FACTORS INFLUENCING THE DEGREE OF POLLUTION WITH CHROMIUM OF TÂRNAVA MICĂ RIVER IN TÂRNĂVENI CITY

RETI KINGA-OLGA[1], I. D. MANCIULA[1]

ABSTRACT. Chromium pollution of Târnava Mică River in Târnăveni city is possible due to several factors: the presence of three settlings basins inside the former industrial units S.C. Bicapa S.A. in the vicinity of the river, the degradation of the insulating layer inside the structure of the settling basins, over-capacity storage pits, the soil type existing in the examined area, the weather, the climate and the groundwater level. This study examines the direct and indirect relationships between these factors and their influence upon the river pollution. In order to obtain relevant results on the degree of pollution of Târnava River, detailed analysis of relevant factors since 2004 were made, after which time there was a decrease in chromium concentrations in Târnava Mică River. Following an analysis matrix we can conclude that there is a direct influence between the chromium concentration in Târnava Mică River, climatic conditions and the infiltration of waste disposal.

KEYWORDS: pollution, environmental factors, Târnava Mică River, settlings basins.

1. INTRODUCTION

The pollution has affected many cities in Romania, especially the forced industrialized cities during the communist period. Pollution has occurred due to uncontrolled or accidental discharges from industrial establishments, which had a maximum productivity until 1989. Thereafter began a rapid decline of the industry on a national scale, but not manifested by a significant reduction in pollution. Pollution has persisted over time, until now, mainly due to:

- surface storage of untreated industrial waste components that affect the quality of the environment through leakage and evaporation;
- lack of decommissioning of industrial units, which resulted in major changes for the landscape areas which are currently subject to landscape degradation.

Among the localities of this type is Târnăveni city, which is located in the central Târnava Plateau, on the riverside of Târnava Mică River, in a slight widening of its sector. The presence of methane gas near the village was the basic element in the emergence and development of local industries, especially the chemical industry. This industrial development has had repercussions on the quality of environmental components in the vicinity of industrial area, mainly on

[1] Babeş-Bolyai University, Faculty of Science and Environmental Engineering, Cluj-Napoca, 400294, Fântânele Street, No.30, Tel. 0264-307030, e-mail: retikinga@gmail.com

water quality in Târnava Mică River, due to several factors of influence which we take into account in our analysis: the distance to the river, degradation and overloaded capacity of the sludge storage areas, weather-climatic conditions, soil type and groundwater level.

2. STUDY AREA

In Târnăveni city, the main source of pollution with negative effects on the environment was represented by chemical factory, which in 1991 was organized in two industrial units: S.C. Bicapa S.A. and S.C. Carbid-Fox S.A. The unit is located in western city Târnăveni, having Târnava Mică River to the south, some residential neighborhoods to the north and north-west and some arable land to the east and west (figure 1).

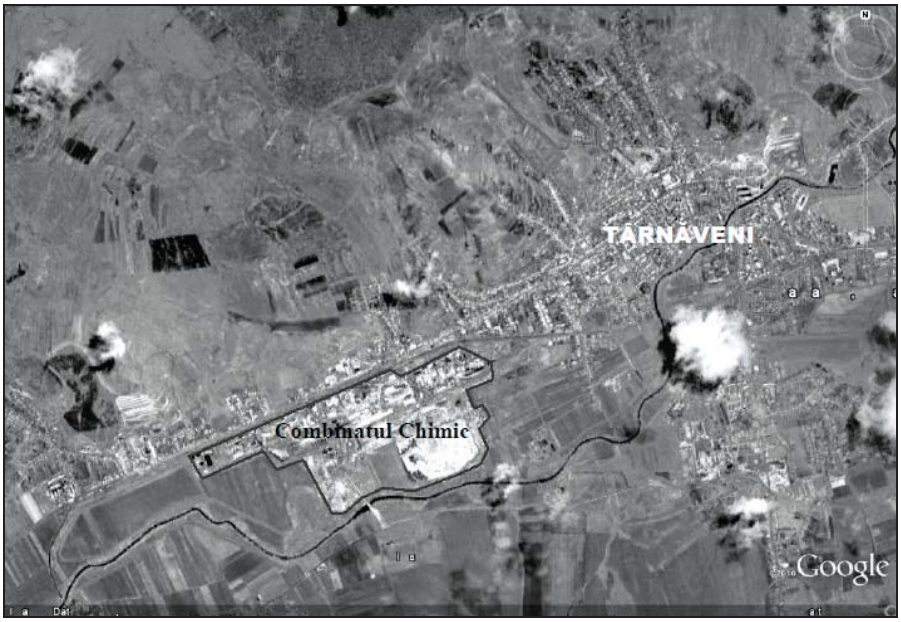

Figure 1. ***Location of the chemical plant in Târnăveni city***

The industrial unit started its activity in 1916 by producing explosives and war gases, and then manufactures carbide until 2007, when they stopped all production activities. Those two industrial units had the following profile of activities:

- S.C. Bicapa S.A. was specialized in manufacturing and marketing of inorganic compounds (sodium dichromate, potassium dichromate, chromic anhydride, barite, sulfur, sulfur compounds and oxides), pest control products, ceramic products, and machinery and spare parts components;
- SC Carbid-Fox S.A. has had as main objective the manufacturing and marketing of metal packaging products and several chemical substances (carbide, lime, formic acid, hydrofluoric acid and sodium sulfate).

Both industrial units were equipped with storage facilities for raw materials, finished products and by-products which in turn were organized into categories of substances in open air or semi-open platforms, warehouses, silos, reservoirs and waste landfills and settling basins. Three settling basins inside the industrial unit were used for decantation of the sewage sludge out of industrial waste waters, which comes from sodium dichromate and barite production units. They are arranged as follows:

- the settling basin (B1) began working in 1981 and it was used to store sludge from the industrial wastewater treatment plant;
- the second settling basin (B2) was put into service in 1972 and is currently exhausted;
- the third settling basin (B3) was put into service in 1974 and is now exhausted.

These settling basins are located on the right side of Târnava Mică River, at distances ranging between 15 and 35 m and bordered to the north and west by industrial area, in south by Târnava Mică River and to the east by agricultural land (figure 2).

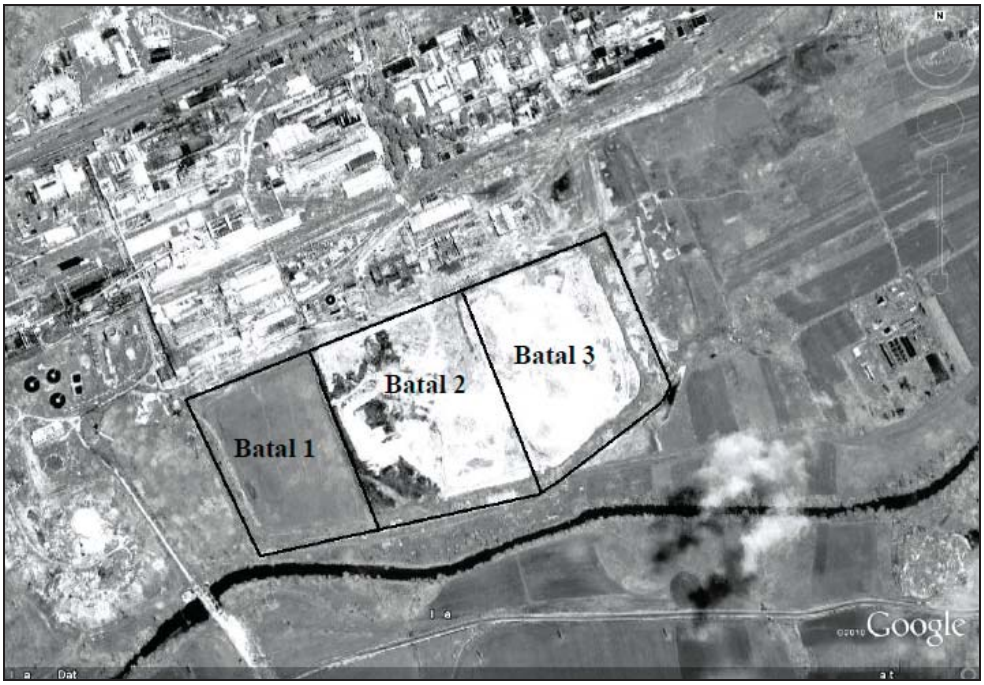

Figure 2. ***Positioning of the settling basins inside the industrial unit.***

Sludge characteristics are presented next in table 1:

Table 1. ***Structural characteristics of the settling basins***

Settling basin	**Year of construction/ elevation**	**Designed height** (m)	**Current height** (m)	**Storage capacity** (thousand m^3)	**Storage capacity reached** (thousand m^3)
B1	1981-1991	5,5	9,5	300	450
B2	1972-1978	6	10	455	750
B3	1974-1975	6	10	206	345

3. METHODS AND ANALYSIS

In our analysis we want to reflect by using an evaluation matrix, the negative effect of the settling basins from the industrial unit on the water quality of Târnava Mică River. Such an analysis should take into account several factors of influence, namely: local morphology, also hydro-geological, meteorological and climatic data, hydrological data and also structural characteristics of the settling basins.

Regarding the land morphology near the basins, this land is relatively flat with a slight tilt towards the Târnava Mică River. The land around the sludge is partially damaged due to seepage, waterproofing soils and basins leakage during periods of heavy precipitation (the leachate exceeds the upper B2 and B3 basins and drain on their slopes).

Lithology in the analyzed site has the following sequence:

- between 0 - 0.30 m: topsoil layer;
- between 0.30 to 3.8 m: layer composed of semipermeable sand clays and dusty sands, and also sandy clays and powders, with a coefficient of permeability k = 2.0 - 2.5 m/day;
- between 3.8 to 10.8 m: layer consists of large and medium sands mixed with fine sands, with an average coefficient of permeability k = 86-100 m/day. Within this layer, ground water can be easily found.
- below 10.8 m the parent rock is composed of shale clays.

Groundwater is affected by the Târnava Mică River, being a drain of the studied area. The general direction of groundwater flow is orientated towards south and the depth at which the groundwater was found is about 2.5 to 3.0 m.

The main course of the study area is the Târnava Mică River, with the following morphometric characteristics:

- minimum flow recorded from September to October Q = 1.3 m^3/s and Q = 1.65 m^3/s from December to January;
- maximum flow in spring, when snow melting overlaps the rainy periods, so the flow ranging between 80-300 m^3/s.

Among the weather-climatic conditions, must mention those who have a direct influence on the leakage of the settling basins and also upon the groundwater

level, namely monthly precipitation and temperatures. The dry period is from September to March and during April-August are recorded significant amounts of precipitation. These parameters were registered in 2004, when samples were taken from the settling basins.

Table 2. ***Precipitation and the temperatures recorded in Târnăveni city in 2004.***

Months	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
Quantity ml/m^2	29	23,5	29	44	32	67,8	37	56	61	35	33	35
Temp ^{o}C	-4	-0,8	+4,65	+10,3	+15,3	+18,1	+19	+18,5	+15,6	+10	+4,4	-2

Concentrations of hexavalent chromium from the settling basins were determined by groundwater sampling in January, April, August and November, from wells drilled at 850 m downstream of the first basin (B1), next to the second basin (B2) and upstream, at 150 m of both basins (data provided by the industrial unit). Data on concentrations of chromium in Târnava Mică River were provided by the National Company "Romanian Waters", Water Basin Administration Mureş. Hexavalent chromium concentration in the first basin (B1) during the operational phase has recorded a maximum value of 1360mg/l, whiles for the other two basins (B2 and B3) the pollutant concentration of 5.8mg/l, comes after washing the pollutant by rain water.

Table 3. ***Cr^{6+} concentrations inside the sludge and Târnava Mică River.***

	Period I		**Period II**	
	November	**January**	**April**	**August**
Downstream Basin B1 (at 850 m)	0,25 mg/l	0,23 mg/l	0,35 mg/l	0,41 mg/l
Right of Basin B2	0,99 mg/l	0,87 mg/l	1,33 mg/l	1,68 mg/l
Upstream basin B3 (at 150 m)	0 mg/l	0 mg/l	0 mg/l	0 mg/l
Basin B1 downstream Târnava Mică River	0,24 mg/l	0,21 mg/l	0,32mg/l	0,40 mg/l
Legislation: NTPA 001/2002	**0,1 mg/l**			

In terms of shielding the settling basins, this is made of gel-concrete with a hydraulic conductivity k = 1.72 x 10-4 m/day, property which shows a very low conductivity and permeability. Infiltrations from settling basins occur due to leakage over the protection dam during periods of high quantitative precipitation.

To determine the impact of leachate on water quality of Târnava Mică River and by taking into account the influence factors mentioned above, we used the matrix method of impact strength to determine the influences of the factors analyzed and the intensity of impact, along these lines:

• - low negative impact
•• - large negative impact
0 - no impact
+ - low positive impact
++ - significant positive impact

Table 4. ***Impact assessment matrix on water quality in Târnava Mică River***

INFLUENCES	IMPACT ON TÂRNAVA MICĂ RIVER
Site morphology	•
Lithology of the area	•
Rain water	••
Temperature	0
Groundwater level	••
River distance from settling basins	••
Cr^{6+} in sludge	••
Cr^{6+} concentrations in wells	••
Basins layer protection	+
Storage capacity of the settling basins	••

4. CONCLUSIONS

The matrix analysis shows that between water quality of Târnava Mică River and the quantity of precipitation, the groundwater level, the excess sludge storage capacity and concentrations of hexavalent chromium from basins and wells, is a direct influence and the negative impact of these factors is significant. Large amounts of precipitation recorded, especially in the rainy period (II), lead to high concentrations of chromium in both wells and river water, due to seepage, basins leakage and infiltrations into groundwater, which is directly related to Târnava Mică River. The proximity of the river, allow the pollutant to reach the river water in a short period of time, affecting its quality. It has been noted that in both seasons (rainy and dry), the concentrations of chromium exceeded the maximum permissible concentration in groundwater and Târnava Mică River, which reflects the fact that there are permanent leachate infiltration into the groundwater, due to a sludge storage capacity exceeded. The sludge influence on the water quality of Târnava Mică River is underlined by the fact that upstream of settlings basins no concentrations of chromium were recorded into the

groundwater. All tests were performed in 2004, when the wells were made, year after which sampling has stopped.

To reduce the negative effects exerted by the settling basins on the water quality of the Târnava Mică River, leachate must be neutralized and wastes must be transported in specially designed landfills.

REFERENCES

1. HORHOI E**.** 2001, *Calitatea mediului înconjurător în culoarul Târnavei Mari. Studiu geoecologic*. Editura Logos'94. Oradea
2. MAC I. (2003), *Ştiinţa mediului*. Ed. Europontic. Cluj-Napoca
3. MUNTEAN O. L., BACIU N., CORPADE C. (2005), *Strategii de dezvoltare durabilă pentru mediul urban*. Environment & Progress. 2005/4. Cluj-Napoca, p. 253-256
4. MUNTEAN O. L. **(**2003), *Impactul antropic asupra componentelor environmentale în culoarul Târnavei Mari (sectorul Vânători – Micăsasa).* Teză de doctorat. Cluj-Napoca
5. RETI KINGA OLGA (2009) Diferenţierea sistemului environmental în structuri urbane cu stări critice în bazinul Târnavei, Teză de doctorat
6. SOROCOVSCHI V. (1996), *Podişul Târnavelor. Studiu hidrologic*. Ed. CETIB. Cluj-Napoca.
7. *** Bilanţ de mediu nivel II,
8. *** PLANUL LOCAL DE ACŢIUNE PENTRU MEDIU MUREŞ (2004), Agenţia pentru protecţia mediului Mureş
9. *** RAPORT PRIVIND STAREA MEDIULUI PE ANUL 2004 ÎN JUDEŢUL MUREŞ (2004), Agenţia pentru protecţia mediului Mureş
10. *** RAPORT PRIVIND STAREA MEDIULUI PE ANUL 2005 ÎN JUDEŢUL MUREŞ (2005), Agenţia pentru protecţia mediului Mureş
11. *** RAPORT ANUAL PRIVIND CARACTERIZAREA CALITĂŢII APEI ÎN PERIOADA IANUARIE-DECEMBRIE, ANUL 2004, Compania Naţională “Apele Române” Administraţia Bazinală de Apă Mureş