# PCBs in Sources and Remote areas in Chile: Recent Advances and Developments.

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## Introduction

The booming development of technology in the 1940's was the major cause of pollution by chlorinated organic contaminants around the world, reaching even remote areas particularly remote mountain areas. In this paper we review some evidences of POPs pollution in sources and remote areas in Chile, in order to improve our mechanistic understanding of POPs pollution. Due to the recent ratification of the Stockholm Convention by Chile, it is interesting to know if the restrictions imposed in Chile (since 25 years) has been effective in the decrease of environmental levels of several POPs. Chile is a very thin fringe of land with 4270 kilometers long, having a latitudinal gradient from 18º S to 56º S, besides there is a very important altitudinal range from the coast to the Andean mountains. Another important characteristic of Chilean geography is the high altitudinal gradient in a very short distance between the sea and the Andean mountains (from 80 to 300 kilometers). The Andes Mountains exert a blocking action for the air mass coming from the ocean, retaining all the precipitations in the western side, in Chilean territory. Northern Chile main productive activities are fisheries (coast), mining (Andes), meanwhile Central Chile's principal productive activities are related to agriculture, mining, industry. Southern Chile main productive activities are agriculture (livestock), forestry, aquaculture, and petrochemical industry in the further south.

## Materials and Methods

Samples of soil, and bivalves have been collected following criteria such as the location nearby urban-rural settings or remote areas away from suspected pollution sources such as agriculture, industry or human settlements, particularly within national parks and reserves. Sampling methodologies have been published elsewhere[1,2]. Analytical methods have involved the use of GC-ECD and GC-MS for confirmatory purposes. In addition, an inventory of PCBs stocks have been developed with the aid of the National Focal Point, this information will be available soon at the National Commission on the Environment (CONAMA) web site (www.conama.cl)

## Results and Discussion

Recently both the national inventory of obsolete POPs pesticides and PCBs have been released. Regarding PCBs results show a remarkable difference between northern and southern Chile, the total amount of PCBs inventoried up to now reaches 600,000 liters, being distributed geographically and according different productive sectors shown in the figure 1.

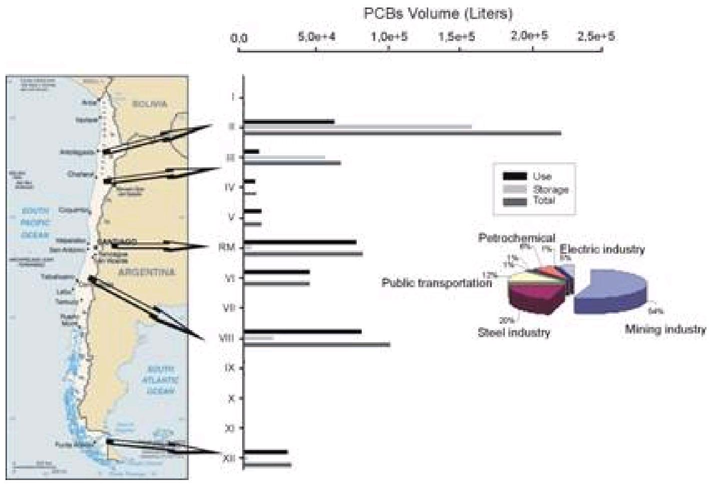


**Figure 1**. PCBs inventory in Chile, different contribution from the productive activities.

The regions in Chile that present the larger volume, in the PCBs inventory are the II and III region corresponding mostly to stored PCBs and the VIII, R.M, VI, XII and V region (in decreasing order) corresponding to a category in use PCBs, the productive sectors that make a more significant contribution to the PCBs inventory are the mining, corresponding approximately to 60% of the total inventory and almost to 90% of the stored PCBs, as long as, the transport (Metropolitan Region) and steel industry (VI and VIII Region), in their group they contribute with almost 30% of the total inventory and with 50% of the volume of PCBs in use (figure 1).

Environmental levels of PCBs in soil samples collected in near source areas and in remote areas are shown in table 1.

**Table 1**: Soil PCBs concentration in source and remote areas in Chile.

| Site | PCBs (ng $g^{-1}$ d.w.) | Reference |
|---|---|---|
| Mining site | 40-140 | This study |
| Pulp Mill site | 30-190 | This study |
| Steel industry | 300 | This study |
| Coal Mining | 380-500 | This study |
| Remote areas Northern Chile | 0.30-2.5 | 3 |
| Remote areas Central Chile | 1.1-3.2 | 3 |
| Remote areas Southern Chile | 1.4-3.2 | 3 |

Clearly, industrial soils are polluted with PCBs even three orders of magnitude higher than remote soils. These results are consistent with results gather by us[4] regarding PCBs and chlorinated pesticides in air samples in remote areas from Chile. In such study, PCBs and some chlorinated pesticides where higher in urban settings, indicating that probably urban areas could be acting as sources for POPs pollution in the Andes, and that observed pollution in soils [1,2], sediments[2] and mosses[5] in the Andes are a reflect of regional transport process.

At spatial level, we have detected POPs gradients on a short (basin)[1] but also long (country) scales in soils and sediment samples. In these cases temperature may explains roughly the 50% of the observed variability, meaning that other factors could be involved in the observed POP pollution pattern. Such factors could be related to precipitation rates, in that regard an ongoing research is looking for analyzing this factor in a more detailed approach.

Biological monitoring of POPs with mussels along the coastline in Chile have been conducted recently, such results are consistent with previous results observed in the International Mussel Watch Program 1991[6], oriented on the measurement of POPs on a wide spatial scale, in areas nearby sources. Table 2 show the major findings of these research

**Table 2**. Ranges of total PCBs concentrations in different mollusk species from Chile (Sericano et al, 1995).

| Species | **Total PCBs range ng $g^{-1}$d.w.** |
|---|---|
| *Perumytilus purpuratus* | 4.16 (VIII region)-46.98(V region) |
| *Alacomya ater* | 8.25 (II region)- 153.9 (XII region) |
| *Choromytilus chorus* | 80-109.8 (XII region) |

The highest levels of PCBs were found in the southermost part of the country. This study was conducted again ten years later and the obtained resuls were quite similar, i.e. the highest concentrations of PCBs were observed in high latitude areas.

Clearly, there is no match between the observed concentration of PCBs in mussels and the related uses of PCBs along the country, even the observed trend is the opposite.i.e. the highest use of PCBs correspond with the lowest concentrations in mussels.This discrepancy between uses and big scale distribution could mean that environmental distribution of such POP compounds even reaching remote areas in the country is still evolving. Temporal trends are still showing that the highest levels of PCBs in lake and Salt Marsh sediments are located in recent times[7,8], and no maximum peack is observed in sedimentary records but in recent sediments.

The PCBs pollution is widely distributed along the country, levels in soils are higher nearby industrial areas, and these areas could be considered as truly sources of PCBs to the environment. The absence of matching between uses and environmental levels of PCBs make suitable perform in depth analysis in such regions with the highest amount of PCBs in use, such analysis should be conducted soon. On the other way, there is a strong interest to analyze if industrial/urban sources are related to levels found in mountain areas located near such sites and even in those regions where no record of PCBs use exist, investigate the fate and mechanism of arrival , and finally to investigate if pollution detected in mountain areas come mainly from regional or global sources.

International cooperation and mechanism existing within the Stockholm Convention should aid to improve the knowlegde about the behaviour of PCBs in developing countries in the southern hemisphere.

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