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Evaluation of Mercury in the Vlora Gulf Albania and Impacts on the Environment

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Abstract: Mercury (Hg) in the Vlora gulf survey area exists in high levels for more than two decades now. This is the reason why there have been and there are still studies being carried out in this area. Hg is now considered as a potential polluter. The study is based on environmental and test indicators. The obtained indicators on land, water and plants give a summarized account of the Hg situation in this area. The utilized method was based on the opening of profiles and the obtaining of the samples according to distance from the source, the electrolysis section. The obtained results after the tests show that land and water media are polluted with Hg. From the plant tests it results that there are high amounts of Hg accumulated in the organ tissues of he plants. The plant species in the surveyed area absorb different Hg, levels, from Juncus acutus 0.115 up to 0.271 Kladofora. Based on the geometric average GA and the median MED, according to distances from 25-100 m the content of mercury results to be 0.9 in 500 mg/kg in the environment. The geometric average is in geographic proportion regarding the content. According to the geographic position of the surveyed environment, minimum values result on the northern and eastern part and the maximal ones on the western part at a GA value (mg/kg) 142.2 and MED (mg/kg) 421.8. This area with high Hg content becomes a cause not only for environmental pollution, but also pollution in animal and human beings and, stimulating carcinogenic diseases.

***Key words**: mercury, pollution, environmental area, land, water, plant, losses.*

Introduction

Among the heavy metals which threaten the human health and the environment are: Cadmium, mercury and lead[1]. Cadmium is used in paints industry, in plastics as well as in batteries. Mercury is utilized in dentistry as well as in batteries. The most significant use of lead from an environmental perspective is its use in fuels[2]. These three metals are intoxicating to the people's health.

Tests conducted in 1998 showed that metallic mercury Hg and the mercury dichloride $HgCl_2$ are visible pollutions in that place[4]. The relatively high conductivity of local geology facilitates the movement of polluted waters in the Adriatic sea medium[6,7]. This study "The levels of Hg pollution and its impacts on the environment" provides an assessment of the situation in the Vlora region environmental areas.

Vlora is located in a coastal plateau in southern Albania and is affected by central Mediterranean climacteric system[3,9].

Geographical location of the surveyed area:

Latitude N.	Longitude E	Latitude above sea level
40° 47`	19° 30`	1 m

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Meteorological data are gathered in Vlora since 1931. The table summarizes data on average monthly temperatures and precipitations for 1931-1991. Average monthly temperature in Vlora during the survey period fluctuates between 24.5°C in July and 8.9°C in January. Annual precipitation in Vlora varies between 708.7 mm (1961) and 1773.0 mm (1937), however the average annual precipitation recorded during the survey period is 1090 mm.

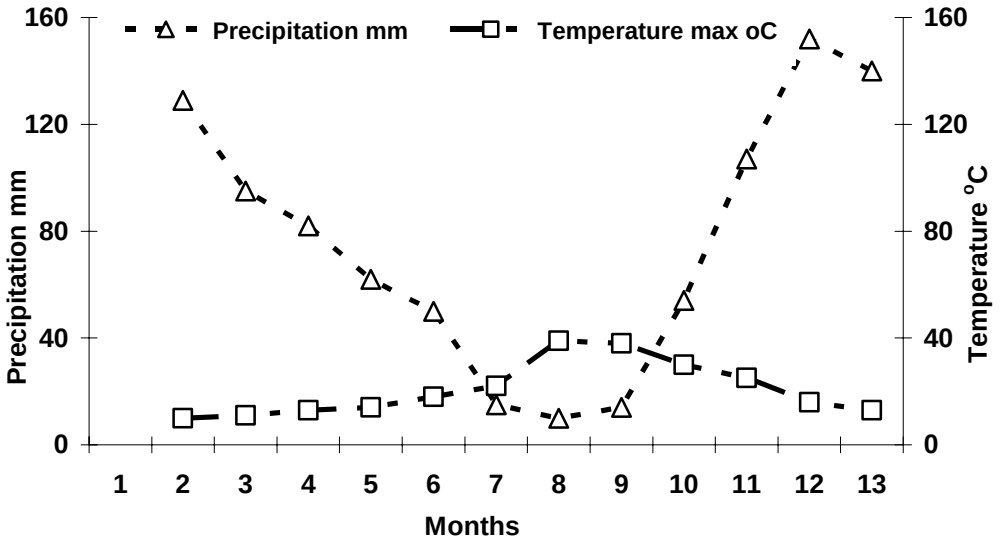

Figure 1. Display of barometric Diagram, Vlora area from 1950 to 2006

According to the Hydrometeorology Institute of the Academy of Science of Albania, the predominant wind direction during the summer (Wind Roses), is northwest and west. Daily winds, during the summer months have been typically accompanied with relatively cold air masses and humidity coming from the sea. During winter time, the wind's main direction entering the sea is generally from east and northeast. Average annual wind velocity in Vlora is 2.5 m/s, however there are stronger winds blowing from time to time from south and south west at 7m/s. Average frequency of a calm status (no wind) is approximately 43 %. More intensive winds blow from southeast in winter time and from northwest during summer time.

Biological Resources

The area of Narta lagoon has a wide variety of plants including 69 species of flora which the Museum of Natural Sciences (Tirana) considers to be important species of economic and property value). The most dominant types of flora include hydrophilic plants, in water lands, common halophytic plants in salted lands and Mediterranean coniferous forests[5,8].

Materials and Method

The data are a result of several indicators obtained from observations on bio-environmental indicators in the Vlora area and Hg measurements and indicators in the environment (earth, water, living creatures).

Pollution from mercury

From 1977 until 1984, the Hg losses were estimated to be 500g/ton produced chlorine. Mechanic losses being caused from mechanic leaks from the equipment, lines, fittings, ventilation equipment were being observed during complete stops of the plant or production halt in special electrolyte vats.

Table 1. Evaluation of Hg annual losses in PVC plant

	Hg loss sources during the production of gaseous chloride						
	Mechanical losses	Evaporation losses	Losses from products				
			NaOH	H_2	Cl_2	Water discharges	Sediments
Hg losses (g Hg/ton produced Cl_2)	300	100	10	25	Negligible	50	15
Total losses	500 g Hg/ton Cl_2						

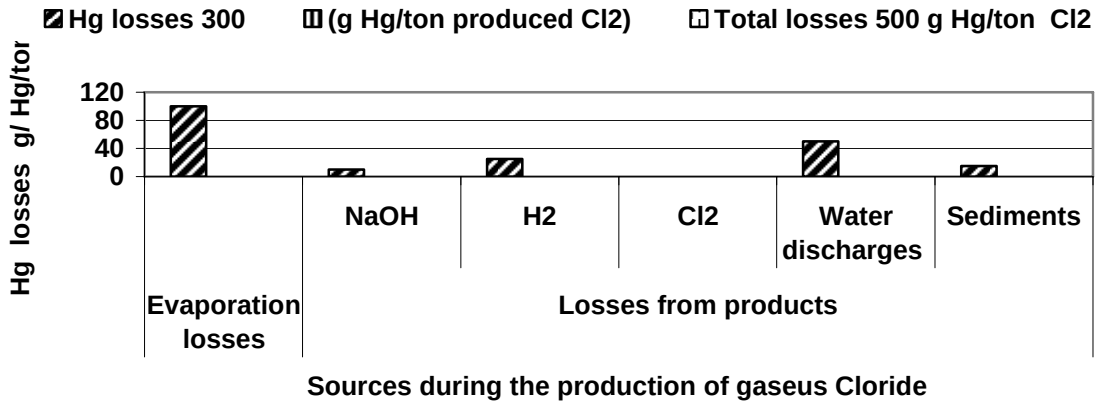

Figure 2. Evaluation of Hg annual losses in PVC from 1977 until 1984

In the first two years, Hg losses amounted up to 850-1000 gr/ton of produced chloride. During this time, the sea black salt was used as raw material for producing saline solution to be use in electrolysis. The impurities of this material would increase the amount of hydrogen produced during electrolysis which increased the risk of explosion and made it very difficult for the saline solution to be purified for reuse. For this reason the saline solution and electrolysis waste were discharged from the electrolytic vat without any recycling of the saline solution or the Hg waste. Every discharge contained 1200 m^3 saline solution and the amount of Hg in it was 0.6 ton.

Such discharges which were done in the first year created what is now called a "natural dam" for the discharge of sludge and saline solution of the whole PVC plant. The sludge contained molten mercury in $HgCl_4^{-2}$ form in concentrations varying in wide limits. The reactions between gaseous chloride, water and mercury in electrolytic vats used to lead to the creation of HgO with a solubility of 50 mg/l and is constant in a wide pH interval.

Na_2CO_3 and NaOH have been used to precipitate the calcium and magnesium inions from the saline solution in order to purify it and reuse it in electrolytic vats. Their use increased the pH of the saline solution.

There were efforts made to precipitate Hg from these solutions with high pH; however the utilized methodology was not successful in introducing thiourea in the process. Mercury was left in the solution as HgO and consequently was not recycled for use in the electrolytic vats.

When the process started to use Na_2S and thiourea $(NH_2)2CS$, the amount of Hg in liquid wastes decreased. Thiourea decreased the concentration of Hg within a few hours from 1,5 mg/l to 0,01 mg/l and mercury was precipitated as HgS. Even the operation of cleaning the catalytic vats generated with sludge polluted with Hg, especially when the cathodes were being used with graphite anodes. The water used to clean the electrolytic vats and for cooling the gaseous hydrogen, was also submitted to the mercury precipitation process in HgS form by eliminating

the passing of soluble Hg in the sea, increasing on the other hand the amount of sludge polluted with Hg. Until 1980, the high consumption of Hg was related to the refreshing of saline solutions before they were concentrated in order to avoid the increase of heavy metals in the saline solutions.

This discharge which amounts to 10% of the total amount of saline solutions, had an discharge effect of almost 60 m^3 per day, so, together with them are discharged about 0.25 ton mercury annually. Until 1984, the quality of sea salt for electrolysis was poor. The amount of substances insoluble in salt varied from 10-12%, which has caused obligatory discharges of salt solvents. The mercury losses resulted only from such discharges area about 0.28 ton per year. After the reconstruction in 1984, the amount of Hg polluted sludge decreased.

Results and Discussions

Status of Hg in the environment (land, water, plants)

1. **Study of the level of mercury in land**
   In order to conduct the study on the level of Hg in land, there were land samples obtained in the territory of former chemicals plant paying attention to those areas identified as having higher values of mercury content in the air and land-air. The samples obtained in the area of electrolysis section, result with a Hg content higher than 20.000 mg/kg. The results do also indicate that pollution from mercury decreases with the increase of deepness as well as with larger distance from the electrolysis department.

2. **Mercury sediments in the Vlora gulf sediments**
   This study has tested polluted areas as well as areas considered unaffected by pollution. The sediments samples were tested for content of mercury and other materials. The average content of Hg in the sediments samples is 0.338 mg/kg, thus higher than the natural level for the Albanian coast or other Mediterranean areas. (0.05-0.1 mg/kg). The samples show e substantial content of lead and cadmium which can only be explained with the discharge of unprocessed urban liquid wastes of this area.

3. **Levels of mercury in the sea living creatures**
   There have been several indicator species tested in order to define the levels of mercury and other heavy materials. Results show that the content of toxic metals in the mussels of the Vlora gulf is comparable with the average levels found in the mussels of the other Adriatic sea areas. The level of Hg in the samples of mussels obtained in the Vlora gulf (0.129 mg/kg) is higher than the Hg levels in the samples obtained in other areas along the Albanian coastline (0.021- 0.040 mg/kg).
   However these levels are under the average levels reported for Mediterranean Sea mussels (0.230 mg/kg) and much lower than the limit value of 0.5 mg/kg e recommended for human use.

The EU norm 79/923/EEC "On the quality required of shellfish waters"

Total Hg content,	< 0.5 mg / kg
Total Cd content,	< 2 mg / kg
Total Pb content,	< 2 mg / kg

Data show that the levels of Hg in land decrease with the increased distance from the electrolysis section as it is clearly indicated in Table 2.

Table 2. Mercury levels in different distances from the Electrolysis Section

Distance (m)	GA(mg/kg)	MED (mg/kg)	Min (mg/kg)	Max (mg/kg)
<25	213	183	22.8	2.471
25-50	36.9	50	1.2	1.9
50-70	40.9	18.6	2.3	1.22
75-100	16.4	17	0.9	500
>100	2.7	1.8	0.008	1.26

GA = geometric average; MED = median

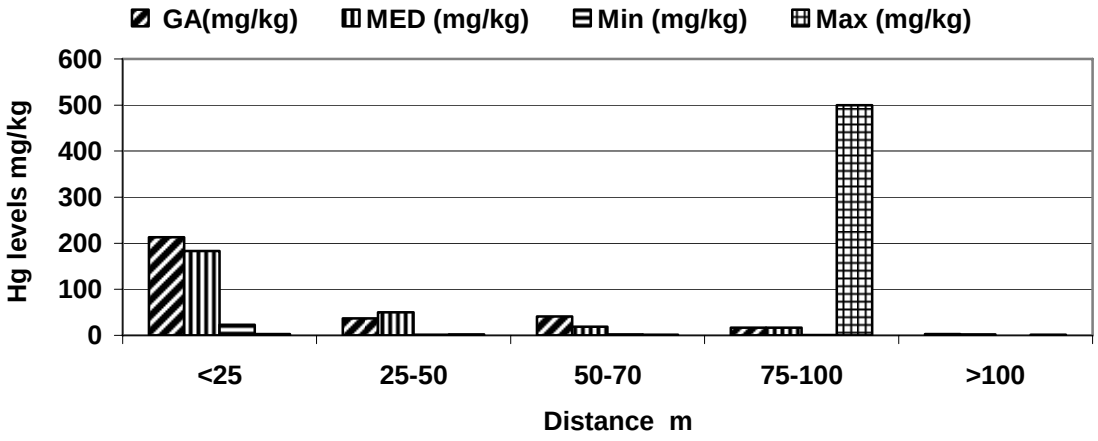

Figure 3. Mercury levels in different distances from the Electrolysis Section

For the study of mercury in the Vlora gulf sediments, there have been samples received at 300m distance intervals. In each profile along its axis towards the sea there have been 3 samples taken at 100m, 300 m, and 700 m from the sea coast. The results of the tests have been summarized in table 3.

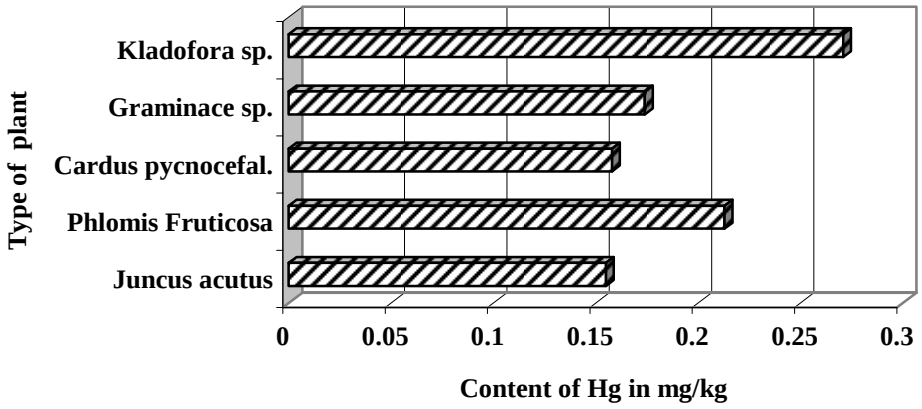

Figure 4. Content of Hg in mg/kg

Table 3. Content of Hg and other metals in Vlora gulf sediments (mg/kg)

Profile	**Distance (m)**	**Hg**	**Pb**	**Cd**
1	100	0.6	23.2	0.14
	300	0.4	14.7	0.12
	700	0.68	9.8	0.13
2	100	0.37	11.2	0.14
	300	0.54	17.4	0.18
	700	0.54	16.9	0.20
3	100	0.45	20.8	0.17
	300	0.57	12.6	0.16
	700	0.56	20.1	0.14
4	100	0.40	24.5	0.23
	300	0.14	20.3	0.21
	700	0.18	14.4	0.12
5	100	0.15	15.4	0.20
	300	0.21	20.1	0.12
	700	0.17	14.6	0.14

Table 4 shows the content of Hg in some characteristic plants which grow only 5 to 50 m away from the sea coast.

Table 4. Content of Hg in the samples taken from the area close to the sea coast (mg/kg)

Type of plant	**Content of Hg in mg/kg**
Juncus acutus	0.155
Phlomis Fruticosa	0.213
Cardus pycnocefal	0.158
Graminace sp.	0.174
Kladofora sp.	0.271

Conclusions

- The sources of Hg losses during the production of gaseous chloride in the production processes result to be in the limits of 500 g Hg/ton Cl_2 taken all together.
- Based on the geometric average GA and the median MED, according to distances from 25-100 m the content of mercury results to be 0.9 in 500 mg/kg in the environment. The geometric average is in geographic proportion regarding the content.
- According to the geographic position of the surveyed environment, minimum values result on the northern and eastern part and the maximal ones on the western part at a GA value (mg/kg) 142.2 and MED (mg/kg) 421.8.
- The plant species in the surveyed area absorb different Hg, levels, from Juncus acutus 0.115 up to 0.271 Kladofora.
- The area presented in the survey requires urgent intervention by means of mid and long term projects, because of the high content of Hg.
- This area with e high Hg content becomes a cause not only for environmental pollution, but also pollution in animal and human beings and, stimulating carcinogenic diseases.
- The origin of Hg in the habitats of soda area is clearly defined and it is a result of use of chemicals in the production of PVC.

- There should be surveys undertaken in future on the impact of Hg on the habitats biodiversity and their improvement.

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