SOME TYPICAL ASPECTS OF WATER CIRCULATION AND MIXING IN AN ESTUARY OF THE VENICE LAGOON

R. ZONTA[1], L. ZAGGIA[2], R. CECCHI[3],
S. RACCANELLI[4], S. VAZZOLER[1] and G. GHERMANDI[5]

[1] Istituto Studio Dinamica Grandi Masse, C.N.R., Venezia, Italy
[2] Dipartimento Scienze Ambientali, University of Venezia, Italy
[3] Istituto Geofisico e Geodetico, University of Messina, Italy
[4] EniChem SpA-SIA, Porto Marghera - Venezia, Italy
[5] Osservatorio Geofisico, University of Modena, Italy

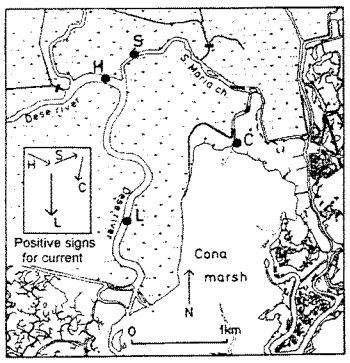

Fig. 1. Location of the four stations in the northern part of the Cona Marsh.

Once vehiculated in an estuary, heavy metals are subjected to a variety of interactions that are mainly governed by hydrodynamics and physico-chemistry at the fresh-salt water interface, and are capable to exert a marked influence on their partition. To study the behaviour of heavy metal discharged in the Venice Lagoon from the drainage basin, the Cona Marsh was chosen as a test area (BERNARDI *et al.*, 1988; GHERMANDI *et al.*, 1993). The marsh receives the fresh water input of the Dese river, an important tributary of the lagoon basin which collects contaminants from urban, industrial and agricultural sources. Some typical features of water circulation in this estaury, evidenced through field measurements made in different periods, are presented describing, as a typical case, the results obtained in June 1993. During a week-long field, continuous recordings of salinity, temperature and current were performed at four stations in the estuary (Fig.1), while other water physico-chemical parameters (dissolved oxygen, Eh, pH) were measured at the time of water sampling for chemical analysis. Suspended particle concentration, organic and inorganic carbon contents were determined after a two steps filtration through 8 and 0.4 µm pore-size polycarbonate membranes, using an expecially designed filtration apparatus (ZONTA et al., 1994).The original sample and the two filtrates were also analyzed for heavy metal concentration by P.I.X.E. and some filters were submitted to SEM/EDS analysis to investigate the particulate composition. The effect of the salt intrusion is depicted in the example of Figures 2. During the first part of the flood tide (α in Fig.2B), the greater part of the water column at station H is interested by fresh water, because of the river discharge occurred in the previous ebb phase (with a velocity of about 20 cm/s at 0.5 depth - Fig. 2A). The high salinity value observed in the bottom layer at the time of tide reversal is rather uncommon for this station and may be due more to seasonal than tidal conditions. This situation is successively altered by the arrival of fresher water previously discharged by the river, a part of which was "stored" in the S.Maria channel. This water is forced backward and then deviated upstream along the upper reach of Dese River by the action of the flood tide. The salt wedge espansion produces the resuspension of particles from the river bottom (Fig.2C, black dots), determining the observed turbidity increase in the bottom water layer, which starts at station L and interests afterwards the whole system. In the period of maximun upstream currents (β in Fig. 2B), no vertical salinity gradients are observable at station H, and resuspended particle concentration interests even the upper water layer at both stations L and H (Fig. 2C, white dots). Successively (γ in Fig.2B), prior to the flow reversal, the salt wedge at station H is restored, and salinity in the upper water layer decreases as a conse-quence of the reduction of tidal forcing. This is accompained by a decrease of turbidity in the whole water column at both stations H and L. The particle load travel-ling up and downstream between these stations, due to the friction on the river bed produced by the salt intrusion, the effect of the S. Maria channel on the circula-tion (GHERMANDI *et al.*, 1993), and salinity variations occurring in space and time along the estuary, strictly influence the behaviour of heavy metal and particularly the rate and intensity of adsorption/ desorption processes.

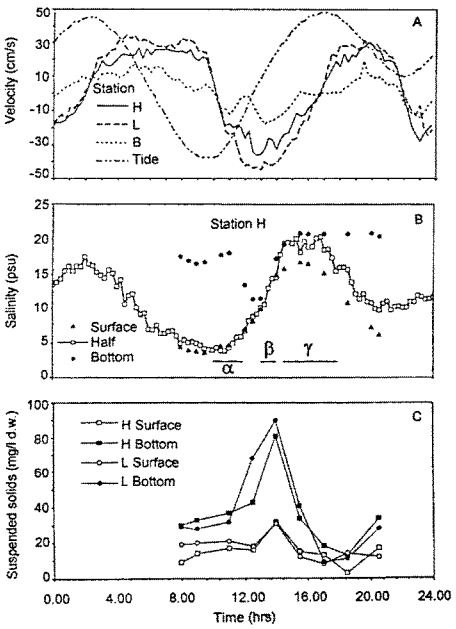

Fig. 2. Hydrodynamical and physico-chemical data measured on 23 June 1993 in Cona Marsh: current (A), salinity at station H (B), suspended particle concentration (d > 8 µm) at stations H and L.

REFERENCES

BERNARDI S., CECCHI R., COSTA F., GHERMANDI G., VAZZOLER S., ZONTA R., 1988. Preliminary Investigation on the Distribution of Heavy Metals in Surface Sediments of Cona Tidal Marsh (Venice Lagoon). *Il Nuovo Cimento*, 11C: 667-678.

GHERMANDI G., CAMPOLIETI D., CECCHI R., COSTA F., ZAGGIA L. and ZONTA R., 1993. Trace metal behaviour during salt and fresh water mixing in the Venice Lagoon. *Nucl. Instr. and Meth.*, B75: 330-333.

ZONTA R., CECCHI R., COSTA F., SIMIONATO F. and GHERMANDI G., 1994. A Filtration System for the Size Separation of Fresh Water Samples. *Sci. Tot. Environ.*, 143: 163-172.