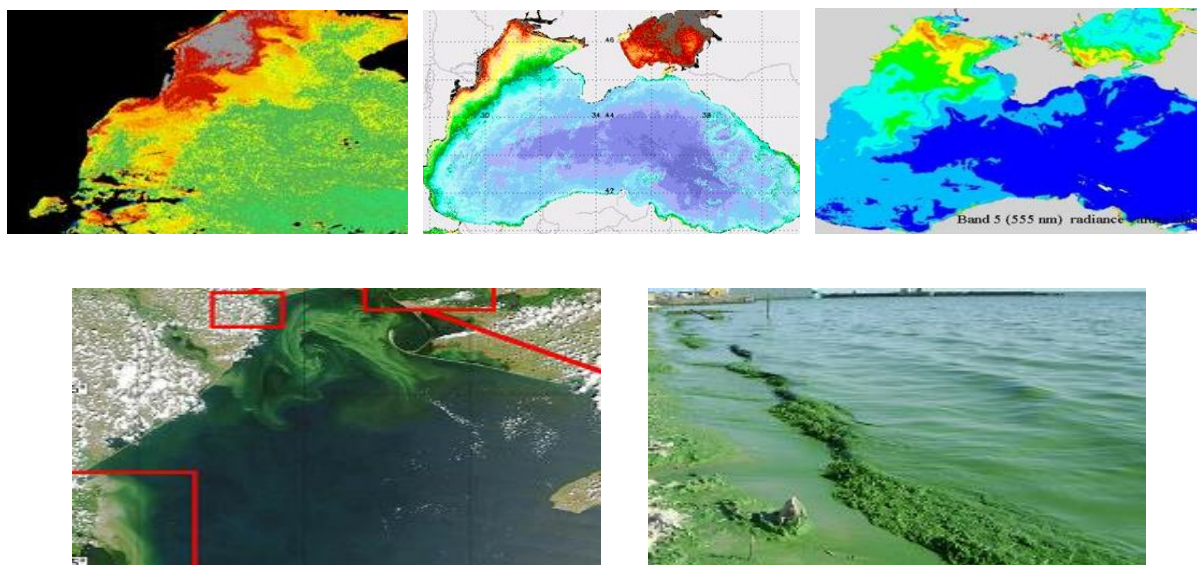


Figure 4. Massive bloom of algae in last decade

Consequently, the intensive algae development increased the bio-sedimentation of the decaying plants, inducing a sharp decline of dissolved oxygen, and reduction of the transparency of marine waters, and of the light penetration. Moreover, a drastic change in the zooplankton communities was determined by the outburst of the species *Cotylorza tuberculata*, *Cassiopea Andromeda* and of the largest jellyfish from the Black Sea, the *Rizhossstoma pulmo*, and the *Aurelia aurita*; all these four species are venomous, presented in Figure 5. The specialists from the NIMR- Constanta have done the pictures.

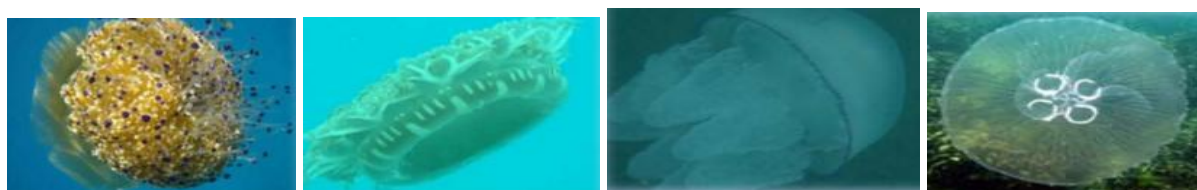


Figure 5. Invasive species of the jellyfish

In the Black Sea, there are about 200 fish species, more than 500 mollusks species and the water plants macrophytes (red, brown, blue, and green algae). Among them, the greatest economic value is represented by no more than two dozens of fish species that represent about 98% of the catches from 1996 to 2016. The number of Pontic shad is permanently decreasing. The main threat for the Pontic shad, for the gray mullets, is the same as for sturgeons, meaning ordinarily, the over-fishing. Some other species are critically, endangered

- due to salinity modifications, as sea horse, thorn back ray, crabs
- due to eutrophication, as angel shark, starry sturgeon, beluga
- due to oil pollution, European eel, smooth hammerhead

The situation of the shad stock is better as compared with the sturgeon due to their natural abilities for more rapid recovery.



Figure 6. Endangered species

In Figure 6, are presented pictures of some endangered species, sturgeon, Pontic shad, and gray mullets made also by the specialists from the NIMR, Constanta.

V. Conclusions, measures for assess the Black Sea environment

Even taking into account the ecological changes due to the environmental factors such as lower water level, water temperature, and pollution, the main factor affecting the fish population, is, in fact, the over fishing. The fish stock has deteriorated dramatically over the past three decades. The local human communities that depend in good part of the fishing, is obviously affected. Conversely, the diversity of the commercial fish caught has decreased over this period from about 26 species to six, but the volume of fish caught has actually increased. This represents a higher volume of some fish species specific from the Black Sea, but not a development of the caught species variation. This aspect is, almost entirely caused by the significant quantity of anchovy fishing made by Turkey, accounting for almost 80% of the total catch from the Black Sea. Illegal fishing in the Black Sea is rapidly increasing, affecting both the marine biodiversity and economic activities in the region. The Black Sea Commission tracks the movement of the ships, of any kind, in the Black Sea, in real time, Figure 7-a. Fish that were previously maintained for breeding now due to the ship performance, equipped with sonar is systematically hunted. In Figure, 7-b is shown a picture made on the Russian coast in 2004, according to the report of the Black Sea Commission.

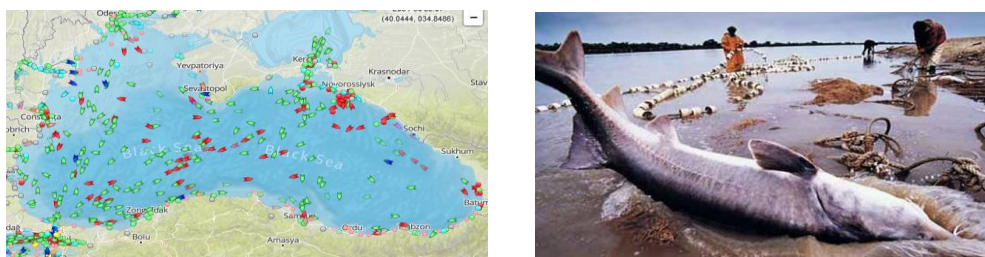


Figure 7. Monitored ships, oil tankers and a massive capture

Accordingly, to the role of the Black Sea region as a transit route for major oil and gas exports, the risks associated with these activities, such as oil spills, or accidental pollution are expected to increase. Around 50.000 ships sail through the Bosphorus every year, including at least 10.000 oil tankers. Several Black Sea ports in Russia and Georgia are terminals for oil and gas pipelines from the Caspian Sea. Nevertheless, while bringing jobs and economic development, the increase of oil transport/transit and handling operations, if not regulated and systematically monitored, could represent additional pressure on the ecosystem of the region. Consequently, the Black Sea Commitment provides a regional cooperation framework to protect against pollution. Introduced in 1994, with amendments in 1997 and 2007, is followed by the New Treat of The New Common Fisheries Policy.

Following the accession of Romania and Bulgaria to the EU, the Black Sea became the focus of various EU policies, both thematic, e.g. Fishery, Integrated Coastal Zone Management - ICZM, MSFD, WFD, Habitat, and Birds Directives and horizontal such as Environment Impact Assessment/Strategic Environment Assessment (EIA/SEA), etc.

In 2015, an updated Strategic Action Plan (BS SAP) for the Rehabilitation and Protection of the Black Sea was adopted, by all coastal countries. Based on an ecosystem approach and coherent with MSFD provisions, the plan aims to resolve the trans-boundary environmental problems. It contains realistic targets, including legal and institutional reforms, as well as suggestions to the investments necessary to solve the main environmental problems:

Changes in marine living resources, with diminishing of the insufficient treated waters and pollution from priority sources

Eutrophication and nutrient enrichment; trace metals, persistent organic pollutants, and radio nuclides aspects

Avoiding chemical pollution, including with oil and decreasing of spilled oil

A number of projects developed by the international teams have restored some environmental aspects: the algae number is reduced and is less frequent, the biomass of *Mnemiopsis leidyi* has been reduced following the invasion of the *Beroys ovata* that feeds on this destructive species. The abundance of fodder zooplankton is increasing, followed by an increase in the stocks of small pelagic fish. National efforts and international cooperation in the framework of the MSFD brought the first signs of recovery to the Black Sea ecosystem.

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