SALTMARSH SEDIMENTARY RECORDS FOR ASSESING PERSISTENT TOXIC SUBSTANCES POLLUTION IN A REMOTE AREA IN CHILE.

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Introduction

Saltmarsh are defined as littoral environment estuarine type ecosystems, where communication with coastal waters in constant throughout the year and sedimentation process are very important. The intertidal hydraulic and sedimentary environment is largely responsible for their characteristics. Besides governing the extent of the intertidal zone it determines the pattern of vegetative growth within it. In regularly flooded tidal marshes within estuaries that receives a considerable sediment load, most of the intertidal zone consist of a thick layer of mud overlying a parent material usually sand. Nutrient-rich suspended clays and fine organic matter settle on the marsh surface. It is well known that persistent toxic substances have a high Koc value, being trapped in fine sediments, in these context, sediments can act as efficient traps for these pollutants since high levels of organic carbon content are observed in these environments. We hypothesizes that sediments can record historical trends of pollution in this remote ecosystems reflecting both terrestrial and atmospheric inputs. Therefore, we are using sediments as tracers of Persistent pollutants in Chile, where little is known about the behavior and temporal trends of these pollutants[1]. This kind of approach can help to overcome the lack of historical data and to understand both spatial and temporal trends of anthropogenic pollution. In addition in southern Chile in 1960, it was recorded a earthquake of high intensity, producing a tsunamic sandy layer in coastal sediments in that area. In this work we present some data on PCBs and Chlorinated pesticides in a vertical profile of sediments within a salt marsh located in a remote area in Southern Chile, the Imperial River salt marsh (38º40'-73º22'). As we can identify the layer caused by the tsunami, therefore we can attempt to verify differences between deposition patterns after and before 1960.

Material and Methods

The imperial river is located between 38º60' SL and 73º22' WL, drains a basin of about 12,054 km^2, main land use patterns are associated to agriculture, forestry and livestock activities. A profile of sediments up to 1 m depth where obtained by using a soil sampling device were obtained in may 2001, samples were sliced in 1 cm layers, stored in precleaned aluminum foil and stored at –20º in the laboratory. Samples were freeze dried, homogenized at 4 phi and extracted using Soxhlet, clean up was done in a florisil column and analyzed by GC-ECD, chromatographic conditions were: injection temperature 220 ºC, detector temperature 310 ºC, chromatographic column PTE-5 (30 m x 0.25 mm film thickness). A standard solution with 49 individual congeners of PCBs was used for quantification. Reference material were obtained from the National Research Council of Canada (CLB, and Sediment reference standard). Recoveries were higher than 70 % for all analyzed congeners. Pesticides were analyzed using the DDTs, HCH and HCB standards. QA/QC each set of samples were extracted along a blank. Reference standard material were also analyzed to verify method performance.

LEVELS IN ABIOTIC COMPARTMENTS

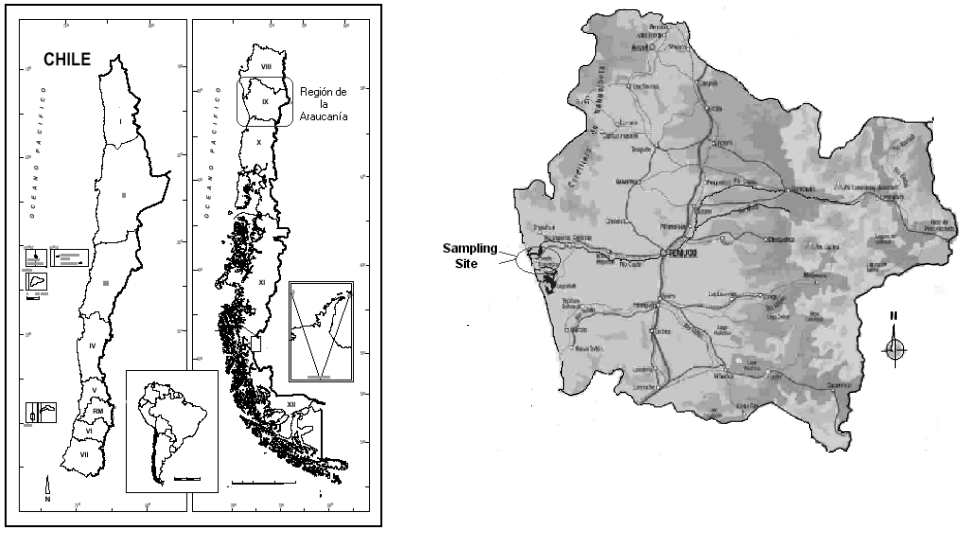

Figure 1. Study area

Several samples were analyzed at the Department of Analytical Chemistry of the UFZ environmental Research Center-Leipzig Halle for intercalibration purposes and quality control purposes. Differences between both laboratories were among 10 %. Organic carbon content was determined in each layer.

Results and Discussion

PCBs were widely used in Chile mainly as dielectric fluids in transformers and condensators, according existing regulations, no new PCBs (known as askarels) are permitted to use in transformers since 1982 [2]

Of 50 PCBs congeners analyzed only 23 were identified in the sediments, results showed levels of PCBs ranging from non detected values to 40 ng g^{-1} d.w. with high concentrations in the superficial layer of the sedimentary record compared. Most important PCBs congeners were PCB 153 and PCB 180, representing more than 30% of total mass in the first centimeter. A highly contaminanted layer were found at the layer 16 cm, above the sandy layer representing the tsunamic event.i.e. post 1960 years. Total profile of sediments are shown in the figure 2. In general concentrations are among ranges founded for remote areas in the northern hemisphere[3], deposition pattern indicate that probably the higher levels detected in more recent sediment layers are resulting from relatively recent pollution process. Imperial river receives urban discharges of small towns located within its basin but also we could not discard other process contributing to the observed pattern such as atmospheric deposition within the basin.

Congeneric composition accounts for heavy congeners from hexa to octa and nona congeners at the uppermost section of the core and (figure 3) suggesting that sources of these pollutants are relatively near the sampling site, since vapor pressures of these congeners does not account for long range transport. Even thought composition of PCBs actually used in Chile were unknown, from the profile obtained it can be mentioned that probably they derive from mixtures such as Arochlor 1260, which congener composition is dominated by hexa and octa congeners accouting of 42 and 38 from these congeners % respectively [4]

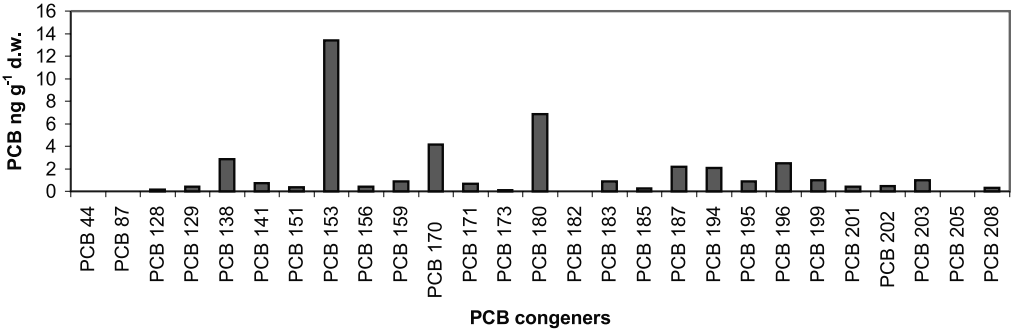

Figure 2. PCBs fingerprint at the uppermost section of the core

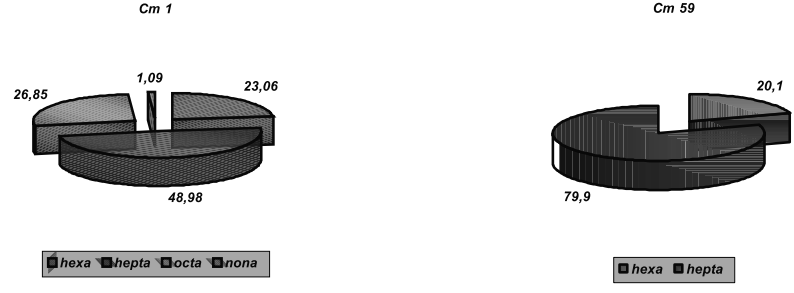

Figure 3. Congeneric composition at the uppermost and bottom section of the core

Total DDTs were also detected but concentrations were very low (below 3 ng g^{-1} d.w.) Figure 4. The general pattern represented that DDTs pollution in the area are very low besides it drains a large agricultural area. DDE/DDT ratios are higher than unity in all analyzed samples indicating a relatively old pollution within the study area. In fact DDT was forbidden in the eighties in Chile. These results are in agreement with previous results obtained in central Chile sediments[5]. Nor HCH not other pesticides were detected in the sedimentary record, but HCB, however the profile of HCB were almost homogeneous along the core. DDTs concentrations when contrasted with organic carbon content suggest higher concentrations in the sandy layer of the record, indicating that possibly a redistribution of residues occurred during the tsunami event. In fact a peack of DDTs were found within the sandy layer of the column (from 20-30 cm) theoretically corresponding to the year 1960. This is a very important fact since redistribution of pollutant within the column can be affected by bioperturbation but also by physical process such as a tsunamic event.

Concentrations of DDTs detected in this work are relatively higher than previously reported for lake sediments located near the experimental area. We explain these data as resulting of DDT export from the Imperial river basin, since agricultural and forestry are the most important activities within the basin, however, levels reported here are found low comparable to other remote areas of the world. Some previous controversial findings relative to the recent use of DDT in these sediments are discarded since DDE concentrations are well above pp'DDT levels.

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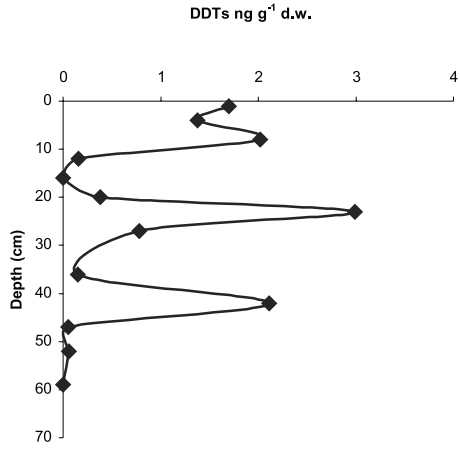

Figure 4. DDTs profile within the sediment column

It is clear from our results that levels of pollutants have been higher after 1960 period, where industrialization and improvements in agricultural production in Chile were established. However all our data suggest that pollution levels were not very high, probably due to the scale of process occurring, not much pesticides used and not a high industrialization within the Imperial river basin. Further research is needed to better understanding the process of chlorinated compounds deposition, and data gathering of pollution data in such remote and not populated area is critical to use natural events as time markers for pollutant deposition.

Acknowledgements

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References

1. Barra R., Cisternas M., Urrutia R., Pozo K., Pacheco P., Parra O. and S. Focardi. (2001) Chemosphere 45, 749.
2. CONAMA (2001) PCBs en Chile: Diagnóstico Nacional de Contaminantes Orgánicos Persistentes (COPs). Documento de trabajo Nº 2 .
3. Muir DGC., Omelchenko A., Grift N., Savoie D., Lockhart W., Wilkinson P. and Brunskill G. (1996) Environ Sci Technol 30,3609.
4. USEPA (2000) PCB risk assessment review guidance document. Interim draft January 2000.
5. Barra R., Pozo K., Urrutia R., Cisternas M., Pacheco P. and S.Focardi. (2001) Bol Soc Ch Quim 46,149 (in Spanish).