WATER POLLUTION IN THE COPSA MICA REGION AFTER ROMANIAN REVOLUTION

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ABSTRACT

One of the most polluted areas with too high levels of heavy metals as a result of non-ferrous metallurgic industry in Romania is the region of Copsa Mica. The main objectives are to assess the dynamics and evolution of heavy metals (Cd, Pb) pollution of the surface and ground waters, and the children’s exposure after the passage to the new environmental framework law in Romania.

Comparison the environmental levels of heavy metal between 2004-2005 years revealed that even with the considerable decrease that was noticed over the last decade, the heavy metals concentration remains more than the maximum admitted value. Also, children’s exposure to heavy metals unfortunately remains rather important. The findings of our study reflect the necessity to intensify the measures of reduction of emission from smelter, along with control of children’s exposure in order to achieve the goal of accession into the EU by 2007.

Keywords: Heavy metals, water pollution, exposure, cadmium, lead

INTRODUCTION

Industrial units began to appear in the Copsa Mica area in 1935, but rapid development did not occur until the forced industrialization of the 1950s, 1960s and 1970s. Pollution in Copsa Mica was almost entirely caused by two factories; Carbozin produced carbon black for dies and tires from 1936 until 1993, and SOMETRA is a non-ferrous metallurgical smelter that is still operational.

The emissions from the two factories contributed to make Copsa Mica one of Europe’s most polluted cities.

Pollutants from SOMETRA, the non-ferrous metalworking smelter, are less visible but more harmful and insidious than those of Carbozin. SOMETRA is largely responsible
for some of the most appalling health problems of Copsa Mica’s population due to its emissions of lead and cadmium. There have been a number of studies that have investigated the levels of heavy metals in environmental factors in this area. These studies indicate high concentrations of heavy metals, environmental factors accumulating those pollutants at higher concentrations than the maximum allowable limit. The exposure at those toxics has led to a deterioration of health condition, contributing significantly to the high rate of morbidity and mortality among the peoples in the Copsa Mica area. The young are more prone to the toxic effects of heavy metals, as the rapidly developing body systems in the fetus, infants and young children are far more sensitive.

The purpose of this study was to report the dynamics and evolution of heavy metals (Cd, Pb) pollution of the surface waters (Tarnava Mare River and Visa stream and Harsiu brook) and of the ground water (individual sources of drinking water) in Copsa Mica area, and to assess the children’s body burden with these particular chemicals.

MATERIAL AND METHODS

The water samples were collected from Tarnava Mare river (5 downstream points - 2, 10, 20, 30, 40 km - and 3 upstream points from the pollution source), Visa stream and Harsiu brook (each one point), and the ground water samples from individual wells for drinking water supply from 7 rural localities near by the river. The wells were selected from whole area of the localities under study. The heavy metals levels in water samples were measured by atomic absorption spectrophotometer using a Perkin Elmer model 300 instrument, in two seasons: in summer and in autumn.

Exposure assessment to heavy metals was based on cadmium and lead levels in blood and urinary samples, measured in 169 children 7-11 years old, using atomic absorption spectrometry with graphite furnace facilities. The children were selected from primary schools of Copsa Mica and Axente Sever localities.

RESULTS

Study area:

Copsa Mica had the misfortune of being designated as one of industrial locations, in spite of the fact that the orographical and meteorological positioning of Copsa Mica is not favorable for polluting industries.

Copsa Mica, with a population of 5,110 inhabitants (1998 census) is located in the Valley of Tarnava Mare River that flows from east-northeast in a west-southwest direction. In the surrounding of Copsa Mica are many streams and brooks and other bigger or less centers. The polluted area is about 50 km² (180,750 hectares). About
200,000 people are exposed to high and medium levels of pollutants, 75,000 live in a highly contaminated area.

Copsa Mica region has a temperate-continental clime with an average annual temperature of 8.6°C. Monthly rainfall has a bimodal type of distribution, with the first peak occurring in May–June and the second peak, the most important, occurring during September–October. Long-term mean annual precipitation ranges from 900 to 1300 mm yr$^{-1}$.

**Surface waters:**

Our results reveal that Tarnava Mare river is high polluted with heavy metals because it receives the industrial waste water eliminate from non-ferrous metallurgical smelter. Cd concentrations ranged from 0.001 mg l$^{-1}$ (in upstream) to 0.12 mg l$^{-1}$ (in downstream). Water Pb concentrations showed a trend similar to Cd. Lead concentrations in Tarnava Mare River ranged from 0.012 (in upstream) to 0.79 mg l$^{-1}$ (in downstream). The mean of the concentrations were 0.017 mg kg$^{-1}$ for Cd and 0.187 mg kg$^{-1}$ for Pb, respectively. Tarnava Mare river can be distributed in three sectors: no polluted (upstream of Medias locality), low polluted (between Medias and Copsa Mica localities) and high polluted (downstream of pollution source) (Figure 1).
Although the levels of heavy metals decrease with the distance, Tarnava Mare River remains high contaminated up to about 40 km downstream from the smelter.

The concentrations of both heavy metals exceed admissible values in Visa stream and Harsiu brook (Table 1), though these surface waters don’t receive industrial wastewaters. This fact reflects the transfer of heavy metals to surface waters from other polluted environment compartments (air and soil). Some studies reported that it is an important way for surface waters contamination.

By seasons the levels of heavy metals in surface waters were different, being statistically significant higher in autumn for cadmium ($t = -3.270; p = 0.0097$) as well for lead ($t = -2.469; p = 0.0356$) (Table 1).

Table 1. Heavy metals levels (mg l$^{-1}$) in surface water by seasons

<table>
<thead>
<tr>
<th>Maximum allowable limit</th>
<th>CADMIUM</th>
<th>LEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.003 mg l$^{-1}$</td>
<td>0.05 mg l$^{-1}$</td>
</tr>
<tr>
<td>Tarnava Mare River</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 km upstream</td>
<td>0.001</td>
<td>0.018</td>
</tr>
<tr>
<td>10 km upstream</td>
<td>0.001</td>
<td>0.038</td>
</tr>
<tr>
<td>2 km upstream</td>
<td>0.004</td>
<td>0.045</td>
</tr>
<tr>
<td>2 km downstream</td>
<td>0.012</td>
<td>0.14</td>
</tr>
<tr>
<td>10 km downstream</td>
<td>0.013</td>
<td>0.21</td>
</tr>
<tr>
<td>20 km downstream</td>
<td>0.016</td>
<td>0.31</td>
</tr>
<tr>
<td>30 km downstream</td>
<td>0.004</td>
<td>0.09</td>
</tr>
<tr>
<td>40 km downstream</td>
<td>0.008</td>
<td>0.14</td>
</tr>
<tr>
<td>Visa stream</td>
<td>0.012</td>
<td>0.21</td>
</tr>
<tr>
<td>Harsiu brook</td>
<td>0.014</td>
<td>0.49</td>
</tr>
</tbody>
</table>

In Tarnava Mare River, heavy metals concentrations decreased significantly ($P<0.05$) with the distance suggesting the importance of the smelter as source of contamination. Also, in upstream from the pollution source the levels for both elements were lower than the maximum allowable limit for surface waters prefigure by national standard [9], whereas downstream from the non-ferrous metallurgical smelter the concentrations were ten times over admissible levels.

These levels are similar to heavy metals concentrations observed by the authors in same area in 1993-1998 period [3] when we found a mean Cd concentration of 0.012 mg l$^{-1}$ in downstream from the smelter and 0.002 mg l$^{-1}$ in upstream from the smelter.

Bardac [1] reported the highest value for cadmium in 1990 (1166.6 times bigger than admissible level). Same study shows the concentration of 1.6 mg l$^{-1}$ for lead (32 times bigger than admissible level) in 1989. Many study conducted at Institute of Public Health from Cluj Napoca before 1989 found in Tarnava Mare river, downstream from the smelter complex, Pb concentrations ranging from 0.1-1.28 mg l$^{-1}$ and Cd
concentrations ranging from 0.08-0.32 mg kg\(^{-1}\) (in 1979 was reported the biggest value, 0.83 mg l\(^{-1}\), exceeding the maximum allowable limit for 276.6 times).

**Ground waters:**

The results of cadmium and lead levels in ground waters are performed in Table 2. The metals were found in all samples, many of them exceeding the maximal permissible values of the national regulation for drinking water (0.005 mg l\(^{-1}\) for Cd and 0.05 mg l\(^{-1}\) for Pb) [7]. Contamination of groundwater is caused by storage of industrial wastes on the soil and by the atmospheric pollution (heavy metals are removed from the atmosphere by dry deposition and by precipitation), and they seepage in to the soil by rainwater.

<table>
<thead>
<tr>
<th>Year</th>
<th>Locality</th>
<th>No. of samples</th>
<th>Cadmium Mean±SD</th>
<th>Lead Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Valea Lunga</td>
<td>33</td>
<td>0.004±0.001</td>
<td>0.028±0.004</td>
</tr>
<tr>
<td>2005</td>
<td>Valea Lunga</td>
<td>22</td>
<td>0.005±0.002</td>
<td>0.040±0.006</td>
</tr>
<tr>
<td>2004</td>
<td>Lunca</td>
<td>42</td>
<td>0.014±0.007</td>
<td>0.120±0.051</td>
</tr>
<tr>
<td>2005</td>
<td>Lunca</td>
<td>29</td>
<td>0.009±0.003</td>
<td>0.301±0.027</td>
</tr>
<tr>
<td>2004</td>
<td>Craciunel</td>
<td>19</td>
<td>0.003±0.002</td>
<td>0.021±0.004</td>
</tr>
<tr>
<td>2005</td>
<td>Craciunel</td>
<td>19</td>
<td>0.004±0.001</td>
<td>0.045±0.010</td>
</tr>
<tr>
<td>2004</td>
<td>Micasasa</td>
<td>25</td>
<td>0.015±0.002</td>
<td>0.481±0.058</td>
</tr>
<tr>
<td>2005</td>
<td>Micasasa</td>
<td>21</td>
<td>0.015±0.002</td>
<td>0.342±0.064</td>
</tr>
<tr>
<td>2005</td>
<td>Axente Sever</td>
<td>34</td>
<td>0.005±0.001</td>
<td>0.054±0.007</td>
</tr>
<tr>
<td>2005</td>
<td>Copsa Mica</td>
<td>10</td>
<td>0.004±0.002</td>
<td>0.061±0.004</td>
</tr>
<tr>
<td>2005</td>
<td>Tarnavioara</td>
<td>9</td>
<td>0.005±0.003</td>
<td>0.045±0.026</td>
</tr>
</tbody>
</table>

Table 2 shows that in the close proximity of the smelter (Axente Sever, Copsa Mica, Tarnavioara) as well as over 30 km distance from the smelter (Valea Lunga, Craciunel) (see Fig. 1) the mean concentrations for bought toxics were lower than in the localities situated between 10-15 km downstream from pollution source (Micasasa and Lunca). These different pollution levels in groundwater could be caused by dispersion of the atmospheric emissions from the high chimney of the smelter. These emissions are not deposited in its close proximity, the wind transporting the particulate (depending on size and weight) for a large area up and downstream of the river (the bell effect). Furthermore, the samples of the groundwater in Tarnavioara and Axente Sever were polluted with heavy metals though these localities are located upstream from the smelter.

Frequently, the residents of these localities ascertained that the volume of the water in the well fluctuates by flow of Tarnava Mare River. These findings suggest that the interaction between Cd and Pb in surface and groundwaters are important.
**Children’s exposure:**

Children living in the vicinity of smelters frequently have heavy metals levels significantly increased in blood. Usually, the levels for these toxics in children’s blood are higher than the levels of non-occupationally exposed adults from the same environment. This indicates that there is a higher uptake and/or absorption of heavy metals in children than there is in adults.

Figure 2 shows that in our study more than half of the children had blood lead values above 10µg/dl, the limit value according to the C.D.C. criteria (US Centre for Disease Control) [8]. The prevalence of children with blood cadmium levels higher than 0.5µg/dl was very high (45.2%), too. For bought toxics the urinary concentrations were above of the safety levels [5] in almost a quarter of children.

![Fig. 2. Prevalence of children distributed among cadmium and lead levels](image)

Comparing the results of this investigation with those becoming from other study conducted in same area [2, 4, 6] we observe an important decrease of children exposure. Ten years ago, all the investigated children had blood lead concentration above 10µg/dl, 84.6% of them having very high levels (higher than 20µg/dl). For cadmium, 85.7% of children had cadmium levels in blood above 0.5µg/dl in 1996.

**DISCUSSIONS**

These results prove that until the early 1990s environmental management was largely absent. The plant at Copsa Mica was part of Stalinist-type industrialization goals focused to drag Romania into a major industrial role. Plant fell to disrepair under Ceausescu who, unwilling to take on more foreign debt, refused to replace failing parts and filters, causing plant managers to sacrifice human health and safety as well as environmental concerns in the interest of meeting short-term production quotas. Heavy metals levels in Copsa Mica area sometimes reached levels that were hundreds times the allowable international limits. Pollution statistics and consequences were state
secrets under the communist regime, and this secrecy prevented both international intervention and local knowledge of the extent of the exposure of residents to toxins.

After 1989, the Romanian Government enacted regulations and set up the Ministry of Waters, Forest and Environmental Protection. The environmental strategy of 1991 and 1992 identified 14 environmental “hot spots,” one of which, of course, was Copsa Mica. Because of governmental changes, though, the Environmental Strategy and the National Environmental Action Program were not approved until 1995, at which time more widespread and intensive measures were taken to alleviate pollution, especially within the “hot spots.”

These efforts, along with the passage of the New Environmental Framework Law and the draft Law on Water and Forestry Code, were large steps in the right direction towards improving environmental conditions in Romania. In Copsa Mica, the carbon black plant Carbosin was shut down in 1993, and the lead and zinc smelting factory, SOMETRA, was opened to international industrial safety experts from the U.N., who upgraded some of the equipment, installed new filters, brought long-needed spare parts, and set up emissions monitors.

This was part of a United Nations Industrial Development Organization project that allotted $211,112 to ameliorate some of the environmental damages that previous mistakes had concentrated on the Copsa Mica area, as well as limit future pollution. The projects that the Romanian Government deemed a priority for Copsa Mica were: equipment modernization at the nonferrous metallurgical plant SOMETRA, and afforestation. Indeed, the period of 1990 through 1994 saw a large reduction in emissions as compared to 1989, mostly caused by cutbacks in production; however, some of the reduction can be attributed to technology improvements and pollution reduction efforts.

CONCLUSIONS

1. Between 1993 and 2005, concentrations of cadmium and lead decreased significantly in surface waters, but Copsa Mica remains extremely polluted. In the Tarnava Mare River, downstream from Copsa Mica, even with the considerable decrease that was noticed over the last decade; the heavy metals concentration remains more than the maximum admitted value.

2. This study highlights the potential danger of ground water for Cd and Pb body burden, the individual wells of drinking water supply being frequently contaminated with these toxics above maximum allowable limit.

3. The intervention plans established in the last decade to reduce heavy metals pollution in Copsa Mica region played an important role in diminishing children’s exposure even if still much of them have cadmium and lead levels in blood above of the safety levels. A long term community action plan is necessary in order to continue reducing heavy metals exposure of children.
4. Environmental improvement efforts will be necessary in the future if Romania want to meet its goal of accession into the EU by 2007.

REFERENCES