C-33

AN ASSESSMENT OF METAL POLLUTION IN THERMAIKOS GULF, GREECE

F. VOUTSINOU-TALIADOURI° and S.N. LEONDARIS°°

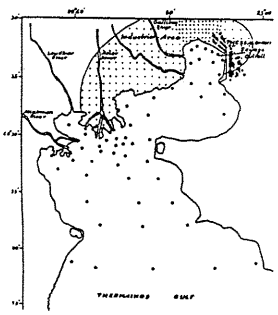
° National Center for Marine Research, Hellinikon (Greece)
°° Department of Geology, University of Athens, Athens (Greece)

Abstract

Surface sediments of Thermaikos Gulf were analysed for Cd, Pb, Cr, Cu, Ni, Co, Zn, Mn and Fe in August 1985. It was found that the sewage outfall of the city of Thessaloniki, the industrial area and the Rivers Axios and Aliakmon were causing metal pollution, especially in the case of Cd, Pb, Zn and Cu.

Thermaikos Gulf (fig.1), in the northern part of Greece, is fairly long and shallow (depth not exceeding 50m). Into it run three rivers, the Axios, into which large quantities of industrial effluents are discharged, the Loudhias and the Aliakmon. The innermost section of the Gulf receives the effluents of about 240 factories and the domestic wastes of Thessaloniki, a city of nearly onemillion inhabitants.

The samples were collected at a network of 56 stations more densely distributed in the innermost section and at the mouth of Axios River. A 0.1 m² van Veen grab was used. Samples were taken from the upper 3 cm. For the determination of metals 1 g of the powered material was digested with 50% of the concentrated solution of HCl for 3 h just below bowling point.



Processing of the filtered solution was performed on a 305 B Perkin-Elmer A.A.S.,equipped with a deuterium background corrector. Several intercalibration exercises proved the reliability of the method. For the samples examined the standard deviation depended on the concentration:in the range 1.3-1.8 g $Kg^{-1}$for iron, 40-80 mg Kg^{-1} for manganese, 5-20 mg Kg^{-1} for zinc, 10-20 mg Kg^{-1} for chromium, 15-35 mg Kg^{-1} for nickel, 2-10mg Kg^{-1} for lead,2-5 mg Kg^{-1} for copper,1-1.5 mg $Kg^{-1}$for cobalt and 0.1-0.5 mg Kg^{-1} for cadmium.

TABLE 1. Levels of metals (ppm) in various areas of Thermaikos Gulf.

Area		Cd	Pb	Cr	Zn	Cu
Sewage Outfall	Mean	4.4	220.0	180.0	770.0	135.0
	Range	2.8-6.0	100-330	140-210	235-1610	100-170
	Pollut.Ratio	14.6	11.8	1.9	16.0	7.9
Industrial Zone	Mean	2.8	165.0	290.0	290.0	80.0
	Range	2.2-3.1	120-245	215-390	220-375	68-85
	Pollut.Ratio	9.3	8.9	3.0	6.1	4.7
Axios River	Mean	5.3	100.0	280.0	200.0	53.0
	Range	2.6-8.7	81-120	230-320	155-250	44-67
	Pollut.Ratio	17.8	5.4	2.9	4.1	3.1
Aliakmon River	Mean	0.3	22.0	280.0	86.0	24.0
	Range	0.3	21-23	215-330	62-135	18-28
	Pollut.Ratio		1.2	2.9	1.8	1.4
Reference Area	Mean	0.3	18.0	95.0	48.0	17.0
	Range	0.3	11-27	66-120	32-74	8-28

Continued

Area		Ni	Co	Mn	Fe
Sewage Outfall	Mean	96	20	480	32,000
	Range	76-115	16-24	295-670	24,000-40,000
	Pollut.Ratio	1.2	1.2	1.0	1.8
Industrial Zone	Mean	93	19	580	35,000
	Range	80-100	16-22	565-660	11,000-46,000
	Pollut.Ratio	1.1	1.2	1.2	1.9
Axios River	Mean	140	25	955	47,000
	Range	110-175	19.29	665-1340	29,000-53,000
	Pollut.Ratio	1.7	1.6	2.1	2.6
Aliakmon River	Mean	240	33	800	34,000
	Range	210-290	19-37	685-1040	22,000-46,000
	Pollut.Ratio	3.0	2.1	1.7	1.9
Reference Area	Mean	81	16	465	18,000
	Range	55-105	14-18	215-740	12,000-22,000

Table 1 shows the mean levels of the metals in the sediments in each area, together with their ranges and the pollution ratio based on the reference area lying southmost. It can been seen that the most polluted section is that affected by the sewage outfall to the east of the Bay of Thessaloniki and the industrial zone to the west.Next comes the area around the mouth of Axios River. The greatest pollution ratio is exhibited by Zn,Cd,Pb and Cu. Zinc, Pb and Cu display the same pattern but not Cd, which presents its highest levels close to Axios River. The Aliakmon River causes only moderate Ni, Co and Cr pollution. The ratio of the concentrations of Fe and Mn is around 55 everywhere. It is intended to study the effect of the granulometric composition of the sediments on the metal contents.

C-34

COASTAL WATER QUALITY CONTROL IN THE EASTERN ADRIATIC AREA

Ilija VUKADIN and Lambe STOJANOSKI

Institute of Oceanography and Fisheries, Split (Yugoslavia)

ABSTRACT

Considerable quantities of untreated effluents significantly affecting the quality of the sea are introduced into areas near big coastal towns along the eastern Adriatic coast, (Zadar, Šibenik, Split, Kardeljevo and Dubrovnik).

Chemical and biological properties of the sea in these areas differ considerably from those in the open sea. If this process continues uncontrolled its present "beneficial" effects on marine production will soon be replaced by the harmful one effecting adversely the marine biota.

INTRODUCTION

Nutrients, so-called eutrophicants, are responsible for many peculiarities of the sea. They are of the basic links in the feeding chain of the marine biota. An increase in nutrient quantities causes intesified biological production by which primary organic matter my be formed through photosynthesis. An excess of these salts my cause a lot of harmful consequences.

MATERIAL AND METHODS

The paper presents chemical parameters, collected from several characteristic stations in the vicinity of big urban center along the eastern Adriatic coast. Data were collected and analyzed during 1980-1985.

Standard oceanographic methods were used.

RESULTS AND DISCUSSION

Presented values of all nutrients in the coastal area considerably exceed those in the open sea. Low nitrite and rather high ammonia values are indicative of their fast biogeneration owing to the intesive primary production in those areas. Rather low values of phosphate are indicative of rapid removal of these salts by biological activity or their rapid deposition from fresh and waste waters soon after reaching the sea. Therefore it may be stated that nitrate (NO_3-N) and silicate (SiO_3-Si) are the principal salts wich are introduced into the sea via domestic, industrial and natural effluents.

Table 1. The ranges and mean of nutrient salts (μ mol/dm^3) in the study area and at the open sea station (9)

Stations (Town)	PO_4-P	NO_3-N	NO_2-N	NH_4-N	SiO_3-Si
Z (Zadar)	0.03-0.30 $\bar{x}$ = 0.05	0.35-2.29 $\bar{x}$ = 1.02	0.03-0.26 $\bar{x}$ = 0.13	0.26-2.60 $\bar{x}$ = 1.24	2.71-10.04 $\bar{x}$ = 5.07
Š (Šibenik)	0.04-0.32 $\bar{x}$ = 0.08	0.38-9.76 $\bar{x}$ = 3.23	0.03-0.82 $\bar{x}$ = 0.17	0.16-3.00 $\bar{x}$ = 1.12	2.96-40.50 $\bar{x}$ = 8.60
S (Split)	0.04-0.34 $\bar{x}$ = 0.07	0.29-2.04 $\bar{x}$ = 0.92	0.03-0.37 $\bar{x}$ = 0.16	0.36-3.00 $\bar{x}$ = 1.00	2.96-12.86 $\bar{x}$ = 5.42
K (Kardeljevo)	0.04-0.31 $\bar{x}$ = 0.07	0.23-2.53 $\bar{x}$ = 1.22	0.02-0.37 $\bar{x}$ = 0.11	0.31-1.48 $\bar{x}$ = 0.96	4.00-20.58 $\bar{x}$ = 7.16
D (Dubrovnik)	0.04-0.17 $\bar{x}$ = 0.06	0.25-1.57 $\bar{x}$ = 1.12	0.02-0.50 $\bar{x}$ = 0.14	0.26-2.14 $\bar{x}$ = 1.29	2.96-15.43 $\bar{x}$ = 6.22
9 Open sea	0.06-0.14 $\bar{x}$ = 0.07	0.30-1.69 $\bar{x}$ = 0.72	0.0-0.38 $\bar{x}$ = 0.09	0.0-4.58 $\bar{x}$ = 1.19	1.02-4.85 $\bar{x}$ = 2.53

Table 2. A phytoplankton, zooplankton and bacterial data in the study area

	Phytoplankton No of cell/dm^3	Biomass of phytoplankton klorophil a/dm^3	Biomass of zooplankton mg/m^3	E.coli /100 cm^3
Z	273x10³	1.36	7.2	120
Š	867 "	4.5	10.3	1855
S	260 "	2.1	9.6	245
K	478 "	1.2	8.2	73
D	173 "	1.3	8.1	43
9	213 "	1.2	7.4	0

A biological data show again that the areas of Šibenik and Split have a maximum number of phytoplankton species and biomass of phytoplankton and zooplankton than the open sea stations. Large number of feacal coliforms were recordered from those stations.

Results of researches of hydrographic, chemical and biological parameters carried out up to now, are indicative of the fact that some areas (Šibenik and Split) are under very strong influence of industrial, urban and natural waters, unfortunately still unpurified, where environmental balance has been seriously threated.Therefore, to avoid serious consequences continuous monitoring of these areas is recommended.

REFERENCES

Buljan, M., L. Stojanoski and I.Vukadin (1979).Nutrient salts as a indicator of urban pollution of the Adriatic coastal waters. Acta Adriat.19(6),35-44.

Vukadin, I. (1980)Heavy metal concentrations in water, sediments and fish in Kaštela Bay. Acta Adriat. 21(2), 151-157.

Kontrola kvalitete priobalnog mora (Vir-Konavle) Elaborati 1979-1985. Institut za oceanografiju i ribarstvo. Split, 1985.

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