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Improvement of Romanian Marine Coastal Water Quality by Urban Sewage Treatment

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ABSTRACT

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Marine water quality is one of the priorities among contemporary Black Sea environmental issues. Its major importance and complex implications are evinced by international and national concerted concern and actions, such as the control of eutrophication and the financing of nutrient reduction supported by the Global Environment Facility (GEF), the continued European Union (EU) commitment to the Black Sea, the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea with related National Action Plans for the entire region.

Coastal water quality along the Romanian Black Sea coast will be considerably improved by the full operation of four wastewater treatment plants at Constantza Nord, Constantza Sud, Eforie Sud and Mangalia until the end of 2008: following main achievements are expected from the modernization of mentioned facilities:

- conformity of wastewater quality parameters with European Economic Community (now EU) Directives,
- improvement of quality control and ecological protection of coastal waters,
- fulfillment of one of Romania's obligations as EU admission candidate country.

ADDITIONAL INDEX WORDS: *Black Sea, Romanian coast, water quality, sewage, treatment plant.*

INTRODUCTION

The Black Sea is the largest tide-less, brackish water, intercontinental sea. It has been exposed from the origin to natural environmental fluctuations and more recently to strong anthropogenic stress (BOLOGA, 1992; COSTACHE, 1998). It now faces a severe ecological disequilibrium which could finally endanger life in this water body.

Anthropogenic activities having severe impact on the Black Sea originate in a drainage system of over five times the area of the sea surface itself; the large territories of the Danubian and riparian countries that constitute this area include over 165 million people from 17 countries (81 million in the Danube Basin alone). The activities are basically marine transportation (e.g., in the Danube, Danube-Black Sea canal, and harbours), industry (e.g., cement, superphosphates, petrochemistry, and nuclear energy), agriculture (e.g., fertilizers, herbicides, and pesticides), fishing (i.e., overfishing), and tourism (e.g., recreation, aquatic sports, and health). As a result of these activities, there has been an evolutionary trend in the Black Sea from an initially diverse ecosystem supporting highly productive fisheries to a highly eutrophic plankton culture with environmental conditions unsuitable for most higher biota (MEE, 1992; BOLOGA *et al.*, 1993, 1995).

The huge development of the marine phytoplankton in the last years, added to frequent blooms, led to major structural

modifications of the entire marine ecosystem. The presence of such algal masses in the sea water has as effect the consumption of oxygen, leading often to hypoxia, which causes the death of other marine organisms (GOMOIU, 1983). Most exposed are the benthic flora and fauna, which are the most favourable for the regeneration of the sand, for the water filtration, and for the marine food chains. The modification of the natural marine streams and the modification of the turbulence areas due to the coastal construction have also an impact on the intensity of interflow changing and on the quality of the biotope, with final impact on the biocoenosis.

Among the important pollution sources in the Black Sea there are all wastewaters discharged from the treatment plants lacking sufficient treatment degree, or wastewaters discharged untreated by some harbours, industrial, and agro-zootechnical complexes.

The Romanian Black Sea coast (Figure 1) is about 245 km long, its coastal zone between 5 and 30 km wide on land, and between 3 and 18 km wide at sea. It has about a 3400 km² surface, and about 650,000 inhabitants, with an 80% urbanisation degree. The protected natural areas cover a 475 km² surface.

Major problems that concern the Romanian coast are ecological, economical, administrative, social-demographic, related to water network and sewage network facilities in localities, and urban development.

Main causes of environmental disturbance are eutrophication, coastal pollution and contaminated sediments, and diffuse (non-point) source pollution. Eutrophication is severe-

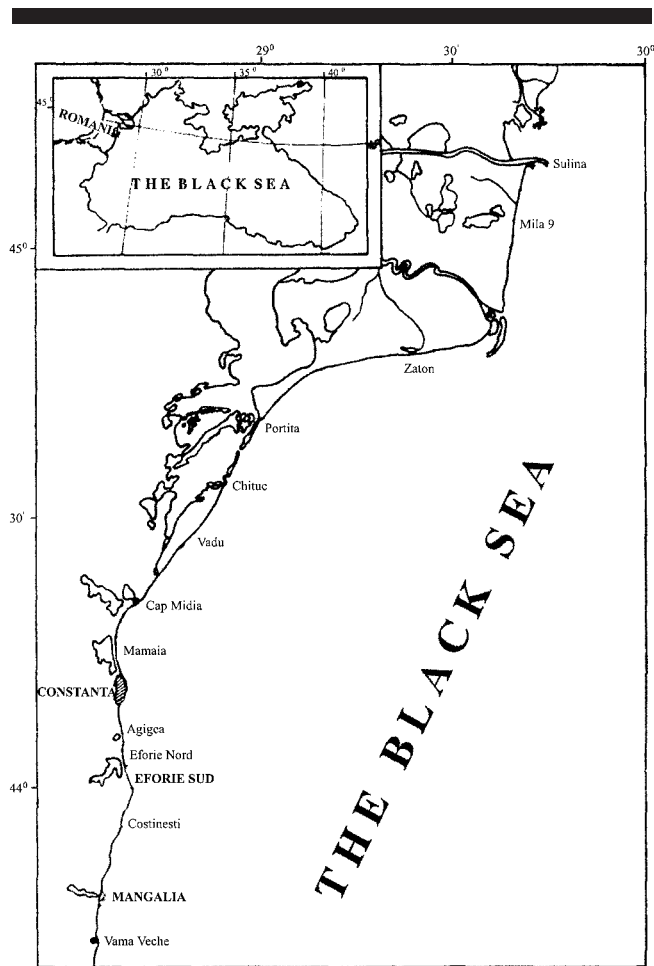


Figure 1. The Romanian Black Sea coast.

ly affecting both the Romanian shallow waters as well as the entire shelf area since the 1950s. A considerable contribution to eutrophication of the Romanian Black Sea sector is incumbent on urban wastewaters (ACWAC, 2000a, 2000b, 2000c).

WASTEWATER TREATMENT FACILITIES ALONG THE ROMANIAN BLACK SEA COAST

The city of Constantza, the second largest in Romania, and Constantza port, as the biggest on the Black Sea and the sixth one in Europe, certainly affect the quality of the coastal marine environment. Constantza County still faces insufficiently upgraded treatment capacity. At present, all urban (industrial and domestic) wastewaters, partially treated or untreated, are discharged in surface waters or directly into the Black Sea. Some areas of Constantza city disconnected from the treatment system discharge their wastewaters in adjacent lakes or in the sea. Therefore, the coastal lakes are highly eutrophic and chemically contaminated.

Population increases significantly during the summer season due to over one million tourists annually. Thus, the sea water quality in tourist areas and the creation of a modern wastewater treatment system are essential for Constantza

County and municipality, in order to encourage indigenous and international tourism, one of the main traditional income sources.

Major pollution problems arise all around existing Wastewater Treatment Plant Constantza Nord (WTPCN) located in the vicinity of Mamaia, the oldest summer resort and of Tabacarie Lake. At Eforie Sud, the wastewater treatment plant is situated near Techirghiol Lake, a natural saline lake with high therapeutic value, proposed to become a "natural protected zone". Improvement of the recently finalized treatment facility in Mangalia is equally important for the southern littoral neighbouring summer resorts.

The efficient treatment of wastewaters is a priority measure of the "National Action Plan for Environment Protection" which comprises important actions to be taken by Romania for adoption of the European "*acquis communautaire*" (MOR/O.G. 18/21.08.2001).

The improvement of wastewater treatment will directly contribute to the implementation of the following directives of the European Union (EU):

- European Economic Community (EEC) Directive No. 76/190/08.12.1975 for bathing waters,
- EEC Directive No. 80/68/17.12.1979 on the protection of groundwater against pollution caused by certain dangerous substances,
- EEC Directive No. 85/337/05.07.1985 on the assessment of the effects of certain public and private projects on the environment (as amended by Council Directive 97/11/14.03.1997),
- EEC Directive No. 86/278/04.07.1986 for environment protection, especially soil, in case of use of sludge resulted from wastewaters in agriculture,
- EEC Directive No. 91/271/21.05.1991 for urban wastewaters treatment.

Romania is also signatory of two relevant conventions for environmental protection: the "Convention on the Protection of the Black Sea Against Pollution" (Bucharest Convention) and the "Programme for Pollution Abatement of the River Danube".

Coastal water quality monitoring of the Romanian Black Sea sector was initiated in 1975 by the Romanian Marine Research Institute (RMRI) in Constantza within the National Integrated Monitoring System. Since 1999, the National Institute for Marine Research and Development "Grigore Antipa" (former RMRI) is now "the technical operator of the national network of physical, chemical and biological monitoring of coastal marine waters and of the survey of coastal erosion". Marine water quality is monitored for research aims and decision making at central and local authority level with respect to sustainable use and development of marine environment and resources (Bologa, 2001).

DISCUSSION OF RESULTS

Wastewater Treatment Plant Constantza Nord

A new approach in order to assure the wastewater treatment and implementation of an adequate treatment system by Constantza authorities, in agreement with basic environmental requirements for modern cities, is the upgrade of the

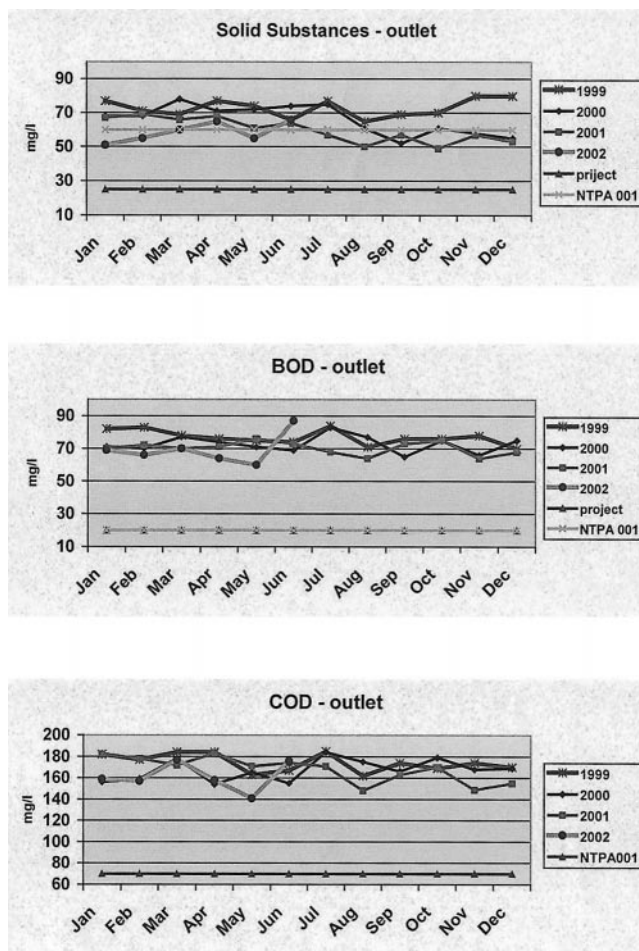


Figure 2. Wastewater treatment plant Constantza Nord.

WTPCN. The WTPCN concerns mainly domestic sewage. It will serve 185,000 inhabitants in Winter, and about 255,000 inhabitants in Summer.

At present, this facility assures only the preliminary mechanical phase and primary treatment. The initially designed capacity represents only half of the present loading. During the Winter season, waste waters from the primary treatment unit are directly discharged in the Black Sea or in an adjacent basin. In the full summer season a significant amount of collected wastewater side-steps the unit and enters directly the sea. Only part of this amount is transferred to the Wastewater Treatment Plant Constantza Sud (WTPCS) by pipes, already highly corroded.

The modernization works refer to an approximate flow of 140,000 m³/d and to a biological oxygen demand (BOD) of over 15 t/d during summer (Figure 2). They will include the construction of a new unit for preliminary processing, biological treatment and treatment of sludge addressing the standards foreseen by the EU Directive for urban wastewater discharges from localities with more than 15,000 inhabitants, as follows: solid suspensions (SS) < 35 mg/l; BOD < 25 mg/l, total N < 10 mg/l, total P < 1 mg/l. Samples of unprocessed

wastewater have been analyzed during the design stage. The project proposed during the feasibility study should lead to the accomplishment of discharged water standards without tertiary treatment. The component includes the establishment of a continuous monitoring and the purchase of laboratory equipment. Additionally, because of the functioning of WTPCN in the proximity of the tourist beach Mamaia, wastewaters will be discharged offshore by pipe as to Standards for bathing waters foreseen by the EEC Directive No. 76/160: < 10,000 total coliforms in 100 ml sample, < 2,000 faecal coliforms in 100 ml sample.

Wastewater Treatment Plant Constantza Sud

The WTPCS is the biggest wastewater treatment plant in Romania, designed for the mechanical and biological treatment of 3,200 l/sec industrial and domestic wastewaters (CRISTEA and BELU, 2001).

This project was realized within the MUDP II Programme totaling 8,929,453 USD. Equipment was assured by the European Bank for Reconstruction and Development (EBRD) (3,251,000 USD), 64% of related works by EBRD (3,634,209 USD) and remaining 36% by the Government of Romania and Constantza County Council (2,044,243 USD).

The duration of WTPCS project spanned the September 1, 1999–December 31, 2001 period.

The following main enterprises accomplished the project: PWT Wasser-und Abwassertechnik (Germany), with subcontractors Erbasu Expert Construct SA Bucuresti, R&M Nimb SA Cernavoda, and PET Communication SA Constantza (Romania). The project was designed by Proed SA and Romproiect SA Bucuresti (Romania). Equipment was provided by Adiss SA Baia Mare (Romania), Erhard (Germany), Flygt (Sweden), a.o.

The following major works have been accomplished:

- Rehabilitation of existing concrete and Parshall canals,
- Installation of new rare and fine gratings with collector system of deposits,
- Rehabilitation of existing sand separators and installation of new bridges,
- Rehabilitation of grease separators and installation of new aeration systems,
- Construction of caissons for grease collection,
- Rehabilitation of existing primary settling tanks,
- Rehabilitation of activated sludge tanks and replacement of old mechanical aeration system by fine bubble aeration system,
- Rehabilitation of secondary settling tanks,
- Construction of a new administration building with laboratories,
- Measuring and monitoring system of water parameters,
- Automatization of entire facility.

Due to the retechnologisation of WTPCS, pollutant discharge was reduced from 2800 t/year to 1240 t/year for SS and from 2700 t/year to 992 t/year for BOD (Figure 3).

Wastewater Treatment Plant Eforie Sud

The purpose of the project for the Wastewater Treatment Plant Eforie Sud (WTPES) is the rehabilitation and the ex-

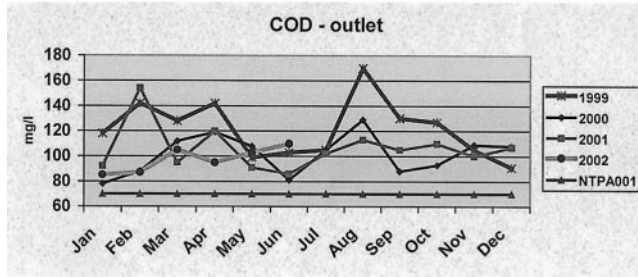
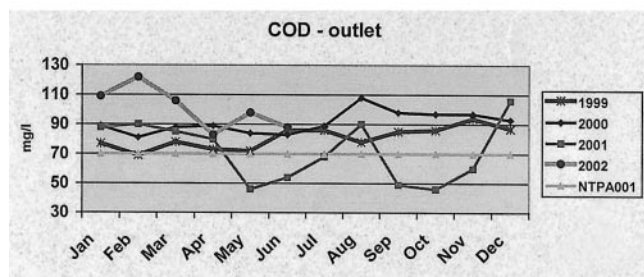
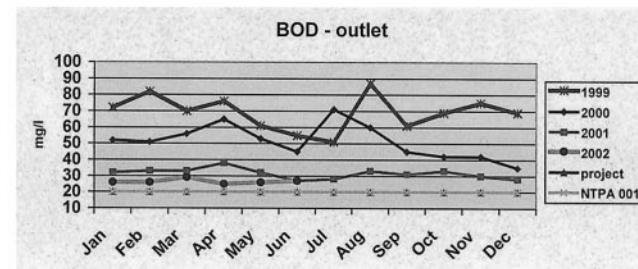
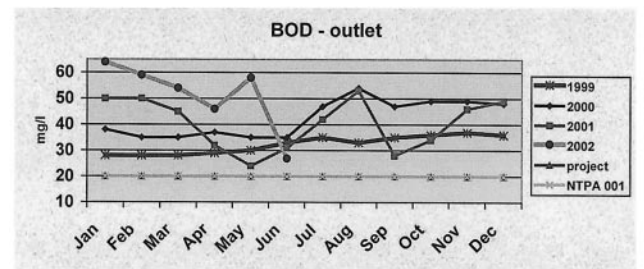
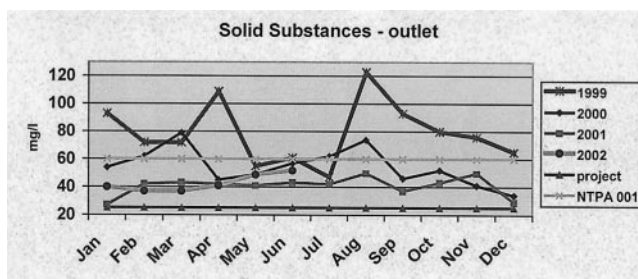
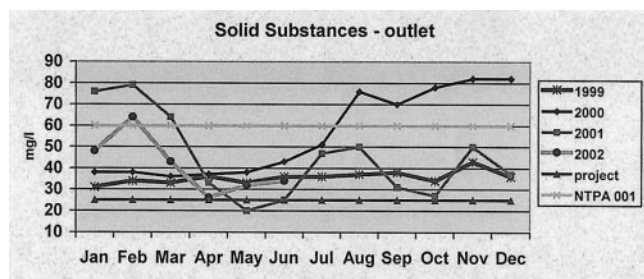


Figure 3. Wastewater treatment plant Constantza Sud.

Figure 4. Wastewater treatment plant Eforie Sud.

tension of the treatment capacity as follows: $Q_{max,day} = 2240$ m³/h in season and $Q_{max,day} = 850$ m³/h in extra season; $Q_{max,day} = 1865$ m³/h in season and $Q_{max,day} = 680$ m³/h in extra season. It will also fulfill all the exigencies concerning the outlet quality, according to the National Decision and EU regulations for standard approval of wastewater pollutant load limits discharged into the water sources (NTPA 001, 1997) (Figure 4).

A discharge pipe ($\phi = 700$ mm, $L = 1,250$ m, depth = 15 m) into in the Black Sea will be constructed.

To protect better Tuzla Lake, the WTPES yard and the neighbourhood will be provided with two electrogenic groups for the wastewater pumping stations.

The public benefit will consist in a better quality of bathing water, in accordance with EU standards.

The preliminary project, accomplished by Carl Bro International, concerns all works to be done: construction, mechanic, hydraulic, electric, SCADA, etc.

Wastewater Treatment Plant Mangalia

The Wastewater Treatment Plant Mangalia (WTPM) has already been rehabilitated, by EBRD assistance, bilateral as-

sistance offered by the Danish government and own resources of the Autonomous County Water Authority Constantza which administers water resources and wastewaters of Constantza county.

The project initiated in 1997, when the Danish Environment Protection Agency with DANCEE (Environmental assistance for Eastern Europe) decided the financing of project documentation and feasibility study finished in February, 1998.

The project for the water treatment line started with the decision of DANCEE, to sponsor Constantza County Council, for technical assistance and replacement of equipment. Due to the retechnologisation of WTPM the pollutant discharge was reduced from 330 t/year to 68 t/year for SS and from 350 t/year to 45 t/year for BOD (Figure 5).

CONCLUSIONS AND ACHIEVEMENTS

The present pollutant discharge in the Black Sea, as BOD, is about 16,250 t/yr, out of which about 40% occur in the Romanian coastal zone. All investments—WTPCN, WTPCS, WTPES and WTPM—will reduce the present load by about 90%. Available data on N are not sufficient yet. P load is low.

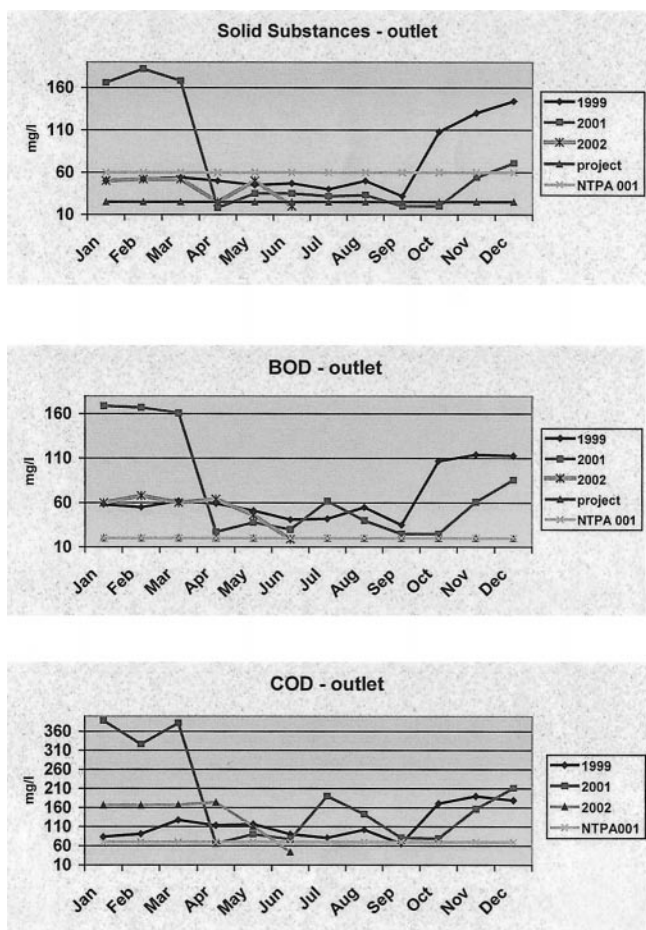


Figure 5. Wastewater treatment plant Mangalia.

So, the general objective of modernizing wastewater treatment facilities, systems, and strategies consists of improvement of environment infrastructure in Constantza County, Romania, EU admittance candidate country, in order to match these needs of the Adhering Partnership. Therefore, the protection of the Black Sea and Romanian coastal waters against industrial and domestic pollution is aimed at modernizing of wastewater treatment plants in order to achieve accepted standards for effluent quality. Furthermore, the accomplishment of above mentioned actions will include amelioration of the sewer systems in order to control wastewater

debits and reduce uncontrolled losses which considerably damage ground and surface water sources. All these measures will certainly help promote tourism by assuring clean sea water in the coastal area.

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