LEAD AND CADMIUM TRANSFER FROM A POLLUTED STREAM TO THE MARINE ENVIRONMENT

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Abstract

In the Mediterranean area and especially in Greece many, rather small polluted streams transfer their heavy metal load to the coastal environment. Asopos River is a typical pollution source for the coastal waters of South Euvoikos gulf. The chemical behaviour of lead and cadmium in this system and particularly in the intermixing zone between freshwater and the marine environment has some interesting features. It includes processes of precipitation, dilution and desorption, which could affect on their bioavailability and toxicity.

Keywords: Asopos; streams; lead; cadmium.

Introduction

Major international conferences (WSSD Johannesburg 2002, WWF Kyoto 2003) stress the need for Integrated Water Resources Management (IWRM) and suggest to address water management at the river basin level. In the Mediterranean, apart from few large riverine systems, there are hundreds of small and medium size rivers characterized by: a) high variation in river flow and discharge, b) high sediment discharge, mostly seasonal c) many scattered polluting activities in small catchment areas and d) lack of systematic environmental management of water. Little is known about the extent in which such small systems contribute to coastal pollution. This study aims at identifying the contribution and the geochemical behaviour of two priority hazardous substances, lead and cadmium in the estuary of Asopos River, which could be considered as a representative case of such systems. The drainage basin of Asopos is one of the most industrialized areas of Greece.

Study area

The drainage basin of Asopos river covers an area of approximately 450 km^2. During the dry season there is almost no physical flow and small pools and hypersaline microenvironments are formed. On the contrary, flash flood events are common during the wet season. The basin hosts more than 220 industries, including textile and dyes, metal finishing plants, chemicals, fertilizers etc. About 80 of these plants produce wastewaters, but only 36 of them are equipped with wastewater treatment facilities. The direct disposal of treated and untreated effluents into Asopos river and its branches is a usual practice [1]. The estuary of Asopos is located at the west coast of Southern Evoikos Gulf, which has relatively strong currents and some tides. The studied area was between 38°18'-38°20' North and 23°44-23°47' East.

Materials and methods

Four samplings were carried out in May, July (dry season), November 2001 (wet season) and July 2002 (after a flash flood event) at the riverine, estuarine and marine compartments of the system. Dissolved oxygen, temperature, conductivity, and pH were measured *in situ*. Water samples were filtered in succession through 8 and 0,45μm Millipore filters. The filters were treated with HNO_3 in PTFE beakers for the determination of particulate metals [2]. Dissolved metals were preconcentrated on "Chelex–100" resin columns [3]. Trace metals were determined by Graphite Furnace Atomic Absorption Spectrometry (Varian SpectrAA-640Z) and Flame AAS (Varian SpectrAA-200). Organic carbon was determined by a Shimanzu Carbon Analyzer 5000A.

Results and discussion

• The three "compartments" of the system were identified and they are characterized by three distinctive regimes: the riverine (salinity <2‰), the estuarine (mixing zone with salinity variations 2-40‰, turbidity maximum) and the marine (salinity >36‰).

• Due to the small depth the water column throughout the system was well oxygenated.

• pH ranges between 7.7-8,7 at the river and between 8.0-8.2 at the sea.

• Dissolved organic carbon distribution also corresponds to the aforementioned division, with the most elevated concentrations in the riverine part and lower concentrations in the estuarine and marine ones (mean values 19.4, 10.7, 4.7 ppm respectively).

• During the period of permanent flow of the river (11/01-7/02) the concentrations of particulate metals were reduced seawards. This pattern of distribution is clear for both expressions, w/v and w/w due to dilution and desorption respectively (Table 1).

	5/01						7/01					
	D		P v/w		P w/w		D		P v/w		P w/w	
	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb
Riv.	0,03	0,60	5,26	1,48	3,05	167	0,07	4,49	0,07	1,50	0,91	19,1
Est.	0,02	0,17	4,16	0,68	0,31	22,7	0,02	0,15	0,01	0,50	0,18	15,0
Mar.	0,04	0,32	0,52	0,41	0,46	49,9	0,03	0,41	0,02	0,29	2,70	43,7
	11/01						7/02					
	D		P v/w		P w/w		D		P v/w		P w/w	
	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb	Cd	Pb
Riv.	0,15	0,48	0,02	2,14	0,54	112	0,07	0,38	0,05	1,46	4,78	320
Est.	0,08	0,42	0,01	0,97	0,32	25,6	0,05	0,43	0,04	0,87	1,67	126
Mar.	0,07	0,38	0,01	0,69	0,34	28,4	0,06	0,55	0,01	0,18	0,20	31,3

• The concentrations of dissolved metals in the estuarine and marine parts are reduced compared to the river due to dilution of the riverine polluting load. However, the desorption of metals from particles entering the marine environment results occasionally to higher concentrations of dissolved metals in the marine compartment in comparison to the estuarine one.

• During the dry (no flow) period (5/01-7/01) the concentrations of both dissolved and particulate metals (expressed as w/w) were increased in seawater in comparison to the estuary. This may be attributed to coastal pollution sources, the contribution of which becomes more visible under reduced riverine inputs.

• The main form of lead is the particulate one whereas, in the case of cadmium the dissolved form, which is also more bioavailable, prevails.

Conclusion

The study of the Asopos River indicates that small and medium size rivers and streams play an important role in the pollution of coastal waters in their vicinity. However, their impact on the pollution of the offshore Mediterranean waters is likely to be very limited.

References

1 - Loizidou M., Spanos I., Lagoudi A, 1999. Planning of central industrial wastewater treatment plant of Asopos area. NTUA Technical report.

2 - Dassenakis M., Scoullos M., Gaitis A, 1997. Trace metals transport and behavior in the Mediterranean estuary of Acheloos river. *Marine Pollution Bulletin,* 34, 2: 103-111.

3 - Scoullos M. and Dassenakis M., 1984. Determination of dissolved trace metals in seawater: the use of Chelex –100 resin. First Hellenic Symposium on Oceanography and Fisheries. Abstr. Pp. 302-309.