

## New Strategies for the Waste Management in the Black Sea Region

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**Abstract:** The paper proposed herewith presents some new strategies for the waste management in the Black Sea basin by designing an integrated system for pollution prevention. The ecosystem of the Black Sea is strongly affected by pollution discharges coming from various sources and among them the marine accidents present the highest environmental risks. From this perspective, in order to reduce the pollution and protect the environment in the Black Sea region, to implement adequate strategies that would allow the possibility of developing an integrated management plan related to the management of the waste discharges into the sea appears to be an extremely important issue. In this respect, the management plan designed in the present work is based on the principles of the waste management as adopted by the EU strategies and has as a key element the implementation of a monitoring system that would be able to identify and evaluate in real time the sources and the effects of the pollution. The practical realization of an integrated management system helps in reducing the amount of waste generated and in reducing also of the environmental pollution and waste management related costs.

**Keywords:** *marine environment, Black Sea, waste management, environmental monitoring system, pollutions*

### 1 Introduction

Nowadays, the pollution in the marine environment is a reality and represents a real threat all over the world due to its destructive effect on the biological resources, of the marine flora and fauna. The environmental alerts generated by pollution have also a serious impact on the coastal activities as well as on the human health for the people living and working close to the coastal environment.

The threats are multiple, they extend very often on large areas exceeding the borders of one single country and they come mainly from discharging wastes and pollutants into the sea. Most of these events are generated by the exploration and exploitation of the oil resources. Some other threats are induced by the coastal urbanization, penetration of invasive species, overfishing or destructive fishing techniques.

Pollution is a complex phenomenon, physical, chemical, biological, and microbiological and is produced by the introduction from human operators either due to negligence, intentionally or accidentally of hazardous substances into the sea (Barnabé and Barnabé-Quet 2000).

Annually, huge amounts of nutrients, heavy metals, pesticides, oil and artificial radionuclide are discharged in the waters of the Planetary Ocean.

Marine pollution has attracted attention of international bodies and in 1972 the ONU Conference from Stockholm adopted a series of recommendations for protecting marine environment. Two decades later at the World Summit in Rio - The Rio Declaration and Agenda 21 were adopted, occasion with which the action principles for marine environmental protection and sustainable use of the biological resources have been formulated ([www.blacksea-commission.org](http://www.blacksea-commission.org)).

In particular, the International Convention for the Prevention of Pollution from Ships MARPOL (73/78) establishes a set of rules which provide that, during the construction and the life of the ships, these have to be equipped with everything it is needed in order to prevent and reduce the discharges of pollutants into the marine environment. Also, MARPOL (73/78) makes some recommendations about the monitoring, recording and on-board waste management, as well as the development of the port reception facilities for the waste collection and final elimination.

Two examples of international conventions whose ratification have made contributions to increase the health of the marine environment are the International Convention on the Control of Harmful Anti-Fouling Systems on Ships-AFS and the International Convention for Control and Management of Ship's Ballast Water and Sediments-BWM ([www.imo.org](http://www.imo.org)).

To protect the marine environment, the European Commission has adopted the Thematic Strategy for the Marine Environment, which introduces the principle of spatial planning based on the ecosystem approach.

In the same time, in the purpose of protecting the marine environment and assuring a sustainable development in the targeted area, national strategies that recognized the need of developing and implementing of an integrated waste management system were developed.

In this context, the present work aims to describe the way of developing an integrated waste management system for the Black Sea basin.

## **2 Environmental risks in the Black sea region**

The Black Sea basin is subjected almost continuously to a process of pollution that has a significant impact on the aquatic ecosystem.

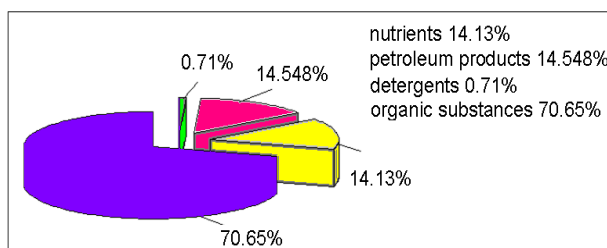
This sea is especially vulnerable because – of all inland seas – it is perhaps the most isolated, and as a consequence the least able to dilute or eliminate toxins once introduced” (Earle 1997).

The pollution sources for the Black Sea are multiple. These are coming either from the land, from the ships or from the sea, and the pollutants have also a great diversity: sediments, nutrients (N, P, Si), heavy metals (Mn, Fe, Cu, Cd, Pb), artificial radionuclide (<sup>90</sup>Sr, <sup>137</sup>Cs), total hydrocarbons, parasite and saprophyte fungi, litter, sewage, persistent organic pollutants, pesticides, oil, etc.

Moreover, to the pollution of the Black Sea also contributes the economic activity of over 165 million people from 17 Danubian and Black Sea countries, consisting in: industry, agriculture, fishing (over fishing), transportation, tourism and others (Bodeanu 2002).

Nevertheless, the Danube River is presently considered the great source of pollution for the Black Sea. The Danube River transports an important quantity of pollutants coming from its entire hydrographic basin (and that covers a surface of about 35% from the surface of the Black Sea basin). The river flow provides suspensions, organic material, an elevated quantity of nutrients (especially those containing nitrogen), but also oil components, detergents, pesticides and phenols (Fig. 1).

The Danube contributes with at least more than half of the quantity of nutrients that are currently discharged in the Black Sea. After 1970 the concentration of nutrients was enhanced a lot (with an average of about  $1.76 \cdot 10^6$  tones/year), (Gomoiu 1995). As an effect of this nutrients enhancement, the biomass of the unicellular algae also increased about 7-9 times in relationship with the period 1960-1965, and this effect can be particularly seen in deep waters as well as in the nearshore waters.



**Figure 1** Substances made by the Danube in Romanian coastal waters (from Gomoiu 1995)

The organic substances, phytoplankton and the mineral particles constitute the majority of the suspensions in the Black Sea basin. After Shimkus and Trimonis (1974), the suspensions from the Black Sea basin are constituted from inorganic substances in a proportion of 25-85%, the organic suspensions representing about 30%, but in function of conditions they can vary between 15-75%. An important part of these suspensions comes from the erosion of the coasts, but most of them are brought by the rivers flow and among them the Danube plays the most important role.

For the period 1961-2000 the debit of solid material at the Chilia arm (the third arm of the Danube River from South to North) was with an average of about  $5-8 \cdot 10^6$  tones/year, an important contribution to this being given by the organic matter coming from the decomposition of the reed which is presented in a great quantity in the Danube Delta (Cohen *et al.* 2006).

The hydrotechnic constructions from the Iron Gates I (1970) and Iron Gates II (1983) have also influenced considerably the quantity of solid debit of the Danube. The volume of the Danube decreasing dramatically ( $25-35 \cdot 10^6$  tones/year), with only about  $4-6 \cdot 10^6$  tones of sand/year (Bondar 1977), (Brewer *et al.* 1974), (Panin *et al.* 1999). The suspension concentration in the Romanian near shore of the Black Sea is presented in Table 1.

**Tabel 1** Suspension concentration in Black Sea water (Banaru *et al.* 2007)

Station	Suspension concentration g/m <sup>3</sup>
Sf. Gheorghe / 15 m	6,58
Cap Midia / 27 m	2,87
Agigea / 10 m	4,1
Costinesti / 10 m	1,37
Mangalia / 3 m	4,09
2 Mai / 1m	6,17

Recent studies on the origin of the suspensions in the Black Sea basin using carbon and nitrogen isotopes (Banaru and Onciu 2007), (Banaru *et al.* 2007), show that in the vicinity of the Danube mouths the suspensions brought by the Danube river are dominant while going towards south the suspensions from marine origin become quantitatively more important. The quantity of organic suspension is smaller at the end of the winters and beginning of the springs than in the rest of the year.

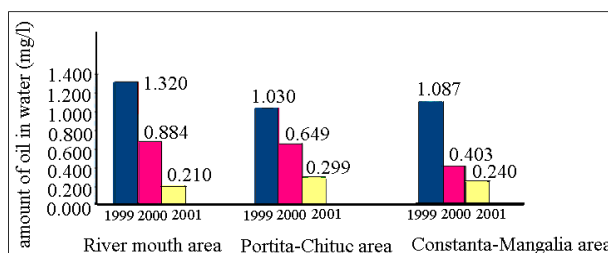
At the southern coast of the Black Sea due to the influence of the salt waters flowing through the Bosphorus Strait the chemical, biological and optical parameters are somehow comparable with those from the western coasts (Yilmaz *et al.* 1998).

Another important pollutant is the oil that arrives usually in the sea through accidentally spillages but also from some sources from the land (Otremba 2002).

The Danube brings in the Black Sea 40-50.000 tones of oil/year that represents about 48% from the oil

quantity discharged in the Black Sea (Zaitsev and Mamaev 1997). To all these, there should be added the oil spillages coming from the offshore oil exploitation but also the discharges coming from the ships.

As regards the Romanian nearshore the quantity of oil from the sea water is decreasing from North to South (Fig. 2), in the area Constanta-Mangalia being about 4,5-6 times smaller than at the Danube mouths and 2-3 times smaller than in the offshore areas where the drilling units are operating (Piescu *et al.* 2004).

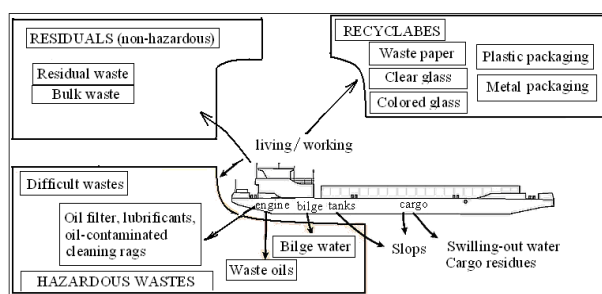


**Figure 2** Distribution of the amount of oil (mg/l) in the neritical area of the Romanian Black Sea coast during 1999-2001 (from Piescu *et al.* 2004)

As regards the oil pollution from the ships this is mainly due to accidental oil spillages during various operations but also a serious source are the accidents especially of the oil carriers.

The last significant accident of the oil carrier „Volganef-139” in the Strait of Kerch showed that although seldom such events may have huge impact on the marine ecosystem. Thus it is currently appreciated that the damages produced by this accident could not be recovered at least for 5-10 years from now on (Milan and Gomoiu 2008). Moreover taking into account the routes of oil transports from the Caspian Sea towards Europe and the fact that the Black Sea is previewed to become an important corridor for the energy transportation from East to West, such accidents might happen also in the future.

To the pollution of the sea contribute also the wastes inevitably coming from the current operations of the ships oil filter, lubricants, oil-contaminated cleaning rags, waste oils, bilge water, slops, swilling-out water, cargo residues, waste paper, plastic packaging, metal packaging etc. (Fig. 3).



**Figure 3** Waste discharges from ships in the sea

The marine flora and fauna are affected also by the accidentally introduction of some foreign species as it is medusa *Mnemyopsis Leyderi* which was brought through the ballast water of the ships. Such intruders may affect some existent species in the Black Sea basin contributing to their extinction (Mihailescu 2008).

The discharges of industrial and domestic wastewater as well as those derived from livestock insufficiently treated have as a result the introduction of the microbiological contaminants which represent a threat for the public health and of the sustainable development of the tourism and aquaculture.

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The discharges of waste with high concentrations of contaminants, above the permissible limits, coming from the Romanian and Ukrainian coasts of the Black Sea constitute also a matter of concern for this area.

The Black Sea pollution leads to various unwished effects as harm to the living resources and marine life, hazard to human health, hindrances to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities (Nicolaev *et al.* 2004).

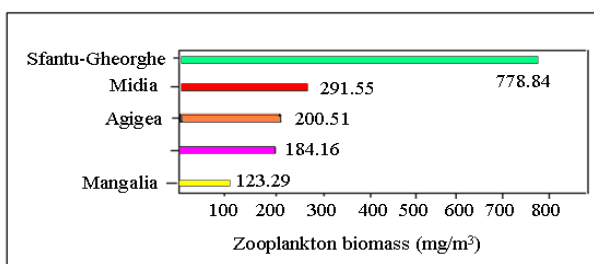
An exhaustive diagnostic analysis across the boundaries (Pop and Manoleli 2007) showed that eutrophication caused by nutrients (in principal nitrogen and phosphorus compounds) is the most severe ecological problem of the Black Sea, this as regards its extension and impact over the ecosystems.

The eutrophication represents the main cause of the ecological imbalance of the Black Sea, especially in the North-West and West areas. The change of the trophic status in the Romanian coastal waters is mainly due to the nutrients inputs of the Danube River, the local pollution sources having an insignificant role compared with the contribution of the Danube.

The accentuation of the pollution made possible the development of some new species of phytoplankton and zooplankton. The excessive grow of the phytoplankton population led to phenomena of algal bloom that were accompanied by the progressive decrease of the biodiversity together with the occurrence of the oxygen deficit, the simplification of the trophic chains, the decrease of the bio-productivity and on the other hand the increase of the fish mortality (Grey *et al.* 2000).

The measurements of the zooplankton in the Romanian near shore showed its decrease from north to south (Fig.4). In the north of the Romanian near shore the considerably greater densities of zooplankton show the important role of the Danube in the pollution process.

The water pollution with oil and its derivates and with residual waters led also to the decrease of the health of the fish population and also to the perturbation to their natural habitat. If in 1965 about twenty five species were commercially exploited, nowadays only five fish species of inferior class are exploited and moreover the productivity is considerable lower (Mihailescu 2008).



**Figure 4** Distribution of the zooplankton in the Romanian zone with shallow water (from Onciu T. *et al.* 2006)

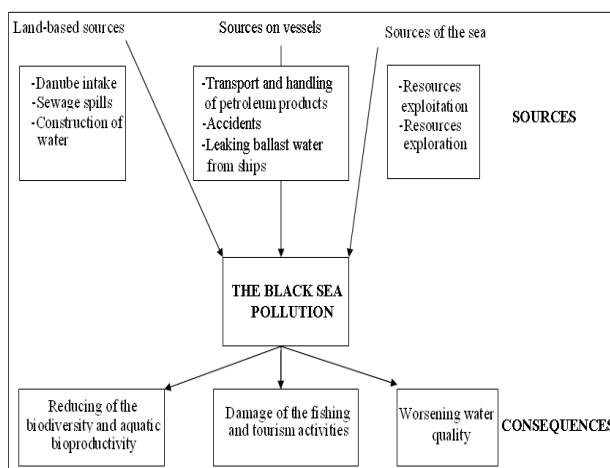
Together with the pollution process, an important contribution to this reduction of the biological resources, in general and of the fish population, in special, is given by the irresponsible and excessive fishing from the last decades.

According to the data provided by the research stations operating along the coast from the Romanian city Navodari to the northern border of the Romanian near shore (Vama Veche) it results that due to the contribution of the pollutants the quality of waters in the Romanian coastal environment is degraded. The most industrial areas: Navodari Constanta harbour and Mangalia harbour are the most polluted often exceeding the standard requirements. The analyses of the mussels showed also very

clear this strong pollution that is characteristic to the above mentioned areas. Thus the mussels contain heavy metals few times more (2-9 times, as a function of the metal) than the mussels harvested from the Costinesti area (where there is no relevant industrial activity), (Dumitrescu and Stanciou 2005).

The beta radioactivity decreases in the sediments from north to south and as regards living creatures the order is: saprophytic algae>fish>shellfish.

The sources and the consequences of the pollution in the Black Sea basin are presented in a synthetic way in Fig. 5.



**Figure 5** Sources and consequences of the Black Sea pollution

Nevertheless, the continuous monitoring that is made in the framework of the Romanian National Environmental Program shows that the waters of the Black Sea are not yet „a lethal mixture of toxic waste”, and moreover the Cross-border Diagnostic Analysis (CDA) demonstrate that the ecosystem of the Black Sea can be protected and reconstructed. The contamination with heavy metals and pesticides is actually limited to some near shore areas. On the other hand, the eutrophications, oil pollution, as well as the terrestrial sources of pollution, represent nowadays a very serious problem (Black Sea Transboundary Diagnostic Analyses...1997).

At the end of this section, it should be also mentioned that the present study is a continuation of the work developed by Gasparotti (2010) which is focused mainly on the pollution due to oil spills in the Black Sea basin. Moreover, as an extension of the monitoring system discussed above, Rusu (2010a) implemented and tested a system based on numerical models that is able to evaluate the oil spill propagation in the Black Sea. Such system can become also an operational tool in the case of the environmental alerts. Using the same system Rusu (2009) evaluated the wave energy resources in the Black Sea and Rusu (2010b) the environmental conditions at the mouths of the Danube river.

### 3 Regional cooperation for reducing the pollution risks in the Black Sea

Together with the Black Sea, the Danube represents the greatest stretch of non oceanic water in Europe. Once the extension of the European Union was accomplished many states crossed by the Danube River become EU members and so that the Black Sea become a coastal zone of the European Union. Taking into account the fact that the ecological situation of the region is extremely serious it becomes a high priority requirement to elaborate a coherent rehabilitation strategy. As a result and for this strategy to be efficient, it must be developed cooperation between all the states from the region. Moreover, the protection of the marine environment was included among the major concerns as regards the international cooperation.

The awareness of the ecological problems acquired a significant role all over the world. The government commitments were increased, as well as those of the international institutions and of the non government organizations, to act for solving these problems having as final target to stop the ecologic decline in the marine environment.

In this context in April 1992 the Convention for the Protection of the Black Sea against pollution (known also as the convention from Bucharest) was signed by all the six countries neighbouring the Black Sea. A direct outcome of this Convention is the establishment of the Black Sea Commission that has the scope to assure the implementation of the measures formulated by the Convention. Moreover, through this Convention the participating states have the obligation to prevent the pollution of the marine environment of the Black Sea in relationship with any source of dangerous substance and material. Cooperation in emergency cases is also foreseen as well as specific provisions related to the pollution through discharge, but also pollution of technical origin from the activities developed on the continental shelf, pollution related with the cross borders traffic, pollution of atmospheric origin, protection of the living resources and some material responsibilities (BSC...2009).

The general obligations of cooperation take the forms of: information, consultation, common actions and negotiations. Specific and detailed rules are related also with the scientific and technical cooperation and with monitoring of the marine environment

In order to accomplish the objectives of the convention each part should take into account the negative effect of the pollution from its Exclusive Economical Zone over the marine environment from the entire basin of the Black Sea. Thus all the necessary measures have to be taken either individually or in common and in concordance with the international standards that were adopted to prevent, reduce and control the pollution and to protect the marine environment in the Black Sea. According to the above Convention all the parts should cooperate in elaborating additional protocols as well as bilateral and multilateral agreements to conserve and protect the marine environment in the Black Sea.

In order to accomplish and complete the specification of the Convention from 1992, the states involved have signed and applied also some other documents that have the objective to promote the multilateral cooperation in this specific area. Such documents are: the Ministerial Declarations related with the protection of the environment of the Black Sea (signed in Odessa, Ukraine, 1993, Sofia, Bulgaria, 2002 and Bucharest, Romania, 2007). These are texts predominant political having as pragmatic objectives protecting the marine environment on short and long term, especially as regards the control of pollution, the rehabilitation of the natural resources and the rational management of the wastes (Bratianu 1999).

The program of environmental management and protection of the Black Sea developed by the Global Environmental Facility (GEF) was open in Constanta in 1992 and it is focused on the Black Sea and the Azov Sea, especially as regards the coastal areas of the countries neighbouring these two seas as well as the basins of the tributary rivers with the notable exception of the Danube River for which a special GEF program is being implemented. This program follows the development of an operational complex and long term framework for the regional cooperation in order to limit the continuous process of degradation of the marine environment and resources for their durable utilization. The program concerning the interaction between the Danube River and the North West part of the Black Sea (EROS-2000), proposed in Paris in 1994 and having a notable contribution from the European Union has as main objective the development of a systematic research concerning the quality of the environmental conditions from the region targeted. Besides specialists from the countries crossed by the Danube River, or countries neighbouring the Black Sea at this program participate also scientists from countries with outstanding scientific tradition as: France, Belgium, Germany and UK.

There is currently under implementation also a continuation of the programs EROS-2000 for the occidental Mediterranean Sea (Gomoiu and Skolka 1996).



Other specialized programs are: the Program for Monitoring, Laboratory Analyses and Information Management for the Countries Neighbouring the Black Sea, the Regional Multi-Institutional Cooperation Program, the Regional Black Sea Program for Marine Research and Services, etc.

The measures taken for the protection against pollution of the marine environment are also foreseen in some other international documents as the Accord from 2<sup>nd</sup> of April 2001 concerning the formation of the group for naval cooperation in the Black Sea or as well in the bilateral treaties in the field of the environmental protection signed by the states neighboring the Black Sea (as for example the Accord from 10<sup>th</sup> of September signed between the Governments of Romania and Turkey). This bilateral agreement establishes the main sectors in the cooperation related with the pollution prevent in the Black Sea basin (Gomoiu 2004).

In October 1996, in the framework of the Commission for the Protection of the Black Sea against Pollution, it was agreed the implementation of the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea against Pollution (Porumb 1998). The Strategic Action Plan for the Conservation and Protection of the Black Sea was signed by all the representatives of the countries that are neighbouring the Black Sea (Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine). This document contains a set of principles, specific politics and actions that have the objective to increase the regional cooperation in the direction of the enhancement of the environmental health, this issue having a direct impact on the population living close to the coasts of the Black Sea. In this way the same principles established at the Conference of Rio de Janeiro (1992) are considered as: promotion of the concept of durable development, the principle of precaution in taking decisions, the principle of the preventive action, the principle of using clean technologies, the principle of using adequate economical instruments for sustaining a durable de-pollution, introduction of the environmental considerations when designing all the regional strategies and plans, promotion of a close link between the countries neighbouring the Black Sea basin, etc.

The success of this Strategic Action Plan for the Black Sea will depend also in a great measure on the implementation actions and of the implication of the authorities from all the countries involved ([www.blacksea-commission.org](http://www.blacksea-commission.org)).

The contemporary international community could contribute effectively to this plan together with the local authorities so that to preserve for the next generations a healthy environment in the Black Sea. It has to be however highlighted that such a durable development necessitates a close international cooperation.

#### **4 Development of an integrated waste management system for the Black Sea region**

The serious state of pollution of the marine environment in the Black Sea and its destructive effects for the aquatic ecosystems, water quality and human health, as well as the many ways of pollution and the diversity of the pollutants discharged in the Black Sea make the issue of reducing the pollution and protecting the environment of the Black Sea to be very complex.

In order to solve this problem it is necessary to develop and enforce adequate strategies for the Black Sea basin. A crucial step in this direction would be the implementation of an integrated management related to the pollutants discharged into the sea. On the other hand, this means also to define adequate principles and methodologies that would constitute the bases of an integrated management system in the Black Sea basin, in accordance with the sustainable development.

The waste management represents also the basis of their manipulation having as effect that less waste will be discharged in the sea.

The general strategy regarding the waste management in the European Union (1996) established appropriate principles which must represent the basis of the waste management (BSC...2009). Among these principles the most relevant would be:

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- the principle of the preventative action – production of waste should be minimized and if possible avoided;

- the principle of the responsibility in relationship with the occurrence of pollution and its payment - this means that those entities developing waste or contaminating the environment have to pay the cost of the entire action performed to neutralize the pollution;

-the principle of the anticipatory action – the potential pollution sources must be anticipated;

-the proximity principle – wastes should be stored closer to the place where they are produced in order to minimize their transport distances and the risk of accidents, as well as saving resources.

A modern waste management system represents an overall systemic of knowledge regarding the application of principles and requirements of environmental protection in waste management on the basis of the knowledge of their environmental aspects in order to fully reduce their environmental impact, and if possible with minimal costs and economic benefits.

The management system must coordinate all the activities that contribute to solve the waste issue and to improve the environmental quality. The concept of waste management focus the activities towards the environmental issues. The practical realization of such a system helps reducing the amount of waste generated and also reducing of the environmental pollution and waste management related costs.

A very important issue for a sustainable waste management is the selection, development and implementation of technologies and techniques for prevention and waste reduction, recovery and neutralizing them with a minimal environmental impact and economic rational. This issue can be resolved by implementing globally advanced technologies, and by developing processes for the waste recovery in the local frame.

The concept of the integrated waste management in the Black Sea basin represents a group of ideas and processes which follow the diminishing of pollution in the marine environment. This is based on the ecological principles developed by the EU strategies, the implementation of new industrial technologies to reduce the negative impact of the waste with minimal costs and maximum benefits. Such management has as components: waste management principles, the legislative and institutional framework, the aim and the objectives of the waste management, the management plan, the monitoring system and a set of valid options for the ways of achieving the proposed goals.

As regards the principles of the integrated waste management in the Black Sea basin they take into account the main principles established by the EU strategy for the waste management as: the prevention of pollution by reducing the amount of discharged waste in the Black Sea and their concentrations of hazardous elements, including the Danube, considering the main role of this river in the Black Sea pollution and anticipating in this way the potential pollution. A good waste management system begins with increasing the amount of waste prevention. The prevention and minimization of the waste should have priority in any waste management plan; the polluter pays the full cost for the environmental pollution.

Reducing the waste spilled into the Black Sea consider the gradually diminishing of the amount of pollutants brought through different ways in the sea basin. A special attention should be paid to the nutrients input into the Black Sea in order to reduce the eutrophication phenomena. This is presently considered as being the main cause of the deterioration of the aquatic ecosystems. Nevertheless, the contribution of other pollutants, especially oil, should be also taken into account.

Since the Danube discharges the largest amount of nutrients into the Black Sea, it is imperiously necessary to adopt a strategy in the sense of reducing the nutrients in this river. The provisions for the Danube Strategic Action Plan (that has as major objective to maintain the nutrients level from 1995) are insufficient to reduce eutrophication in the Black Sea. Pollution monitoring is required throughout along the Danube river flow in the framework of the management of the waste discharged into the Danube (BSC... 2009).

Diminishing the contribution of the pollutants into the Black Sea is also possible using a modern waste water treatment plants in the Black Sea coastal cities, by adopting cleaner production techniques and technologies and those that lead both to waste reduction and to their neutralization.

The wastes coming from ships are also a matter of concern. Implementation of MARPOL (73/78) regulations and the increasing capacity of port facilities in relationship with the wastes storage may lead to reduce the pollutants discharges from ships into the sea. Discharges of wastes into the fluvial or marine waters can be reduced if the vessels are required to deliver their wastes into the port reception facilities before leaving the ports.

Adopting of a constraint system in accordance with the international laws, including fines for illegal waste discharges in the sea, is another way to reduce the pollution in the Black Sea basin ([www.imo.org](http://www.imo.org)).

For the waste discharges into the sea, the establishing of the concentration levels for traces of contaminants in dredged materials is a very important issue.

All these issues can be managed properly in the framework of an integrated management of the ports.

The legislative and institutional frameworks refer to the compliance to the environment protection legislation, national and international.

The aim of this integrated management system is the gradually diminishing of the water pollution in the Black Sea to a level that will not affect the aquatic ecosystems and the water quality. The main objectives are: reducing the amount of pollutants discharged into the sea, which come from the shore, by insufficient treated wastewater discharge, by ships and by the sea itself. The final result would be reducing of the pollution impact on the environment and on the human health.

The management plan plays a key role in the sustainable management of the waste and includes as main elements the followings: planning, the way and steps to achieve the waste management, the pollution research process by determining the types and quantities of the wastes discharged, a detailed description of the procedures for the management of the wastes discharged into the Black Sea.

The monitoring system represents an instrument of managerial activity which should ensure an information flow on the sea water quality (Visan *et al.* 2002).

The concept of the monitoring system is based on the definition of the integrated monitoring which includes a system of observations, assessments and diagnoses of the marine environment and the forecast of its changes under the influence of the natural and anthropogenic factors, in order to get reliable scientific support and recommendations for the management.

It involves the development and implementation of appropriate policies regarding the environmental monitoring and protection to ensure a sustainable development (Bologa 2004).

In Romania, monitoring of the environmental quality started at the Romanian Marine Research Institute (RMRI) within the National Integrated Monitoring System in 1975.

The monitoring system for the integrated waste management in the Black Sea refers to the following main directions:

- monitoring the sea water quality by frequent samplings and measurements of physical, chemical, biochemical and microbiological indicators of water quality. Based on the water quality monitoring may collect effluent charges, using the principle „the polluter pays”;

- monitoring the pollutants which were identified as being hazardous, in terms of quality and quantity;

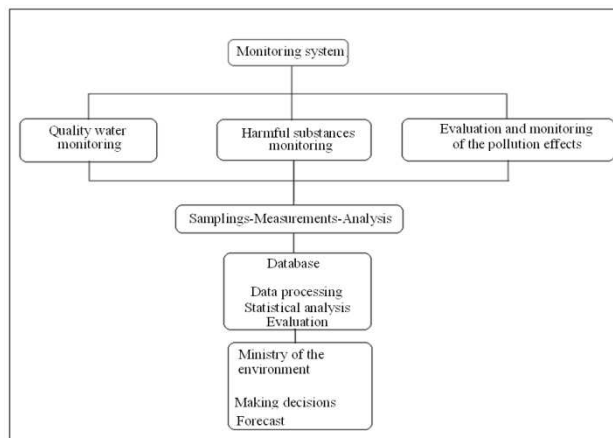
- monitoring the Black Sea by measurements, evaluations and assessments of the risks concerning the sea pollution. This monitoring is based on measuring the biological effects of the main contaminants.

The data collected by the monitoring system are stored in a database and based on them the main decisions are made.

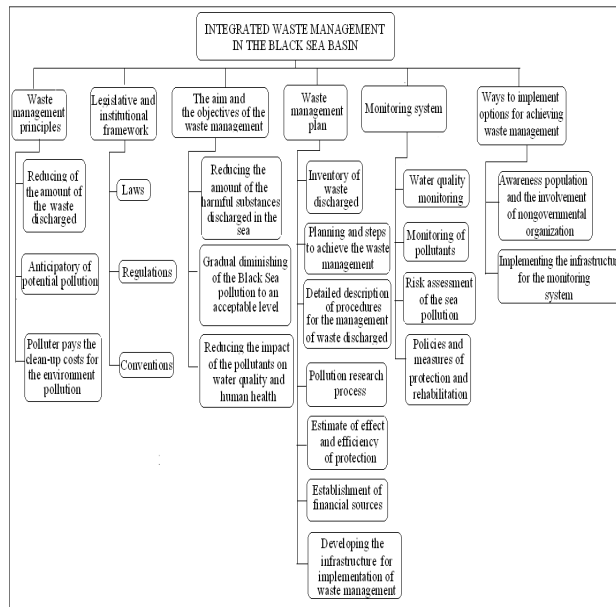
The scheme of the monitoring system is presented in Fig. 6.

The options concerning the ways of achieving the proposed objectives are related to: the public awareness on reducing environment pollution by developing some educational projects and involving also some nongovernmental organizations in this process; and developing the infrastructure related with the implementation of the management system.

The implementation of the integrated waste management system in the Black Sea basin will contribute to a better coordination of the activities and would bring major contributions in solving the waste issue in the targeted area (Fig.7). All these will have as a result the diminishing the amount of wastes discharged in the sea, as well as a notable reduction of the pollution followed by the rehabilitation of the aquatic ecosystem.



**Figure 6** Monitoring system



**Figure 7** Integrated waste management system in the Black Sea basin

## 5 Final considerations

The main conclusions resulting from the present work will be outlined in this section.

1. The Black Sea is continuously subjected to a significant pollution process due to the discharges into the sea of numerous pollutant substances coming either from the land, from the sea or from the ships.
2. The highest pollution in the Black Sea comes from the Danube River. The river transports important quantities of pollutants coming from its entire hydrographical basin. Due to this pollution process, the Black Sea ecosystem is still in an advanced state of ecological disequilibrium.
3. In order to reduce pollution and protect the environment of the Black Sea a close cooperation between the states neighbouring the sea is required. In the same time, the implication of the international organisms that should adopt better rules and action principles in order to protect the environment represents also an important factor.
4. It is presently a strong need for developing and enforcing adequate strategies related to the Black Sea, especially as regarding the adoption of an integrated system for discharging waste in accordance with the sustainable development.

Finally it will be also highlighted the fact that at the basis of the integrated waste management system which should be implemented in the basin of the Black Sea are the main principles of the waste management established by the rules and strategies of the European Union. A key place in this integrated waste management system should be taken by the management plan and the monitoring system. The management plan includes especially organizing the waste management as well as the estimation of the effects of its implementation. On the other hand, the monitoring system has the role to survey the specific ecosystems, to identify and assess the main pollution sources and the pollution effects.

## 6 Acknowledgement

The work was made in the scope of the project GRU-13-P-LP-147-GL-UK (project WAVES).

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