ATMOSPHERIC FLUXES OF HEAVY METAL CONTAMINANTS TO THE VENICE LAGOON

J. Kirk COCHRAN[1], Mauro FRIGNANI[2] and Marco SALAMANCA[1,3]

[1] Marine Sciences Research Center, State Univ. of Stony Brook, New York, USA
[2] Istituto per la Geologia Marina, CNR, Via Gobetti 101, 40129 Bologna, Italy
[3] Universidad de Concepcion, Concepcion, Chile

Salt marshes that are flooded only by extreme high tides are exposed to the atmosphere most of the time and thus record the atmospheric fluxes of contaminants to coastal areas (McCAFFREY and THOMSON, 1980). In order to obtain the atmospheric fluxes of some anthropogenic heavy metals to the Venice Lagoon, we collected a stalt marsh core in October 1992, from a site near S. Erasmo. The core was sectioned and analyzed for the naturally occurring radionuclide ^{210}Pb (half-life = 22.4 y) and trace metals (Fe, Mn, Ag, Cd, Ni, Pb, Zn). The chronology for the core was obtained using the constant flux method (APPLEBY and OLDFIELD, 1978; McCAFFREY and THOMSON, 1980). This method assumes a constant flux of ^{210}Pb from the atmosphere to the marsh surface. The inventory of unsupported ^{210}Pb in the core (25 dpm cm^{-2}) agrees well with prior analyses of ^{210}Pb inventories in marsh cores from the northern part of the lagoon (18-25 dpm cm^{-2}, BATTISTON *et al.*, 1988) as well as with predicted atmospheric fluxes to the site (TUREKIAN *et al.*, 1977).

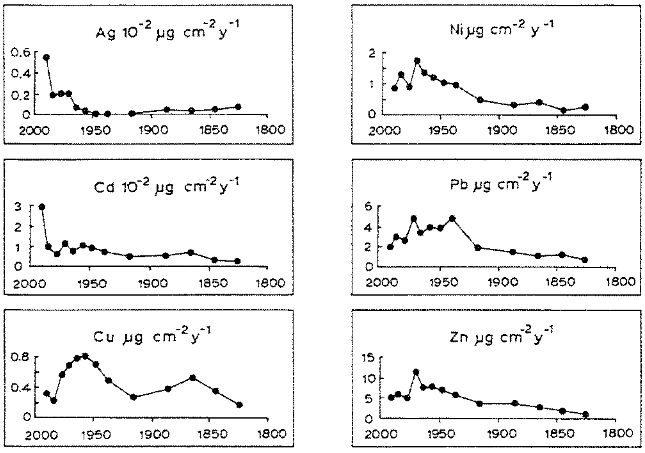

Fig. 1 - Variation of excess metal fluxes as a function of time.

The mass accretion rate of the marsh has varied over time, from 0.10 g cm^{-2} y-1 to 0.20 g cm^{-2} y^{-1}. At present the marsh is accreting at an accumulation rate equivalent to 0.17 cm y^{-1}, comparable to the eustatic rise in sea level. Fluxes of excess metals, defined as the fractions of metals above pre-industrial background levels observed at depth in the core, have varied significantly over time (Fig. 1). Several patterns are evident : fluxes of excess Ag and Cd show increases to the present, Ni and Zn show increases to about 1970 with decreases to the present, Cu displays a maximum flux at about 1960 followed by a decrease, and Pb shows increases to a period of relatively constant values (from 1940-1970) with recent decreases. These patterns reflect both regional trends in the atmospheric transport of trace metals and local inputs from the industrial development at Porto Marghera and Mestre.

Table 1. Comparison of ΣExcess Metal/ΣExcess ^{210}Pb ratios in marsh and Venice Lagoon sediments.

	Pb	Zn	Cu	Ni
Marsh	18	32	3	5
Lagoon :				
S. Erasmo	14±8	49±23	13±7	37±46
Campalto	39±6	300±300	25±13	24±10
Cona	19	40	12	19

Comparison of inventories of excess ^{210}Pb in the marsh core and in subtidal sediments from the Venice Lagoon shows that, on average, ^{210}Pb input to the lagoon is dominated by the atmospheric flux (Table 1). Redistribution of sediments and associated ^{210}Pb and trace metals by physical and biological reworking of lagoonal sediments causes local variations in inventories, and ratios of excess metal inventories to excess ^{210}Pb inventories can better permit source variations in metal inputs to be resolved. Ratios of metal inventories to ^{210}Pb inventories demonstrate that point source inputs of metals are evident in lagoon sediments near the mainland, but that atmospheric inputs tend to dominate in the northern and eastern portions of the lagoon.

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MUSSEL WATCH : ASSESSMENT OF THE MARINE ENVIRONMENTAL QUALITY IN THE GULF OF TRIESTE (NORTHERN ADRIATIC SEA)

P. DEL NEGRO, L. MILANI, P. RAMANI, N. BURBA[1], S. FONDA UMANI[2]
[1] Marine Biology Laboratory, Trieste, Italy
[2] Department of Biology, University of Trieste, Italy

It is established that bioaccumulation in mussels adequately reflects the changing levels in the environment. for most contaminants. The degree of their accumulation by mussels depends on their filtering activity, growth, biochemical composition, reproductive condition and metabolism. These factors are in turn affected by environmental variables, such as temperature, salinity, dissolved organic matter and nutrients that influence the phytoplankton availability (WIDDOWS and DONKIN, 1992). The aim of this paper is to evaluate if faecal contamination of mussels reflects seawater contamination in different hydrochemical conditions.

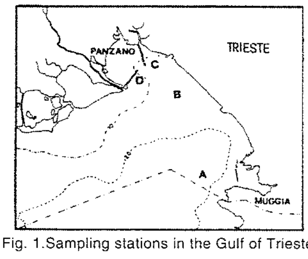

Fig. 1.Sampling stations in the Gulf of Trieste.

Starting from March 1991 until December 1992, a monitoring programme was carried out seasonally in four mussel farms located 200 m offshore in the Bay of Muggia (station A), along the coast of Trieste (station B) and in the Bay of Panzano (station C and D; Fig.1). For each station the physical structure of the water column was determined by using a CTD Idronaut Mod.401 multiparameter probe. Surface water samples were collected for the analysis of dissolved inorganic nutrients (GRASSHOFF *et al.*, 1983) and for the assessment of Total Coliforms (TC), Faecal Coliforms (FC) and Faecal Streptococci (FS) (APHA, AWWA, WPCF, 1989). The same bacteriological parameters were analysed in mussels randomly chosen from rearing ropes in each station. The hydrodynamism of the whole Gulf, stretching from the mouth of the Isonzo River (Bay of Panzano) to the Bay of Muggia, is mainly linked to the ascending eastern current flowing from the Istrian coasts, which carries higher salinity waters from the Middle Adriatic into the northern basin. Lower density and lower salinity freshwater coming from rivers, mainly the Isonzo and the Timavo, and urban wastes tend to flow on the surface (DEL NEGRO *et al.*, 1993). The river inputs are particularly evident in stations C and D, characterized by lower salinity and higher temperature values, whereas the eastern current is mainly perceived in stations A and B, characterized by higher salinity values. The results of faecal contaminants presence in seawater are reported in Table I.

	Spring								Summer							
St.	A		B		C		D		A		B		C		D	
	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92
TC	2	17	0	172	141	542	130	278	49	13	23	23	49	23	0	23
FC	2	2	0	11	79	49	130	7	49	9	5	5	22	0	0	0
FS	2	0	0	2	21	0	1100	0	0	6	6	2	2	0	0	5

	Autumn								Winter							
St.	A		B		C		D		A		B		C		D	
	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92
TC	22	17	7	23	918	1609	130	79	49	542	11	70	1609	1609	918	1609
FC	5	0	0	0	9	33	2	17	13	348	0	5	33	45	27	278
FS	0	0	4	0	109	5	26	0	5	17	0	2	0	221	13	130

Table I. Presence of Faecal Pollution Indicators in sea water (MPN.100cm^{-3})

According to cluster analysis two groups of stations were identified : A and B, C and D. The highest values of Coliforms and Streptococci were observed in stations C and D clearly due to urban and industrial wastes flowing in the area and to the river inputs that receive wastes both in Italy and Slovenja. In Stations A and B the pollution was mainly due to diluted urban waste. During 1992 an increase of TC values was observed in all the stations, particulary in spring and winter, while Streptococci generally decrease. No difference between stations appeared with bacteriological analysis of the mussels (Table II). In autumn and winter FC:FS ratio is always low (under 0.7 value) according to high Streptococci values. Unlike water situation, generally the uptake of faecal bacteria by mussels was greater in 1991 than 1992, particularly Coliform values decreased in the last year.

	Spring								Summer							
St.	A		B		C		D		A		B		C		D	
	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92
TC	1100	240	1100	150	1100	240	240	460	1100	9	1100	15	1100	11	1100	93
FC	75	15	290	0	120	23	4	15	24	0	290	0	19	7	1100	0
FS	75	29	6	93	43	93	240	93	1100	150	150	1100	150	1100	150	11

	Autumn								Winter							
St.	A		B		C		D		A		B		C		D	
	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92	'91	'92
TC	1100	120	1100	210	1100	1100	1100	150	460	1100	1100	1100	1100	1100	1100	1100
FC	15	75	4	4	75	7	4	28	240	23	6	4	278	0	39	23
FS	1100	1100	43	1100	1100	240	1100	1100	15	53	1100	1100	0	0	34	1100

Table II. Presence of Faecal Pollution Indicators in mussels (MPN.100cm^{-3})

The trend of Total Inorganic Nitrogen (TIN) and P-PO_4 confirms the identification of two aforementioned groups of stations : C and D generally present the highest values. In spring and winter 1992 TIN values were higher than 1991. This is in agreement with the water FC trend and it is probably due to intense rainfall in the area. In conclusions, no relationship was found between water and mussels faecal contamination. A possible explaination may be the different sampling method : the water was collected from the surface, while the mussels were taken at various depths. Another factor well known is the integrated response that mussels provide to the "total pollutant load" (WIDDOWS and DONKIN, 1992). For this reason, the concept of "mussel watch", largely considered as more confident than few analyses in the water, may only be used for the assessment of sea water faecal pollution when knowing the influence of environmental variables on mussels metabolism.

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