Sources of PCDDs/PCDFs from Industrial and Municipal Waste Water Discharges and Their Spatial and Temporal Distribution in the Sediments of the Venice Lagoon

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Introduction

The Venice lagoon lies in the north of Italy and extends over an area of about 550 km^2, bounded by the mainland on the north and by sandy littorals on the south and communicating with the Adriatic sea by means of three openings. The mean depth of the lagoon is less than one meter, but there is a complex network of natural and artificial canals which allow communications and transports. The major sources of PCDDs and PCDFs are represented by the industrial area of Porto Marghera, at the north-west edge, and by the city of Venice, which is located in the middle of the lagoon (1). In the area of Porto Marghera about 130 discharges have been identified. Only 20 of these are permanently active, the remaining being still used to drain meteoric waters because most of the industries connected their discharges to the drainage system of the central plant of Fusina, which treats also the municipal wastes of the city of Mestre and other urban areas of the mainland. This plant has a capacity of 250,000 equivalent residents and an average flow of about 3,000 m^3/h and is operating since 1985. Besides the Fusina plant, the most representative discharges of this area are those connected with the following plants: central biological treatment plant of the industrial petrochemical area (av. flow of about 2,000 m^3/h), central treatment plant of chlorinated wastes of the petrochemical area (av. flow of about 40 m^3/h), manufacturing plant of 1,2 dichloroethane (DCE) and vinyl chloride monomer (VCM) (av. flow of 35 m^3/h), treatment plant of an oil refinery (av. flow of 260 m^3/h) and treatment plant of a coal power plant (av. flow of 1,500 m^3/h). All these plants have been operating since the early eighties. Before this time, the wastes originated by the same processes were subjected to less efficient treatments.

The city of Venice is not served by a modern sewerage system and the municipal waste waters are drained into the lagoon through thousands of small discharges, eventually after sedimentation treatments by septic tanks.

Other sources of PCDDs/PCDFs are represented by the rivers which flow into the lagoon from the mainland, and by atmospheric fallout from the industrial area and the intense boat traffic inside the city of Venice.

In the present paper, preliminary results of a study founded by the Ministry of Justice and the Ministry of Works to assess the PCDDs and PCDFs contamination produced by industrial and municipal waste water discharges in the Venice lagoon are presented.

Materials and Methods

The most representative effluents of Porto Marghera were sampled at the outlet of the following plants: central treatment plant of chlorinated wastes of the petrochemical area (sample 1); DCE (1,2-dichloroethane) and VCM (Vinyl Chloride Monomer) manufacturing plant (sample 2); central biological treatment plant of the petrochemical area (sample 3); treatment plant of crude oil refinery (sample 4); treatment plant of coal power plant (sample 5); central biological treatment plant of the industrial area of Porto Marghera and of the city of Mestre (sample 6). One sample of wastewater of civil origin was collected from a septic tank of a house in the city of Venice (sample 7).

Two sediment cores were collected in the following areas: in front of the main discharge of the petrochemical area which collects the effluents of the central biological treatment plant, the treatment plant of chlorinated hydrocarbons and DCE/VCM manufacturing plant (sample 8); in the open lagoon, at about 5 km from the industrial area (sample 9). Furthermore, a superficial sediment (first 30 cm of sediment) was collected in the Grand Canal of the city of Venice. The cores was sectioned, according to their length, in two or three fractions, each measuring about 20 - 25 cm. The different sampling positions are indicated in Fig. 1. Waste water and sediment samples were analysed by HRGC/HRMS according to US EPA 8290/94 method.

Results and Discussion

The PCDDs and PCDFs congeners profiles of the waste water samples (samples from 1 to 7) are shown in Fig. 2. Sample 1 and sample 2, collected at the discharges of the central treatment plant of chlorinated wastes of the petrochemical area and the DCE/VCM manufacturing plant, were characterised by a definite prevalence of OCDF. These findings are in agreement with the results obtained by other authors on the same type of effluents (2). Also sample 3 and sample 4, collected at the discharges of the central biological treatment plant of the petrochemical area and the treatment plant of crude oil refinery, respectively, were characterised by a prevalence of OCDF. Sample 5 and sample 6 (treatment plant of coal power plant and central biological treatment plant of the industrial area of Porto Marghera and of the city of Mestre) showed an almost equal distribution between OCDD and OCDF. Finally, sample 7, collected from a septic tank of the city of Venice, showed a prevalence of OCDD, in accordance with the results found by other authors for human dejection (3). The I-TE values of the different sediment samples, expressed as ngTE/kg of dry sediment, are shown in Table 1.

Table 1. I-TE values of the different sediment samples

Depth of The core (cm)	I-TE VALUES OF THE DIFFERENT SAMPLES (ngTE/kg of dry sediment)		
	Sample 8	Sample 9	Sample 10
Superficial	-	-	16.0
0 - 20	14.3	19.8	-
20 - 40	6.2	0.5	-
40 - 60	6.0	-	-

These results indicate that, in the selected areas, the superficial sediments showed level of contamination consistent with those found by other authors (2) and that the contamination is higher for the superficial sediments than for the bottom sediments. The congeners profiles of the different sediment samples are shown in Fig. 3. This figure indicates that in the samples collected in the open lagoon near the industrial area (samples 8 and 9) OCDF was the prevalent congener, not only in the superficial fraction (0 – 20 cm) but also in the deeper fraction (20 – 40 cm). Only the bottom fraction of sample 8 showed a different profile distribution, with hepta-furanes as the most abundant congener. On the other hand, sample 10, collected in the Grand Canal of the city of Venice, presented a distribution very rich in OCDD. By comparing the congener distributions profiles of the wastewater samples (Fig. 2) with those of the sediments (Fig. 3) it is possible to observe that there is a strong relationship between the profile of wastewater samples 1 and 2 (discharges of the central treatment plant of chlorinated wastes of the petrochemical area and the DCE/VCM manufacturing plant) and sediment samples 8 and 9, with the exception of the bottom fraction of sample 8 (40 – 60 cm). Furthermore, the profile of wastewater sample 7, collected from a septic tank is very similar to sediment sample 10, collected in the Grand Canal.

Conclusions

The results of this preliminary study indicated that the PCDDs/PCDFs congeners profile distributions of the sediments of the Venice lagoon seem to be strongly influenced by the wastewater discharges. In particular, the discharges from chlorinated hydrocarbons production and treatment plants, characterised by a definite preponderance of OCDF, seem to have influenced a large area in front of Porto Marghera, while the untreated discharges of the city seem to have directly contributed to the profiles of the city area, very rich in OCDD. Furthermore, the I-TE values of the different fractions of cores of the sediments near Porto Marghera seem to indicate that the recent PCDDs/PCDFs contamination in the considered area is higher than in the past. Further investigations are necessary to assess a more definite picture of PCDDs/PCDFs contamination of the Venice lagoon.

References

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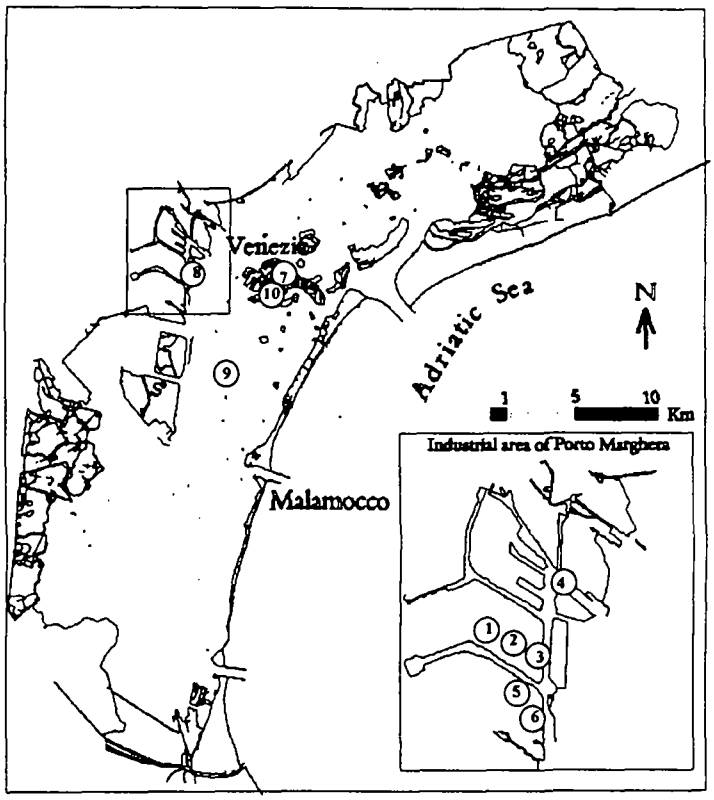

Fig. 1. Position of the sampling station of wastewater and sediments in the Venice lagoon

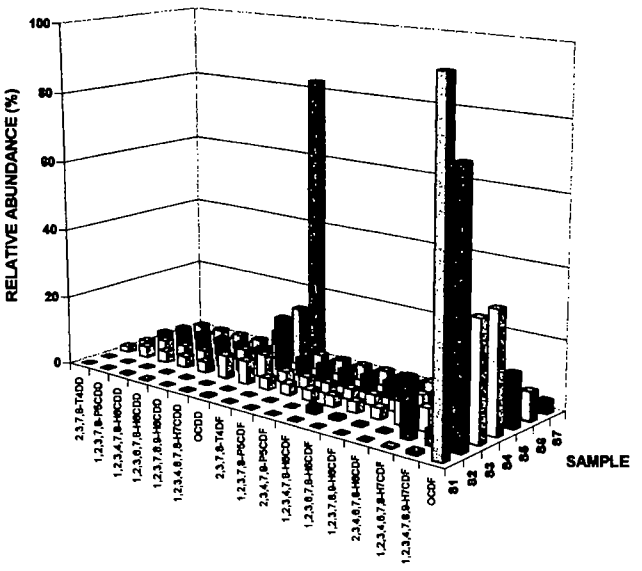

Fig. 2. PCDDs and PCDFs congeners profiles of waste water samples

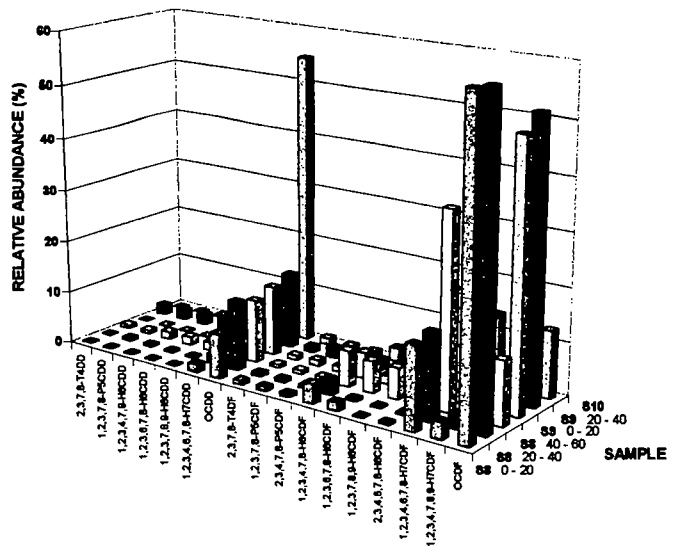

Fig. 3. PCDDs and PCDFs congeners profiles of sediment samples