

## CONSIDERATIONS CONCERNING THE RISK INDUCED BY THE FLOODS AND INUNDATIONS IN ROSIA MONTANA WATERSHED

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### Abstract

*The paper describes Rosia Montana basin space which may be affected by the floods in the existing antropic regime and the possibly of the accidentally. The implementation of the project to the exploitation of the gold fields in Rosia Montana with an area of 1254 hectares creates the problems related to environmental protection. The assessment of the drainage surface was separately realized on the two watershed affected by Rosia Montana Project, Rosia watershed and Corna watershed. The flood area is betraying and to analyze the impact in the situations mentioned. There are extended the observations on the inundations produced by failure of some works and determined the risk produced of them.*

*Between the measures of the preventions, allowance and fighting of the effects caused by the floods are analyzed and those related to monitoring of the water quantitative and qualitative from this region, as well as forecasting and warning system of meteorological and hydrological phenomena. There are the considerations on the risk maps with its extension for the accidental floods.*

*Finally have been proposed some extra structural and non structural measures for decreasing the negative effects on the environmental. Preventing, allowance and fighting of flooding are conceived by the structural measures: the storages (Cetate dam and the gathering pond of the water contaminated; the system of the settling pond; the deviation of water in Rosia catchments area) and nonstructural measures (the strategy of the flood risk management, the forecasting and warning system of the weather and hydrological phenomena; the flood risk map).*

Keywords: the settling pond, non-structural and structural measures, drainage surface, the gold field.

### 1. INTRODUCTION

The implementation of the project to the exploitation of the gold fields in Rosia Montana with an area of 1254 hectares creates the problems related to environmental protection. The technology for the extracting of the gold fields using the sodium cyanide (NaCN) and the reagents, determined the controversy in the world.

The waters have resulted from the extraction process has a high concentration of cyanide, and the environmental protection measures have an efficiency which raises many questions.

The paperwork analyzes the impact of the exploitation to the gold fields on the water resources in the zone.

### 2. THE SPACE HYDROGRAPHIC. THE ANTROPIC REGIME OF THE FLOODS

The studied area covers a surface of 24.4 km<sup>2</sup>, is part of the Abrudelului watershed, which discharges into the Aries River. The main tributaries of Abrudelului (Rosia valley and Corna valley) are situated on the right bank. The valleys are characterized by a rapid torrent of the surface water.

The streams are supply by the source from the slopes. Their flow is variable, dependent of the season, the amount and the periods of the precipitation.

The assessment of the drainage surface was separately realized on the two watershed affected by Rosia Montana Project, Rosia watershed (14.7 km<sup>2</sup>) and Corna watershed (9.7km<sup>2</sup>). In the small watersheds, such as Rosia and Corna that can be complete cover by the heavy rain, the flows of the streams present

the large variations directly related to the intensity and time of the rain. [Jurca I., 2009]

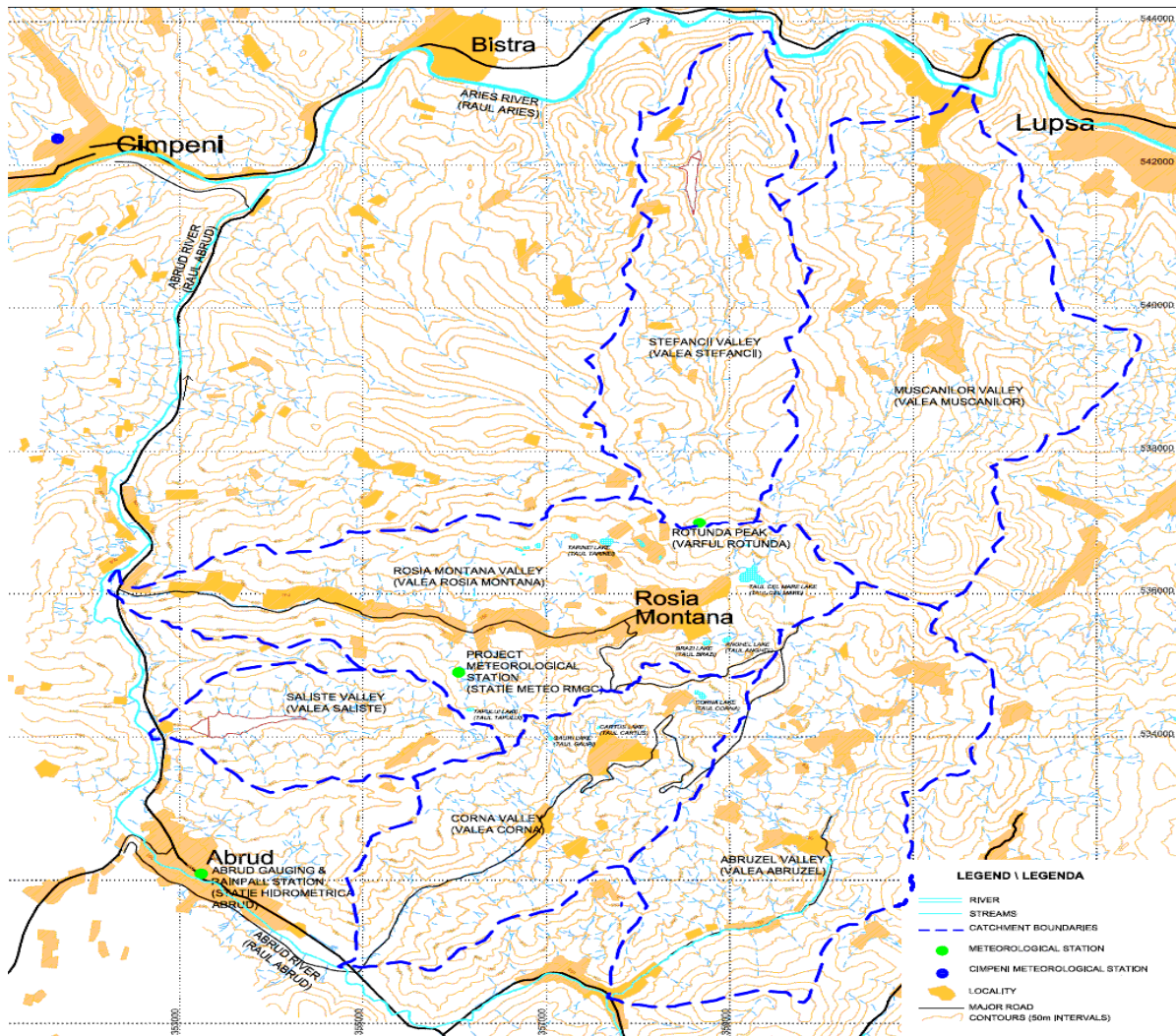


Fig. 1 - The hydrographic space of Rosia Montana

On the larger watersheds are found controlling the regulation of the runoff in the conditions which the rains are generalized in the whole watershed. The mains characterize of the streams and the watershed affected by Rosia Montana Project is representing in the table no.1.

The runoff coefficient [R. Drobot, 2004] varies in the micro-watershed between 35 -80 % conditioned of the watershed slope, the

coefficient of the watershed wooded, the soil texture, the index of previous rainfall, the frost level of the soil and the gravity of the impermeable artificial surface from the watershed.

Table1 – The watershed characteristics of Roşia and Corna Valley

i	The stream	Length (km)	The surface of watershed (km <sup>2</sup> )	The average slope (m/km)	The average altitude of the watershed (m)	Surface wooded (ha)
1	Rosia	8	14.7	68	892	210
2	Corna	5	9.7	38	833	236

The hydric regime of the stream is more balanced so using water is more efficient. The periods that the minimum runoff generally appears to can constitute in the risk phenomena that may affect the self-purification of the stream, in the conditions that the tributaries of the contaminated water will have the constant discharge.

The place studied to superposes on small catchments area (Roşia, Corna, Abruzel, Sălişte and Ştefanca) between that first two catchments area noted through the gravity area affected by project.

These small water courses are the right tributaries of Abrud River that flows in Aries River, immediately the downstream of Campeni town.

In the absence of some hydrometric stations, with longer registration period, to use to the extrapolation of the average monthly flows on the period of 37 years, based on the average daily flows at the Abrud hydrometric station located in close proximity, have been founded since 1965. After the values extrapolation arose an average multi-annual flow of 0.176 cubic meter / seconds for Rosia River and 0.067 cubic meter / seconds for Corna River.

As a result of the changes from the catchments of two water course, the average flows will follow to fall after 7 year of extrapolation to 0.086 cm/s for Rosia River and 0.038 Corna River.

April is the highest average runoff (0.337 cm/s for Rosia River and 0.126 cm/s for Corna River) and September is situated to the opposite side (0.088 cm/s, respectively 0.032 cm/s). The highest the average monthly flow was estimated for March of 1981 year (1.29 cm/s, respective

0.31 cm/s) and the lowest flow is for October 2000 year (0.016 cm/s, respective 0.004 cm/s).

Based on the limited dates series has resulted of the hydrometric measurements (Rosia and Corna automatic hydrometric stations that it have been working since 2001 April), the activity of interpretation and analyze of the runoff annual hydrograph not results the relevant results. There should be a period of least 20-30 years of measurements and the older dates may not extrapolate in optimal conditions, as well as for the average monthly flow, because in the continental temperate climates the spatial and temporal variability of the rainfall is very high and the answer of the micro-catchments area to the rain is more quickly than larger river basins, often leading to floods called “flash flood”.

Analyzing the hydrographs that represent the evaluation of multi-annual average daily flows (figure 3) (in the absence the dates regarding to the momentary flows) from 2001 April until to the end of 2000, it was found that:

- the maximum daily average flows recorded in 2004 spring, both on Rosia and Corna River (2.18 cm/s, respective of 1.64 cm/s )
- annual frequency of the these floods is high, registering an average three floods / year with the flows higher than 5 times the average flow and two floods / year with the flows higher than 10 times the average.
- most floods occur in summer, in the conditions of the heavy rains rich, that rapidly exceeding the infiltration capacity of the soil, and the spring, while some rich rainfall and the snow melts.

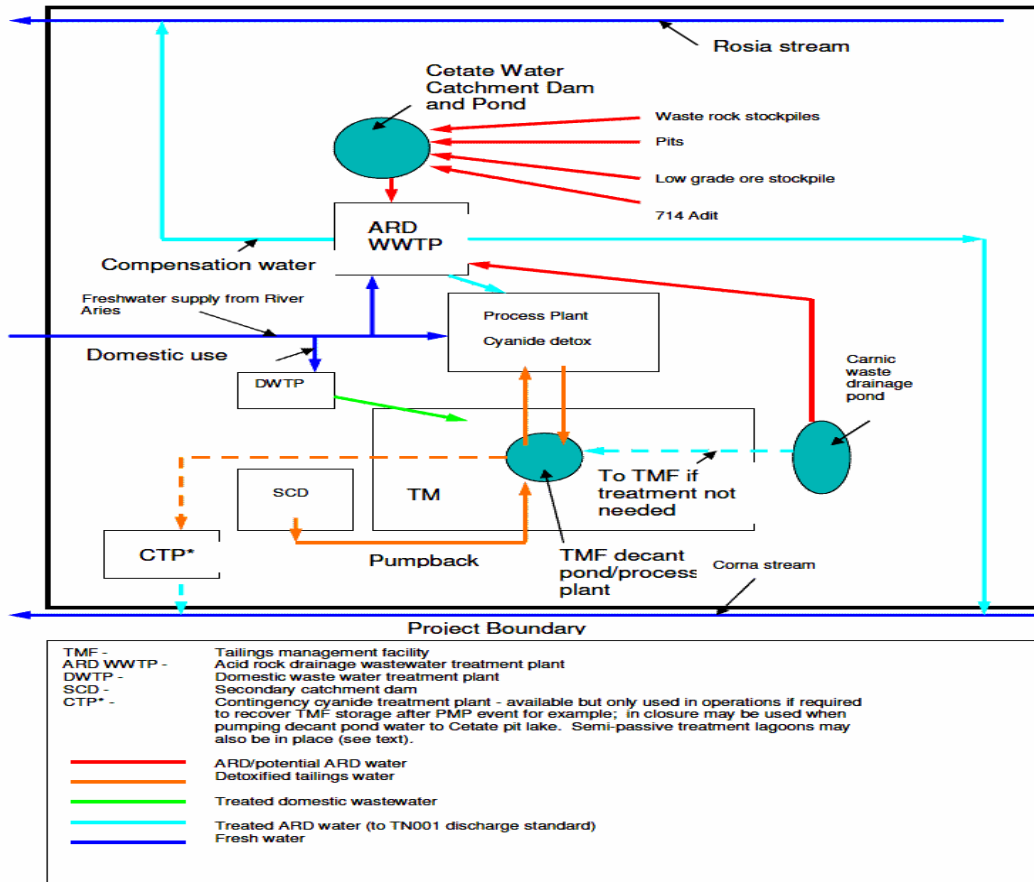


Fig. 2 – The water circuit of the area affected by the gold field project from Rosia Montana (after CRAIM)

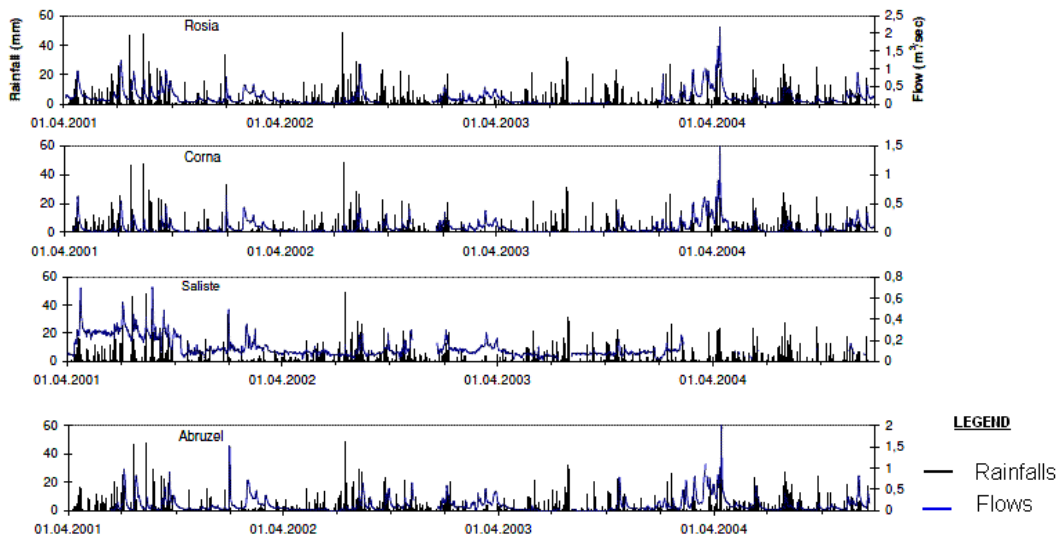


Fig. 3 – Daily rainfall and average daily flow (Jurca, 2009)

### 3. THE NATURAL AND ACCIDENTAL FLOODS POTENTIAL

Analyzing the dates on the floods and the damages produced by the floods and inundations during 1995-2004 at Rosia Montana and Abrud, are the following conclusions:

- in both cities the ten days average frequency of flooding is higher 6/10; analyzing the older dates (1978-2004) registered at Abrud station to found that wasn't floods of 1982 until 1995, so it could be seen rising on the frequency of flood in the region.

- the most significant damages resulted from the flood of December 1995 (the most serious that it affected the Abrud catchments area) – the damages estimated at 1,6 million \$ in Abrud city and 62,000 \$ in Rosia Montana village, following by those of June 1998 – 1,15 million \$ at Abrud, 1997 April – 50,000 \$ Rosia Montana and 2000 April – 29.000 \$ at Rosia Montana (<http://www.rmgc.ro>)

- the biggest damages has been produced the hydro technical works on Abrud river, in Abrud city (2,58 million \$).

- the damages caused the households amounted \$60,000

In the physical sector affected by project, the risk of flooding will be very lows because:

- the catchments area reduced for Rosia and Corna River in the affected area of exploitation, that will further reduce towards the end of the project.

- the development of some structures that will affect almost all reception basin of two water courses and that allow only very little measure the runoff of the water (quarries, sterile dumps, the settling pond)

- the natural slope of the land that it don't allow the stagnation and accumulation of the water in the area no affected by the works and the high slope of the stream that promote quick drainage of the water.

- the creation of the hydro technical structures of drainage (bypass channel) for the rainwater on the site

Moreover, the storages to be created in Corna and Rosia River will decrease the flooding risk in downstream of them through the control about a part of Abrud catchments area.



Fig. 4 – The flood on the Rosia valley

The runoff regime of Rosia and Corna streams will be strong influenced by the hydro technical projects proposed, the system of the construction with the settling pond at Corna and Cetatea dam (on Rosia river) primarily.

The design of Corna dam of the system with the settling pond was based on the criterion of the probable maximum flooding. In the case of Rosia Montana, the settling pond and Corna dam are oversized; the dam can keep in the pond twice the water volume from a probable maximum flooding.

### 4. THE PREVENTING, ALLOWANCE AND FIGHTING MEASURES OF FLOODING

Preventing, allowance and fighting of flooding are conceived by the structural measures: the storages (Cetate dam and the gathering pond of the water contaminated; the system of the settling pond; the deviation of water in Rosia catchments area) and nonstructural measures (the strategy of the flood risk management, the forecasting and warning system of the weather and hydrological phenomena; the flood risk map).

Downstream of two dams in the area affected by the project (Corna and Cetate dam), the floods resulted can easily exceed the low-flow-channel, flooding the lands and the limitrophe objectives until a level directly proportional with the breach size, the filing rate of their storages and the life period of the project. The propagation sceneries of the flood through the river bed of Corna and Rosia river and the receiver them, Abrud River (materialized in form as maps of the flood risk) (figure 5).

The potential forms of the physical impact on the aquatic environment, which may arise as

a result of the project implementation, are [Adrian Carabet, 2001]:

- the taping of the sediments and the material in suspension
- reducing the discharge of the surface water
- water catching

The potential forms of the chemical impact on the aquatic environment, which may arise as a result of the project implementation, are: cyanide, the products resulted from the treatment of the cyanide, the acid water of mine, the wastewater.

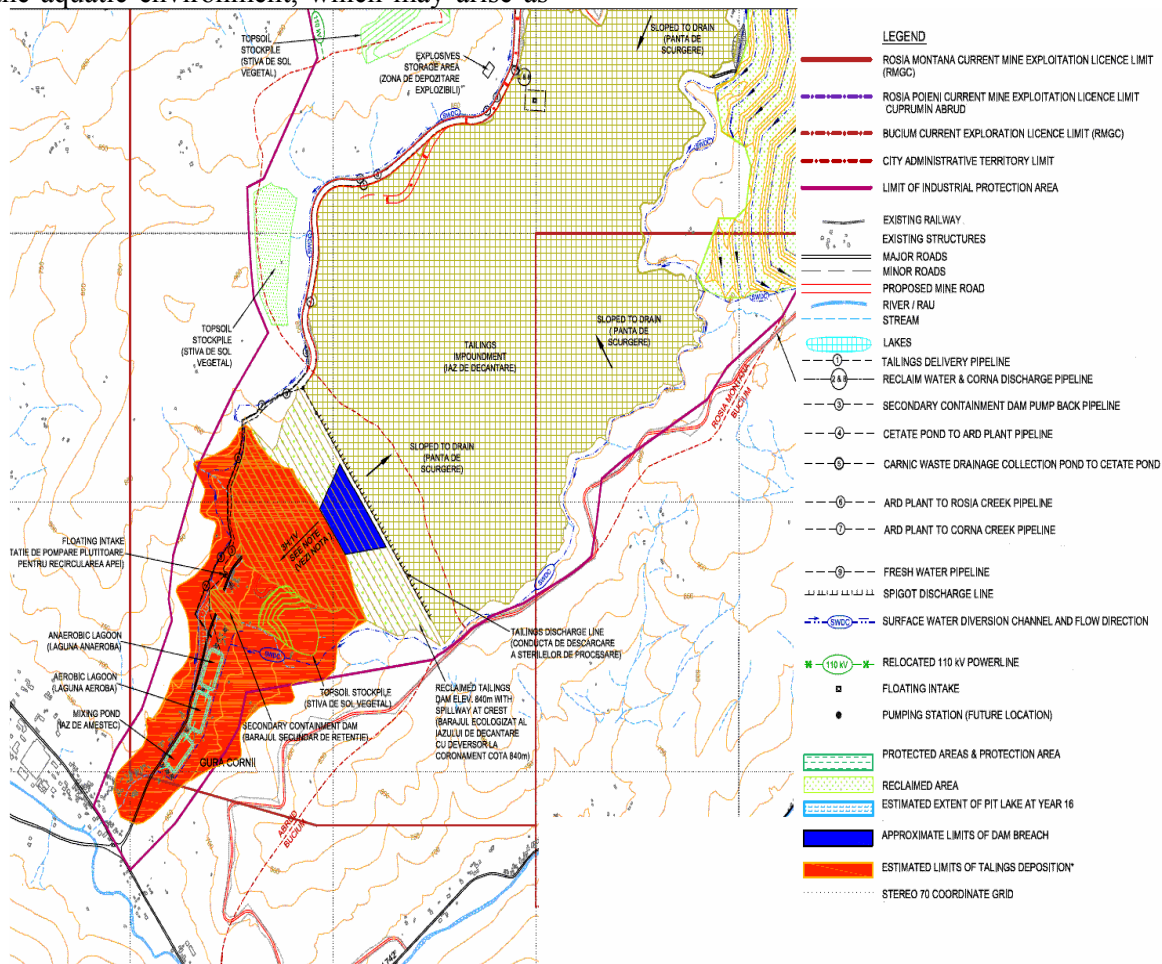


Fig. 5 – The areas estimated of the sterile deposition in case the dam failure (after CRAIM)

## 5. CONCLUSION

The analysis of the induced risk by the floods produced in hydrographic space of the project to the gold field extracting in Rosia Montana,

was realized to base on the hydrological and hydro geological studies from this area.

Because the water management works proposed to run in the area studied the risk to produce some floods is reduce.

Water quality resulting from extraction of gold has high concentrations of cyanide, in particular and in the absence of proofing measures of the settling pond mat foundation and uneven settlement produced of the sterile deposited in them can affect the quality of the groundwater.

The accidental discharges of the water from the settling ponds and then on those accumulated because of the secondary dam of retention can leading to the pollution of the surface water.

## 6. REFERENCE

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