Waste Assessment of Copper Mines and Plants in Albania and Their Impact in Surrounding Areas

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Abstract

In the paper is presented briefly quality-quantity assessment of waste stockpiles and tailings dams that actually are situated near closed mines or dressing plants. Presentation of their characteristics, quantity and impact in rivers flowing close to them, illustrated with photos in site, is in fact the starting point of designs and studies aiming to avoid the pollution in surrounding areas and to find ways of environment rehabilitation.

INTRODUCTION

Albania was developed as an intensive mining country consisting of numerous of mines and processing units of chrome, copper, coal, Ferro-nickel, limestone, bitumen, tar sand etc.

During the period of time 1986 – 1996, Albania has produced about 7.1 million tons of chrome ore, 6.8 million tons of copper ore, 5 million tons iron-nickel ore, 12, 5 million tons of coal, 1 million tons of bituminous coal, 100 thousand tons of natural bitumen, 500 thousand tons bituminous sands, 250 thousand olivine, and more than 25 million tons of limestone.
After 1991, the transition period caused a sharp decline of Albanian mineral production.

In consequence of this activity, big waste quantities, mainly solid, were generated inevitably, situated close to mines and dressing plants, in form of sterile mineral stock-piles or in form of tailings dams extracted by mineral processing in dressing plants.

It was carried out a study to evidence all the stockpiles and dams situated close to mines and dressing plants, as well as analyses of them and river water, sediments and lands in surrounding areas.

In this paper are presented briefly only copper mine and dressing plants stockpiles and dams in Albania and their impact in the environment.

COPPER MINE STOCKPILES

Ten copper mines and three dressing plants have been in operation in Mirdita District. Actually none of them is in operation, for the reason of failing of this industry from economic point of view. Rich copper ores and concentrates have been treated in Metallurgy and Refinery plant in Rubiku town. During their activity solid waste are deposited close to the mines, their quantities measured in situ [Boci, 2000] are shown in Table

1.

Table 1. Mirdita district stockpiles.

Mine	Operation Time		Solid Waste Ton
	Open	Close	
Rubik	**1935**	**1996**	**65 000**
Kurbnesh	**1956**	**1994**	**1 042 951**
Spac	**1965**	**1996**	**1 108 000**
Kacinar	**1967**	**1991**	**190 476**
Derven	**1972**	**1994**	**312 000**
Thijrre	**1973**	**1994**	**177 292**
Kullajxhi	**1983**	**1990**	**56 524**
Gurth 2,3	**1984**	**1996**	**73 476**

Three copper mines and a dressing plant have been in operation in Kukes Has District. All of them are closed. During their activity solid waste is deposited close to the mines, their quantities measured in situ are shown in Table 2.

Table 2. Kukes district stockpiles.

Mine	Operation Time		Solid Waste Ton
	Open	Close	
Gjegjan	1961	1993	10 082 000
Gerdhesh	1978	1987	65 065
Shenmeri	1982	1993	95 911
Golaj	1986	1993	39 715

Six copper mines and three dressing plants worked in Puka and Shkodra Districts. During their activity solid waste is deposited close to the mines, their quantities measured in situ are shown in Table 3.

Table 3. Puka&Shkodra districts stockpiles

Mine	Operation Time		Solid Waste Ton
	Open	Close	
Tuc	1966	1992	76 466
Porave	1972	1991	65 000
Kçire	1981	1992	70 317
Rrug Rin.	1982	1991	83 577
Munelle	1982	1992	84 721
Lak Roshi	1980	-	15 548
Karme	1979	-	4 550
Qafe Bari	1975	1995	346 840
Fush Arez	1989	1995	32 000
Paluce	1983	1997	341 445

Korca District were in operation three copper mines and one dressing plant. During their activity solid waste was deposited close to the mines, their quantities measured in situ are shown in Table 4.

Table 4. Korca district stockpiles.

Mine	Operation Time		Solid Waste Ton
	Open	Close	
Rehove	1980	1990	320 000
Çiflig	1980	1990	115 000
Dushk	1978	1990	57 000

Total sum of solid wastes of copper mines in Albania (see the Map in Figure 1) is about 15 million ton, where 3.1 million ton are situated in Mirdita District, 10.3 million ton in Kukes District and 1.1 million ton in Puka Shkodra districts, while about 0.4 million ton in Korca District.

Solid waste are disposed close to the mines but they have a visible impact in environment for the reason of their mineral composition, where predominates pyrite and other sulphide minerals.

COPPER PLANT DAMS

Poor cooper deposits have dictated the construction of 7 mineral processing plants, in order to produce cooper concentrate grade over 18 % Cu and about 88% recovery. These plants are situated in Kurbnesh, Reps, Fush-Arrez, Rreshen, Rehove and Golaj. (See map, Figure 1). Today, the mineral processing plants in Albania are no longer in operation and some of them have been closed or others have been planned for conservation. However, the respective tailings dams situated close to the dressing plants remain a serious concern regarding their chemical-physical potential and more over environmental risk. The mineral processing plants have produced tailings that represent 85 - 90% of the raw material quantity. All copper dressing plants have been operated with selective schemes, separating initially the cooper concentrate from the pulp with pH 11.5 and further more, separating the pyrite concentrate from the pulp with pH 5-6. The regulation of pH in the pulp performed, by adding in the process the lime and sulfuric acid. The tailings contain ions, which have a negative impact in environment. During operation, used reagents, passed with the mineralized froth in concentrates, but a part of them passed in tailings.

From the representative samples, taken from the dams, it comes out that the tailings contain about 0.2% Cu and 10% S. Usually 60% of quantity is under 0.07 mm. During the grinding of mineral at 60% under 0.07 mm, a great part of quantity was ground under 0.01 mm. This over grinded amount, which enters in the limit of the colloidal grains, is the main factor for environmental pollution and disappearance of fishery and life in the rivers, where these tailings are poured. The dams, being constructing near the branches of rivers, pollute not only these branches, but also the rivers up to their pouring down to the sea. It is the reason the fish population have been disappeared during operation in Kurbnesh, in Uraka stream. Now

after the plant closing, it has been noted a reappearing of the fish life in that area.

In Tab 5 is given the particle size distribution of tailings deposited in Kurbneshi and Repsi dams. opper tailings mainly consist of chlorite, quartz, carbonate, epidotic, clay ECT.

Table 5. Tailings particle size distribution.

Kurbnesh dam		Reps dam	
Classes (mm)	**Weight %**	**Classes (mm)**	**Weight %**
+ 0.16	**8.50**	**+ 0.16**	**24.40**
+ 0.07	**36.2**	**+ 0.07**	**22.20**
+ 0,032	**13.5**	**+ 0.032**	**16.90**
- 0,032	**41.8**	**- 0.032**	**36.50**
Total	**100**	**Total**	**100.00**

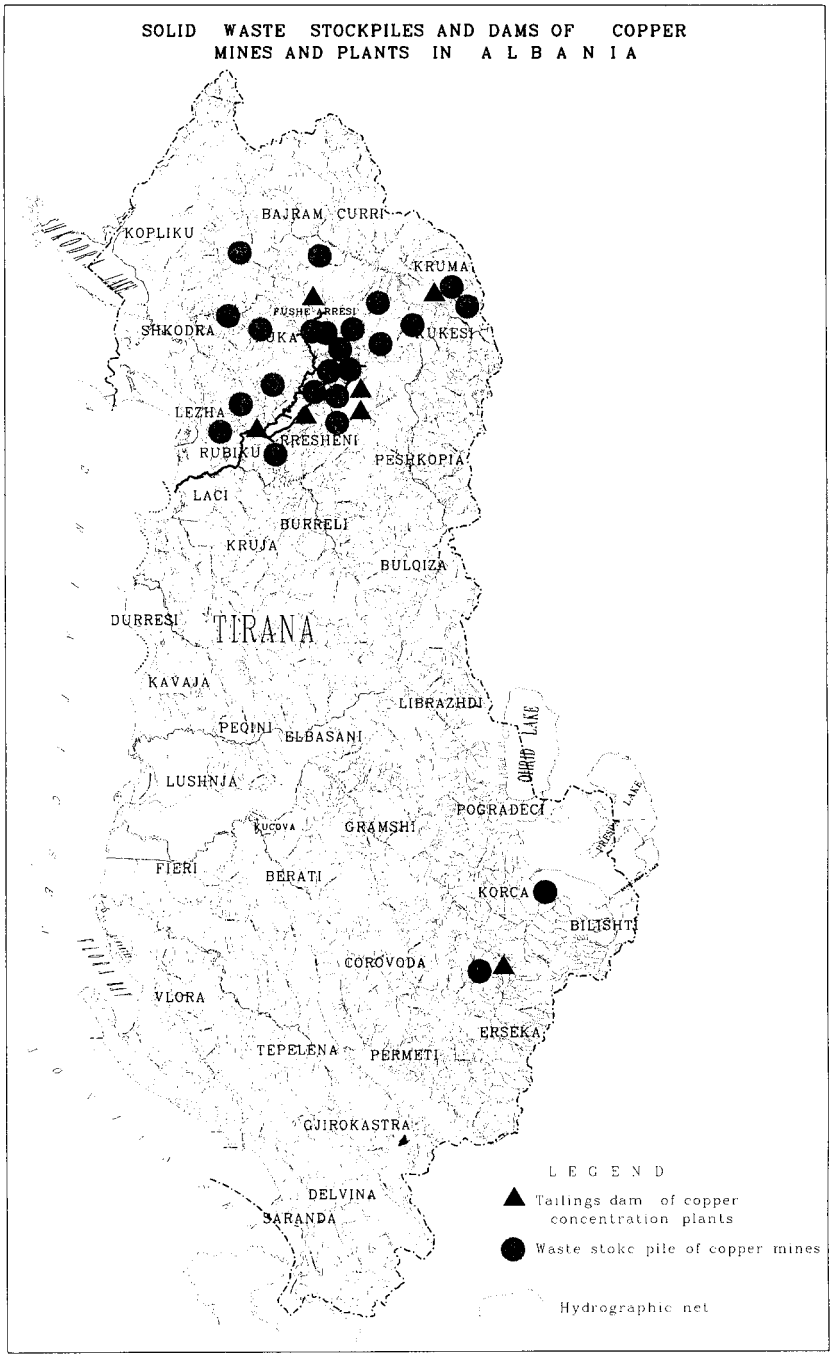

Figure 1. Situation of copper mine and plant solid waste in Albania

The presence of sulphide minerals causes an acid medium in drained waters, which are leaking from the dams and pouring in the rivers.

The dams, being big deposits of fine materials, have the risk to be broken in the event of rains, pouring down at the respective rivers [Demi,2000]. Dams become in this way sources for the environmental pollution. At the photos of dams (Figures 2, 3 and 4), we can easily state this fact.

Figure 2. View from Kurbneshi dam

Figure 3. View from Kurbneshi dam

During drying seasons and with strong winds, it happens that great quantities of tailings are blown up by the wind and move away, polluting all the surrounding area. While during winter, the dam surfaces are frozen, creating deep breaks, preparing further breaking of it.

Table 6 represents the tailings quantity of all the dams of copper mineral processing plants, calculated in the base of operation material balances.

Figure 4. View from Repsi dam

Table 6. Calculated dam quantity.

Dam plant name	Quantity, ton	Content Cu %
Kurbneshi	3582649	0.17
Reps	3695067	0.18
Fush Arrez	3103361	0.22
Rehove	611037	0.15
Reshen	444588	0.19
Golaj	349691	0.17
Mjede	44552	0.14
Total	11830945	

Treated copper ore quantity in all plants has been 12 757 798 ton. It is recorded that are produced 767 943 ton copper concentrate and 568 910 ton pyrite concentrate during the operation time in all dressing plants. From the difference is calculated that the tailings quantity in all dams must be 11 830 945 ton.

The factice assessment of tailings quantities in the dams was carried out measuring their dimensions and density in site, calculating their volume, surface and quantity. The data for three dams are given in Table 7.

Table 7. Real quantity in three dams.

Dam name	Real tailings quantity, ton	Tailings lost, %
Kurbnesh	**1 785 216**	**49.08**
Reps	**1 851 297**	**47.11**
Rreshen	**277 669**	**30.58**

Comparing with calculated quantity of the same dams (See Table 6), it is visible that only half of quantity that must be, is actually present in the dams.

In general the technology of the tailings storage in the dams is not satisfactory, often they are broken down at the frontal part, or they have created harmful holes for the normality of the dams and other risky developments. Resuming what we have mentioned above, it is to be noticed that the material remaining at present in the dams represents only about 50% of the total quantity they should have. That means that during their function there has not been achieved the objective of their storage in view of environmental protection, the fish in the rivers have been completely disappeared after the dams location, and a decrease in the fertility of the sheep and caws at the areas down the dam streams.

We have to mention also that possible immediate erosion destruction should cause great quantities of inert quartz and pyrite materials to pollute the rivers and the lakes in catastrophic dimensions.
Representative samples chemical analyze results are given in Tab 8, in %.

Table 8. Some component contents in the dams.

Dams	Cu	Zn	Fe_2O_3	S
Kurbnesh	**0,13**	**0,07**	**17,37**	**6,2**
Repsi 1	**0,25**	**0,08**	**20,95**	**15,7**
Repsi 2	**0,11**	**0,025**	**9.18**	**7,5**
Repsi 3	**0.14**	**0.04**	**9.37**	**8.12**
Rreshen	**0.12**	**0,035**	**15.06**	**12.4**

Precious elements have passed in copper and pyrite concentrates, because they associate copper and sulphur minerals in their structure.

STOCKPILE AND DAM IMPACT

Water analyses of the rivers that are running through these areas show the presence of ions of Cu, Fe, Zn, SO_4 in a high level.

The study performed about the degree of pollution of the Fani River [Sweco&MPTI, 1999] from the cooper extracting and processing industry, clearly indicates that gravity of the pollution, due to this natural phenomenon, is very high.

Two projects were carried out by MPTI for monitoring of Mirdita and Puka Zones, the first one in cooperation with SWECO (Swedish Company), while the second one has started last year and will finish on the end of this year.

The object of these projects is the assessment of pollution in Copper Mining Industry Area of Mirdita and Puka Zones and comparing it with allowed limits, to compile a plan for monitoring and necessary measurements for environmental protection in these zones.

Monitoring work has included sample taking in the rivers and their branches, which flow close to solid waste stockpiles and dams of copper mines and dressing plants, situated in mentioned zones, measurement of water flow in sampling points, sampling of sediments in the interesting points close to river costs, as well as sampling of land in Rubik Metallurgy and their analyses.

Sample point number in the first project was 32 and the time of sampling applied in April 1998, January 1999, April 1999 and September 1999.

Samples were analyzed for the components metals (particularly for heavy metals), for pH, conductivity and total alkalinity.

Analyze results for some river water samples taken in September 1999, are given in Table 9.

Table 9. Water sample analyses, September 1999.

Sample in rivers	pH	Cond. mS/m	Cu µg/l	Zn µg/l
Softa	3.4	72	2 200	4200
Fani Vogel	8.5	21	5	<2
Fani Vogel	7.6	24	120	210
Fani Vogel	5.3	30	87	160
Mati	7.6	29	20	6
Fani Vogel	7.9	22	140	200
Fani Vogel	7.9	23	150	1 000
Fani	8.1	17	18	3
Mati	8.0	21	2	<2
Fani	7.9	21	35	31
Fani	7.7	21	140	170
Fani	7.9	19	52	50

Underlined figures show very high levels of pollution by Swedish Environmental Agency (It is for copper >45 µg/l and for Zinc > 300 µg/l).

High levels of pollution in accordance with Swedish Environmental Agency are for copper 9 - 45 µg/l and for Zinc 60 - 300 µg/l.

In the base of analyses and river flow measurements were calculated the quantities of copper and zinc transported every year from mine and plant waste by rivers to Adriatic Sea. The results in the base of analyses and measurements in September 1999 are shown in Tables 10and 11.

Table 10. Copper and zinc quantity from mines

Mine	Cu, Ton/year	Zn, Ton/year
Qaf Bari	16	6.4
Lak Roshi	0.03	0.03
Spac&Gurth	3.5	6.6
Total	20	13

Table 11. Copper and zinc quantity from rivers

River	Cu, Ton/year	Zn Ton/year
I zi	5.0	1.9
Fani Madh	0.47	<0.1
Fani Madh	3.2	0.95
Fani Vogel	6.0	6.0
Smea	0.3	0.09
Fani Vogel	20	-
Fani Madh	6.6	3.8
Fani Madh	97	118
Mati	53	80

It was remarked that pollution level has been decreasing during monitoring period of time. It could be explained by full production stopping of mines, plants and metallurgy after July 1999.

The highest copper concentration is in lower part of Mati River, close to the sea, while metal quantity transported in upper part of rivers has been decreasing during monitoring time. The last row of Table 11 shows measurement in Mati River, which have been the same during monitoring time. It means that, important quantities of metals are deposited in lower part of river in form of sediments and transported quantities are increased when river debit is increased.

Another main direction of monitoring was the evidence of leaching is coming from solid waste stockpiles and dams of copper mines, plants and metallurgy. The sampling program was concentrated in Repsi and Rubiku towns. Analyze results showed that Rubiku Metallurgy Zone is very polluted in copper and other heavy metals as Pb, Cr, Zn and As. Around production area copper content was 10 000 mg/kg for every sample, while in Repsi Plant it was between 280 and 3700 mg/kg (International figures for rehabilitation necessary of industrial zones are 190 – 600 mg/kg).

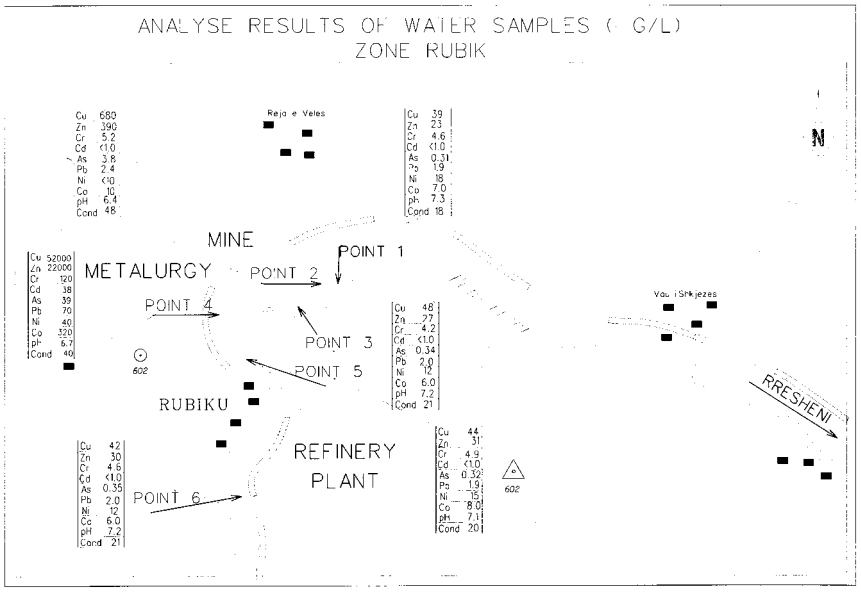

Figure 5. Water analyses in Rubiku zone.

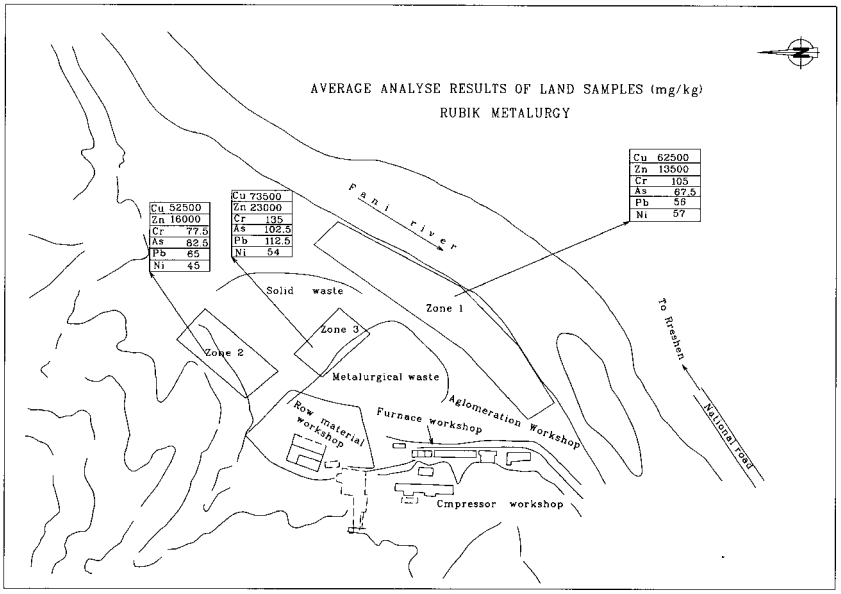

Figure 6. Sediment analyses in Rubiku zone.

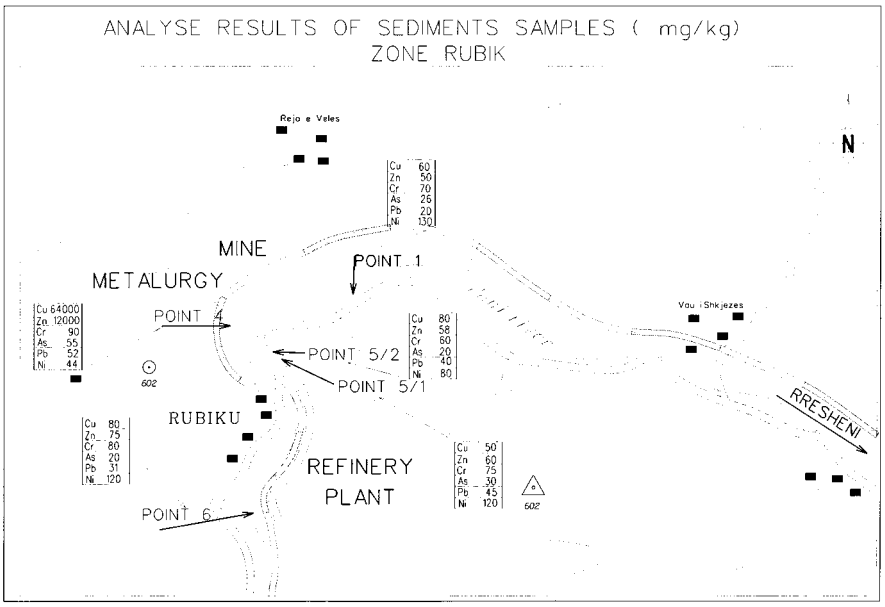

Figure 7. Land analyses in Rubiku zone.

The second project [Shushku, 2001] was carried out during 2001 year, two monitoring times July and December. In figures 5, 6 and 7 are represented sampling points and analyses for water, sediments and lands in Rubiku Zone.

The sampling stations are as follows:

Point 1 is in Fani River before pouring of Rubiku Mine
Stream in the river.
Point 2 is in Rubiku Mine Stream.
Point 3 is in Fani River after pouring of Rubiku Mine
Stream in the river.
Point 4 is in Rubiku Metallurgy Stream that flows
Through Metallurgy Zone.
Point 5 is in Fani River after pouring of Rubiku Metallurgy Stream in the river.
Point 5/1 is on the left side of Fani River after Rubiku
Metallurgy.
Point 5/2 is on the right side of Fani River after Rubiku Metallurgy.
Point 6 is in Fani River after Rubiku Refinery.
Sediments samples were taken in both river sides in those places where the sedimentation was visible.

It is a matter of fact that the highest activity in Rubiku town has been in Metallurgy, so its impact in environment is visible. For that reason inside the Metallurgy Zone were determined three contaminated areas, where were taken land samples, that were analyzed, as is shown in Figure 7.

Analyze results show that Rubiku Zone is very contaminated with copper and other heavy metals as Pb, Cr, Zn and As. Copper content in three studied zones is very high.

Now at the present situation, with mines, dressing plants and metallurgy no more working, a revitalization of the life is noticed in the rivers, while the vegetation on the dams are out of consideration.

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