Water Chemism Within the Settling Pond of Valea Straja and the Quality of the Suha Water Body (Eastern Carpathians)

GHEORGHE ROMANESCU[1], ALINA TIRNOVAN[1,2], ION SANDU[3]*, GIANINA MARIA COJOC[1,2], IULIANA GABRIELA BREABAN[1], ALIN MIHU-PINTILIE[1]

[1]Alexandru Ioan Cuza University of Iasi, Faculty of Geography and Geology, Department of Geography, 20A Carol I 20A Blvd., 700505, Iasi, Romania

[2]Siret Water Basin Administration, Bacau, 1 Cuza Voda Str., 600274, Bacau, Romania

[3]Alexandru Ioan Cuza University of Iasi, ARHEOINVEST – Interdisciplinary Platform, Laboratory of Scientific Investigation & Conservation, 22 Carol I, Blv., Corp G, 700506, Iasi, Romania

The settling pond of Valea Straja is part of the Lesu Ursului-U.P Tarnita mining complex for copper and barite exploitation. It functioned as settling pond for tailings and mechanical treatment in the period 1989-2006. The settling pond comprises many polluting elements: xanates, AGF 250, copper sulphate, lime, sodium cyanide, sodium hypochlorite, chlorinated lime, sodium silicate, active charcoal, sodium sulphate, etc. The amount of precipitations has increased in the past years; in this sense, it is worth underscoring the heavy rains usually recorded during the warm period of the year. Huge discharges may lead to dam breaking or to the overflowing of polluted water. The maximum value of precipitations and the maximum equivalent discharge that can be taken over by spillway pipes are calculated. Pollutant elements risk getting into the hydrographical network downstream (affecting almost the entire Suha catchment), which supplies the riparian localities. Currently, almost all the physico-chemical parameters of the Suha River water – in the Ostra section, downstream from the settling pond – classify it as class II quality.

Keywords: catchment, major risk, pollution, mining exploitation, settling pond

Non-ferrous ores in the north of Eastern Carpathians are rich, and they have been exploited for a long time. Lately, most mining exploitations have been closed, because they used outdated equipments and they were not productive. Mining complexes were supposed to be included within a monitored technological closing program. In this case, the tailings ponds went through ecologization processes. Because the goals failed to be attended in time, constructive elements and machines began to suffer damages. Most abandoned mines and tailings settling ponds are imminent pollution hotbeds.

The national and international literature is extremely rich on issues related to pollution risk: status of settling ponds, conservation degree of abandoned mines, river runoff in mining areas, quality of surface water and groundwater, etc [1-23]. Most studies concern the active or abandoned mining areas in countries with a long tradition in the field: Poland, Czech Republic, UK, France, Romania, etc.

Most of the times, small-sized catchments (that do not benefit from permanent risk monitoring) are studied on very rare occasions [24-34]. This category also includes the Suha catchment. The studies that analyzed the runoff processes were only interested in the main hydrographical arteries [35]. Getting to know the particularities of the Suha catchment is highly important for the identification of measures specific to preventing risk situations.

The central-southern area of the Suha catchment is influenced by the mining exploitations within the Lesu Ursului- U.P. Tarnita complex. The surface of the mining complex is 711,858 m^2, of which: 240,836 m^2 are ascribed to the Lesu Ursului exploitation (Lesu Ursului precinct, Isipoaia precinct, Pârâul Ursului precinct, Well 7, waste dumps, roads, pumping stations); 417,022 m^2 for the Tarnita factory (barite flotation, non-ferrous flotation, damage pond, pump stations, settling pond of Valea Straja).

The exploitation and processing of ores produced the following: mine waters (63 l/s) in the pumping station basin, which were mixed with waste and hydraulically transported to the settling pond; graywaters and pluvial waters in the precincts, which ended up (by gravity) in the wastewater treatment plant downstream from U.P. Tarnia. Afterwards, they were evacuated gravitationally in the Brăteasa creek; surface waters from the settling pond of Valea Straja, which were evacuated in the Straja creek, downstream from the pond, with the help of inverse probes.

The processing of non-ferrous ores within the factory left behind flotation waste, which was sent toward the pumping station. After mixing the waste with water, it was hydraulically pumped toward the settling pond. The technological instalment was designed to process 3,500 t waste daily. The technology used within the preparation section comprised the following: partial flotation of copper and zinc (resulting in the Cu+Zn concentrate) and total flotation of copper, zinc and lead, along with the separation of the Cu+Zn concentrate from pyrite and waste. We present below the outcome of the technological process:

-a copper concentrate with the following content: 15.49 % Cu, 1.56 % Pb, 3.53 % Zn;

-a collective concentrate with the following content: 5.65 % Cu, 1.79 % Pb, 46.17 % Zn;

-tailings deposited in the settling pond.

The mining activity within the Suha catchment began in 1950 and ended in 2006. It generated major risks upon the environment. The area is still in conservation, but it does represent an important source of regional pollution. The central polluting element is constituted by the settling pond of Valea Straja. The extraction and processing of non-ferrous copper and barite imposed the use of highly polluting reactive substances, still found in the tailings deposits. The

* email: ion.sandu@uaic.ro or sandu_i03@yahoo.com

settling pond of Valea Straja is part of the Lesu Ursului-U.P. Tarnita mining perimeter, where the mining activity of non-ferrous ore extraction and processing was conducted at the surface of mining precincts: Tarnita (at the mouth of the Alunis tunnel, 840 m high, on the Brăteasa River); Pârâul Ursului (on the river with the same name, at the mouth of the Alunis tunnel, on the opposite side of the Tarnita precinct, 875 m high); Isipoaia (on the creek with the same name, 732 m high). The Tarnia factory – situated in the commune of Ostra – comprised the following: non-ferrous ores factory, barite preparation factory, thermal power plant, water catchment from the Brăteasa creek, pumping station of the waste toward the pond, the settling pond of Valea Straja, etc.

Study area

The settling pond of Valea Straja is situated in the Suha catchment, at the intersection between the meridian of longitude 25°43'30'' east and the parallel of latitude 47°21'15'' north, on the Straja creek (Obcioara), right side tributary of the Brăteasa River. The catchment of the Straja River is situated in the Suha Mountains, in a transition zone from the crystalline-Mesozoic unit to the flysch unit [21, 22]. The landform is represented by average-height mountains, which decrease in height from the spring toward the confluence with the Brateasa River. The main mountaintops in the area are the following: Ostra Mountains (1,381 m), Ostra Mică Peak (1,324 m), Gugiumanului Peak (1,384 m), Capu Muntelui Peak (1,164 m) (fig. 1).

The settling pond of Valea Straja is part of the Lesu Ursului-U.P. Tarnita mining complex and it was built for depositing the tailings resulted from the technological process and for the mechanical treatment of wastewater resulted from depositing the tailings and mine waters. The settling pond of Valea Straja is included in the category of valley settling ponds with dam in the back (it blocks a valley using two dams: one downstream from the settling pond, with foundation consolidated with coarse local material and the rest made of tailings; the second dam is made of local material and it helps diverting the stream and orienting the water from precipitations toward the lack situated at the end of the pond). The settling pond of Valea Straja contains the following: the 24 m-high dam downstream from the settling pond, with a priming role; the dam upstream from the pond; the support dam upstream from the priming dam, which delimits the lack at the end of the pond; the diverting dam (in the back), which changes the direction of the Straja stream; the reservoir, situated at the end of the settling pond; the dam that deviated the Valea Straja stream (fig. 2).

From a morphometric perspective, the settling pond of Valea Straja features the following characteristics: the pond surface at the level of the priming dam is 4.5 ha, and at the level of the tailings dam cornice – 6.45 ha; the elevation of the priming ground base is 854 mdM; the elevation of the priming dam cornice is 876.5 mdM; the elevation of the tailings dam cornice is 891 mdM; the beach elevation is 887.5 mdM; instalments were able to process 3,500 t/year. The settling pond of Valea Straja was inaugurated in 1989; in 2006, the conservation period began. It represents the final point of the technological ore preparation; its role is to store huge amounts of tailings and to treat mechanically the water used for the hydraulic transportation of tailings from the factory to the pond.

From the perspective or risk assessment, the settling pond of Valea Straja is classified as second rank pond, as it may produce serious damage and important destructions from a social, ecologic and economic standpoint. The risks entailed by the settling pond of Valea Straja are related, first, to the pollution of water, soil and air, because the extraction and processing of ores required the use of highly polluting reactive substances: xanates, AGF 250, copper sulphate, lime, sodium cyanide, sodium hypochlorite, chlorinated lime, sodium silicate, active charcoal, sodium sulphate, Polofin, etc, all partially found in the tailings of the settling pond of Valea Straja.

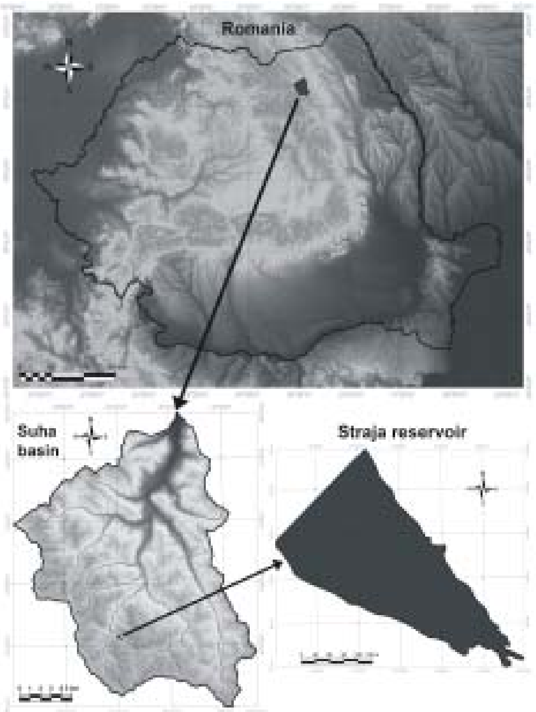

Fig. 1 Geographic position of the settling pond of Valea Straja on the Romanian territory

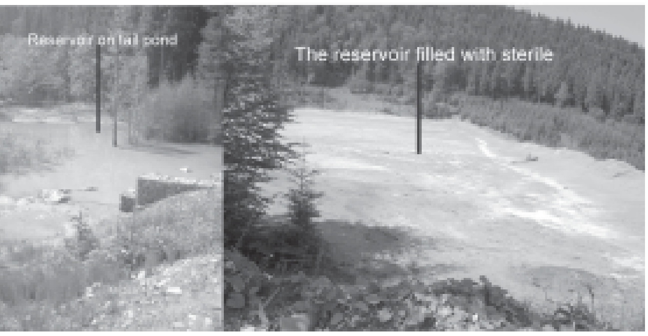

Fig. 2 Accumulation of water and tailings in the settling pond of Valea Straja

Experimental part

The field measurements used the LEICA GPS 1200, comprised of a reference station and rover. The GPS was chosen over the Leica TCR1201 Total Station for greater efficiency and to determine as many points as possible. Measurements were taken during July 2013. To begin the measurements, a field trip was organized to the ANCPI Suceava (National Agency for Cadastre and Land Registration Suceava) in order to obtain at least three ground control points. Three sets of coordinates were necessary to decrease errors as much as possible. Measurements were conducted in the Stereographic Projection 1970, or STEREO 70, which is the official cartographic projection of Romania, replacing the GausseKrüger cartographic projection following Decree No. 305 of September 1971. Morphometric measurements concerned the length of spillways exiting the lake situated

Sample	pH (units)	Suspensions mg/dm^3	Fixed residual mg/dm^3	Sulphates mg/dm^3	Cu mg/dm^3	Pb mg/dm^3	Zn mg/dm^3	Fe mg/dm^3	Mn mg/dm^3	Cd mg/dm^3
Input water from the pond in inverse probe	7.67	28	412	198.75	0.122	0.043	1.09	0.4	0.401	0.006
Upstream of the pond water quality	7.62	4	288	40.74	0.065	0.024	0.107	0.3	0.011	0.002
Output water from the pond in inverse probe	7.1	112	1452	728.35	0.011	0.023	0.697	0.6	7.35	0.004
Water quality at Ostra	8.16	11.3	314.4	28.68	13.53	1.46	5.88	0.095	0.003	0.055

Table 1
WATER QUALITY WITHIN THE SETTLING POND OF VALEA STRAJA

at the end of the pond, the diameter of spillways, the length, width and depth of torrents situated on both sides of the settling pond, the dam, etc. Elements such as the inverse probes, the under-crossing gallery, etc, were identified and located.

In two points before and after de Dam Lake have been collected samples of water (November 2014) and sediment in suspension in pre-conditioned bottles with 5% nitric acid and later rinsed thoroughly with distilled de-ionized water. Samples were acidified with 10% HNO_3, filtered through a 0.45 μm micropore membrane filter and kept at 4°C until analysis. Representative aqueous samples are extracted with concentrated nitric acid in laboratory microwave unit MARS 6, according to the EPA method 3015A. Determination of the elements in all samples was carried out by ICP–MS (Agilent 7700x). The accuracy of analytical procedure was checked by analyzing the standard reference materials METRANAL 1 – river sediment, recovery rates ranged from 61 to 96% for all investigated elements. Water samples were analyzed in the A.B.A.S. Siret lab in Bacău.

For Suha River the samples were taken monthly or quarterly (seasonally), throughout the year 2014. Samples were taken from the settling pond and the Ostra section (downstream from the pond) on the Suha River. A.B.A.S. Siret database provided the records on the precipitations fallen in the Suha catchment and in the surrounding localities. In this context, we also analyzed the relationships between the amounts of precipitations and the water discharge in the lake.

Results and discussions

The quality of water within the Suha catchment is good. It is prone to decrease, because the waters of the settling pond of Valea Straja exceed the dam and they end up in effluent streams. The qualitative parameters of waters within the Brăteasa creek – in the Ostra section – are classified as class II, III and IV quality. The waters and tailings within the settling pond may have an immediate effect on the quality of Straja, Brăteasa, Suha and Moldov rivers. Water samplings taken from the surface of the settling pond underlined the necessity of ecologizing the body of water. The following elements were analyzed and interpreted: input water in inverse probe; output water in inverse probe, which takes over the surface water of the lake; waters of the Straja creek, located upstream from the settling pond (table 1).

Results of analyses show that, from a qualitative perspective, the water samples from the Straja creek, upstream from the settling pond (S.2), range within normal chemical parameters. In this case, the concentrations of sulphates, residuals, Cu, Pb, Fe, Mn, Cd do not exceed the limits imposed by STAS [Romanian State Standards]. The output water in the inverse probe includes Zn ions that exceed legal limits by 39%; Mn ions exceed the legal limit 7.35 times; sulphates exceed it by 21%, while fixed residual exceeds accepted limits by 100%. The input water in the inverse probe includes Cu ions and Zn ions that exceed the legal limits by 22% and 118%. The values recorded downstream (S.1) are almost identical to those recorded upstream (S.2) (fig. 3).

The Suha water body was assessed through the Ostra section (downstream from the settling pond), which has RO01 typology and is situated 996 m high. The substrate of the sampling area comprises stones and gravels, the stream is wavy, and the average width of the riverbed is 3 m (slope of 30%). The water body assessment – based on physical-chemical elements – showed a good status of the water body: in almost all parameters, it is classified as class II quality. It ranks in class III quality only concerning dissolved oxygen, chlorides, sulphates, calcium and magnesium (table 2).

The accidental discharge of waters from the settling pond may have a negative impact on the ecosystems within the Suha catchment. Polluted water may lead to an increasing amount of matters in suspension and to increased soluble salts. Heavy metals released in the water represent a real hazard of organism contamination.

The vulnerable points of the settling pond are the following: the grids of inverse probes; the under-crossing gallery that takes over the precipitation water through inverse probes; the rings and spillways that direct the water running off from slopes to the back of the settling pond are filed with alluvia and floating matters (in fact, water is taken over by the same under-crossing gallery); the potential breaking of the dam located downstream from the settling pond, already severely fissured (fig. 4).

In 2008, following heavy rains fallen in July, important amounts of alluvia and floating matters from the slopes clogged the spillways of the lake located at the end of the pond (table 3). The guards and competent bodies intervened immediately and managed to unsilt the grids, thus avoiding a catastrophe. History repeated itself in 2013.

Because the settling pond presents a major risk, considering its vulnerability, this paper proposes to calculate the maximum amount of water taken over by spillway rings and the maximum amount of precipitations that could determine a catastrophic situation. To attain these goals, the statistical values of precipitations were determined, correlated with runoff coefficients and with water discharges (table 4). A rain with 1% insurance results in 125 mm/h, and a 0.60 runoff coefficient; 2% insurance leads to an average of 98.8 mm/h, and a 0.55 runoff coefficient. A 5% insurance results in a value of 67.55 mm/h, and a 0.50 runoff coefficient. 10% insurance leads to an average of 46.2 mm/h, and a 0.45 runoff coefficient.

After pinpointing the statistical values of precipitations, the volume of precipitations by catchment surface of the basin was calculated. Findings show the following: 1% insurance corresponds to a precipitation volume of 517,500

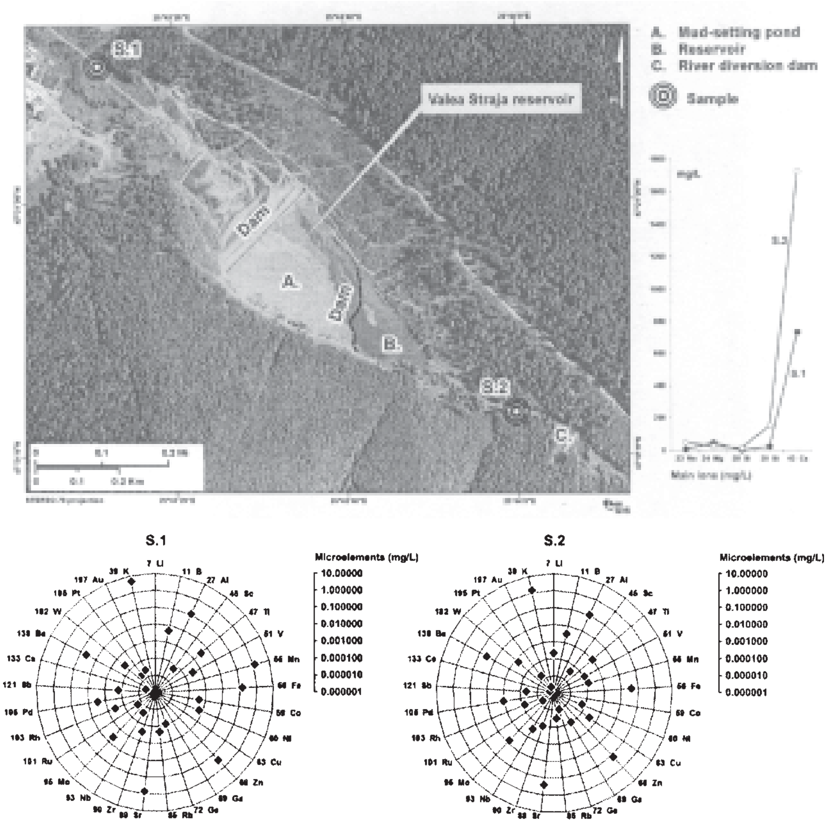

Fig. 3 The chemical parameters of water upstream and downstream from the Valea Straja reservoir

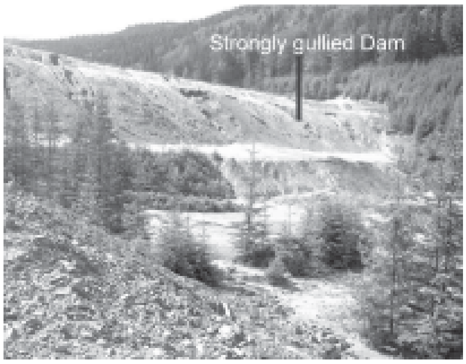

Fig. 4 Significantly gullied dam located downstream from the settling pond of Valea Straja

m^3; 2% insurance corresponds to a precipitation volume of 409,032 m^3; 5% insurance corresponds to a precipitation volume of 279,450 m^3; 10% insurance corresponds to a precipitation volume of 191,268 m^3. The runoff volumes record the following values: a discharge with 1% insurance leads to runoff volume of 309,420 m^3; 2% insurance leads to runoff volume of 244,530 m^3; 5% insurance leads to runoff volume of 139,25 m^3; finally, 10% insurance leads to runoff volume of 86,071 m^3 (table 5).

For determining the discharges by various insurances, we set a three-hour period as average for high water raise, 12 hours for total high water period and a 0.26 coefficient of high water form. The mathematical calculations resulted in the following values: for 1% insurance – maximum discharge of 27.5 m^3/s; for 2% insurance – maximum discharge of 20.0 m^3/s; for 5% insurance – maximum calculated discharge of 12.4 m^3/s; while for 10% insurance – maximum discharge of 7.66 m^3/s. After determining these values, possible Q max to evacuate through the three spillway tubes (800 mm in diameter) within the deviation dam was calculated (fig. 5).

For calculating maximum evacuated discharge, the following parameters were taken into account: from the dam cornice to the gabion, the distance was 1 m; from the gabion to the spillway tubes – 1 m; from the upper base of the spillway rings to the lower base of the spillway ring – 2 m. The determination of maximum possible amounts to be taken over in the case of spillway rings without clogging was based on the formula of orifices with nozzles [36, 37]: $\mu\Omega\sqrt{(2gH)}$,where: μ = velocity coefficient – 0.82; Ω = surface of the orifice: $\frac{\pi}{4} * 0.40^2 = 0.502\ m^2$ 2g = gravitational acceleration; H = height of the water column from the orifice axis.

The following calculations were performed:

a) Q m^3/s 1 tube from the base to the gabion, where:
$$= 0.82 * 0.502\sqrt{(2 * 9.81 * 2.60)} = 2.94\ m^3/s;$$

b) Qm^3/s 1 tube from the base to the cornice, where:
$$= 0.82 * 0.502\sqrt{(2 * 9.81 * 3.60)} = 3.46\ m^3/s;$$

c) Qm^3/s 1 tube from the top to the gabion, where:
$$= 0.82 * 0.502\sqrt{(2 * 9.81 * 1.40)} = 2.15\ m^3/s;$$

d) Qm^3/s 1 tube from the top to the cornice, where:
$$= 0.82 * 0.502\sqrt{(2 * 9.81 * 2.40)} = 2.82\ m^3/s.$$

If water level reaches the gabion, the evacuated discharge is 7.30 m^3/s; if it reaches the cornice of the dam, the discharge increases to 9.20 m^3/s. The hydraulic calculation proves that tubes can take over only up to 9.81 m^3/s. Discharges exceeding this value cannot be evacuated through the spillways, case in which the water would exceed the cornice of the dam (fig. 6). The friable material of the dam would be eroded soon, and water filled with pollutants would penetrate river streams. In order to pinpoint the risks, it is necessary to make a correlation between recorded discharges and amount of precipitations [33].

The dam of the settling pond is highly prone to breaking because floods are frequent in the Suha catchment; their intensity has increased significantly in the past few years. The risk is high because natural conditions are favourable to floods: extended surface of the hydrographical basin upstream from the settling pond; existence of seven torrents on the right side of the settling pond; slopes with big inclination (20-45°); weak forestation; the texture of the soil, full of diluvium, hence with low storage capacity; very deep gullying of the settling pond dam, which makes the pond highly prone to clogging, etc.

Parameter	Ostra Section				Quality class
	01.10.2014	16.07.2014	14.05.2014	22.01.2014	
Air temperature (^{0}C)	11.5	24.0	10.0	-5.00	-
Water temperature (^{0}C)	10.00	17.0	7.50	0.00	-
pH	8.25	7.72	8.20	8.36	-
Alkalinity (mol/L)	3.00	4.00	3.70	3.20	2
Dissolved oxygen (mgO_2/L)	9.40	8.24	9.77	11.5	3
Dissolved oxygen (%)	83.3	85.3	81.5	78.5	2
CBO5 (mgO_2/L)	1.01	1.20	1.41	1.61	2
CCO-Cr (mgO_2/L)	5.00	5.00	5.00	5.00	2
Total cadmium (µg/L)	0.08	0.08	0.08	0.08	2
Fixed residual (mg/L)	302	264	270	378	2
Conductivity (µS/cm)	447	400	387	592	2
Total mercury (µg/L)	0.06	0.05	0.05	0.04	2
Chlorides (mg/L)	9.90	10.0	13.83	31.7	3
Sulphates (mg/L)	28.1	17.7	23.6	30.6	3
Calcium (mg/L)	24.1	54.5	68.1	66.5	3
Magnesium (mg/L)	5.84	21.4	14.1	29.7	3
Bicarbonates (mg/L)	183	244	226	195	2
Total hardness (mg/L $CaCO_3$)	84.0	224	228	288	2
Total nickel (µgL)	11.9	6.40	5.32	11.4	2
Total lead (µg/L)	6.51	4.69	8.23	9.39	2
Dissolved Cu (µg/L)	2.49	3.62	3.66	2.65	2
Total Cu (µg/L)	4.60	5.11	4.03	4.90	2
Total Zn (µg/L)	25.0	25.0	25.0	25.0	2
Total Cr (Cr^{3+}+ Cr^{6+}) (µg/L)	0.50	2.59	3.99	0.50	2
Dissolved As (µg/L)	0.65	0.31	0.64	0.22	2
Dissolved Barium (µg/L)	96.1	178	169	211	2
Dissolved Boron (µg/L)	8.30	0.75	0.75	0.75	2
Dissolved Selenium (µg/L)	0.50	0.53	0.53	0.53	2
Hexachlorobutadiene (µg/L)	0.10	0.13	0.13	0.13	3
1,2- Dichloroethane (µg/L)	1.80	1.75	1.75	1.75	2
Chloroform (Trichloromethane) (µg/L)	0.50	0.50	1.75	0.50	2
Dichloromethane (µg/L)	3.00	3.00	3.00	3.00	2
Tetrachloroethylene (µg/L)	1.50	1.50	1.50	1.50	2
Trichloroethylene (µg/L)	1.50	1.50	1.50	1.50	2
Carbon tetrachloride (µg/L)	1.50	1.50	1.50	1.50	2
1,1,2- Trichloroethane (µg/L)	2.50	2.50	2.50	2.50	2
1,1,2,2-tetrachlorethane (µg/L)	2.50	2.50	2.50	2.50	2
Dissolved Cadmium (µg/L)	0.10	0.08	0.08	0.08	2
Dissolved Mercury (µg/L)	0.00	0.02	0.04	0.03	2
Dissolved Nickel (µg/L)	8.70	5.39	3.74	9.90	2
Dissolved Lead(µg/L)	5.60	4.24	6.46	1.31	2
Dissolved Fe (Fe2+ + Fe3+)(mg/l)		0.04	0.04	0.08	2
Total Fe (Fe2+ + Fe3+)(mg/L)	0.04	0.04	0.04	0.04	2
Total Mn (Mn2+ + Mn7+) (mg/L)	0.02	0.01	0.07	0.03	2
Dissolved Fe (Fe2+ + Fe3+) (mg/L)		0.04	0.04	0.08	2
Total matters in suspension (mg/L)	4.60	11.6	18.4	4.40	2
Total phenols (phenol index) (µg/L)	2.00	2.00	2.00	2.00	2
Total cyanides (µg/L)	5.00	5.00	5.0	5.00	2
Anion-active detergents (µg/L)	50.0	50.0	50.0	50.0	2
Organic solvents (mg/L)	2.50	2.50	2.50	2.50	2
Fluorides (mg/L)	0.20	0.25	0.29	0.29	2
N-NH4 (mg/L N)	0.01	0.01	0.01	0.01	2
NH4 (mg/L)	0.01	0.01	0.01	0.01	2
N-NO2 (mg/L N)	0.00	0.00	0.00	0.00	2
NO2 (mg/L)	0.01	0.01	0.01	0.01	2
N-NO3 (mg/L N)	0.17	0.31	0.40	0.45	2
NO3 (mg/L)	0.75	1.37	1.76	1.97	2
Total N (mg/L N)	0.23	0.56	0.23	0.55	2
P-PO4 (mg/L P)	0.01	0.01	0.00	0.01	2
P2O5(mgP2O_5/L)	0.02	0.01	0.01	0.02	2
Total P (mg/L P)	0.01	0.01	0.01	0.04	2
Faecal coliforms (no/100 ml)	120	130	110	17.0	2
Total coliforms at 37C (no/100 ml)	150	160	170	40.0	2
Faecal streptococci (no/100 ml)	20.0	20.0	20.0	20.0	2

Table 2
PHYSICO-CHEMICAL PARAMETERS OF SUHA RIVER IN THE OSTRA SECTION (2010)

Hydrometrical station	River	Data	Precipitations mm/24 hours
Gemenea 1	Gemenea	24.07.2008	105
Gemenea 2	Gemenea	24.07.2008	96.2
Slătioara 3	Statioara	24.07.2008	90.4
Stulpicani	Suha	24.07.2008	57.7
Valea lui Ion	Valea lui Ion	24.07.2008	92.4
Pluton	Pluton	24.07.2008	63.1
Sabasa	Sabasa	24.07.2008	60.6
Bro□teni	Bistri□a	24.07.2008	59.2

Table 3
TOTAL PRECIPITATIONS FALLEN IN 24 HOURS IN THE SUHA CATCHMENT AND AT BORDERING HYDROMETRIC STATIONS

Insurance %	Precipitations mm/h	Runoff coefficient
1	125	0.60
2	98.8	0.55
5	67.5	0.50
10	46.2	0.45

Table 4
STATISTICAL VALUES OF PRECIPITATIONS WITHIN THE SUHA CATCHMENT

Insurance %	Volume of precipitations m^3	Runoff volume m^3	Qmax m^3/s
1	517500	309420	27.5
2	409032	224968	20.0
5	279450	139725	12.4
10	191268	86071	7.66

Table 5
MAXIMUM DISCHARGES BY INSURANCES

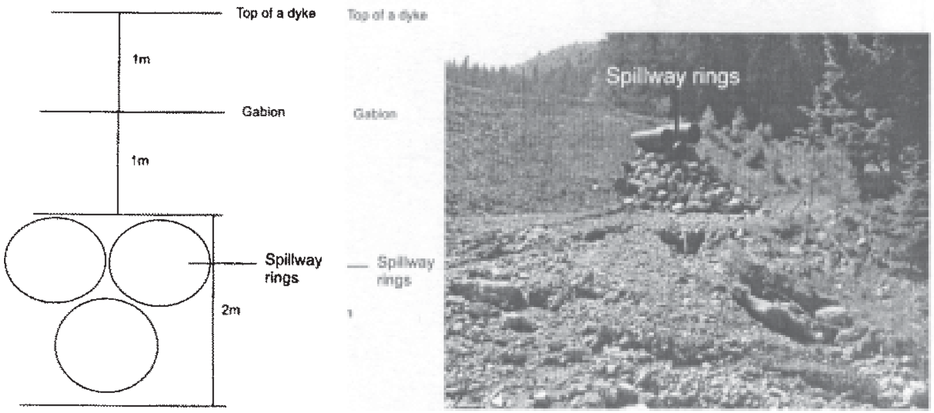

Fig. 5 Position of spillway rings within the settling pond of Valea Straja

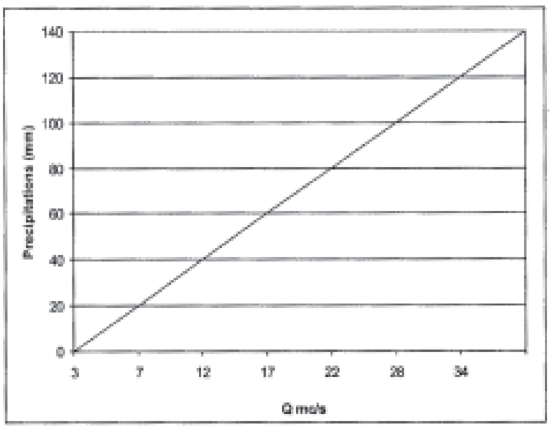

Fig. 6 Correlation graph for maximum discharges =f(precipitations)

Conclusions

The water resulted from the settling pond of Valea Straja represent an imminent danger of pollution for the Straja creek and for the other hydrographical arteries within the Suha catchment. The storage of pollutants in the settling pond is an ongoing source of pollution for the following elements: atmosphere (powders, sulphur dioxide, etc); surface water and groundwater (heavy metal ions: copper, lead, iron, manganese, zinc, flotation reactives, mining wastewater with acid properties, etc); soil (heavy metal ions, acid wastewater, powders, etc); natural habitats, vegetation and fauna, etc. Among its effects, it is also worth noting alterations of estate usage and ownership regime, disabling and dislodging, impact on local water sources, psychological effects on the human communities, etc.

In 2006, the settling pond of Valea Straja began the conservation phase and it has been subjected to gradual ecologization. Tailings running off from the pond during significant or heavy rains are facilitated by outdated technological equipments, by advanced gullying in the catchment and on the dam, by the significant pond clogging, etc. According to specific hydrotechnical calculations, if the water amount exceeds 10 m^3/s, important amounts of tailings would overflow from the lake, with immediate repercussions in the hydrographical arteries of Straja, Brăteasa, Suha and Moldova. Such an event could affect 1,300 dwellings.

Acknowledgments: This work was supported by strategic grand POSDRU 159/1.5/133391, Project "Doctoral and Post-doctoral programs of excellence for highly qualified human resources training for research in the field of Life sciences, Environment and Earth Science" co-funded by the European Social Fund within the Sectoral Operational Program Human Resources Development 2007 – 2013, and the POSCCEO 2.2.1, SMIS-CSNR 13984-901, No. 257/28.09.2010 Project, CERNESIM, is also gratefully acknowledged for the infrastructure used in this work.

References

1.ANDRÁŠ, P., ADAM, M., CHOVAN, M., ŠLESÁROVÁ, A.,. Carpath. J. Earth Env., **3**, no. 1, 2008, p.7.
2.ANI, E.C., CRISTEA, V.M., AGACHI, P.S., KRASLOWSKI, A., Rev. Chim. (Bucharest), **61**, no. 11, 2010, p. 1108.
3.BAJCAN, D., TOMÁŠ, J., TÓTH, T., LAHUCKÝ, L., MendelNet 04 Agro, 2004, p. 1.
4.BALABAN, A., CONSTANTINESCU, E., Rev. Chim. (Bucharest), **60**, no. 3, 2009, p. 316.
5.BREHUV, J., BOBRO, M., HANCULÁK, J., Vodohospodársky spravodaj, **1**, 2003, p. 8.
6.CARABET, A., ION, M., PODE, V., FLORESCU, C., PODOLEANU, C., CRISAN, M., Rev. Chim. (Bucharest), **60**, no. 4, 2009, p. 427.
7.CHICO', M. M., DAMIAN, G., STUMBEA, D., Rom. J. Mineral Deposits, **87**, no. 2, 2014, p. 101.
8.CRUZ, A.M., OKADA, N., Nat. Hazards, **44**, no. 2, 2008, p. 213.
9.DIMITROVSKA, O., MARKOSKI, B., TOSHEVSKA, B.A., MILEVSKI, I., GORIN, S., Procedia Environmental Sciences, **14**, 2012, p. 32.

10.FORGÁC, J., STREŠKO, V., ŠKVARKA, L., Mineralia Slovaca, **27**, 1995, p. 45.
11.FORGÁC, J., STREŠKO, V., Mineralia Slovaca, **31**, 1999, p. 117.
12.FORGÁC, J., STREŠKO, V., ŠOMŠÁK, L., ŠIMONOVICOVÁ, A., Mineralia Slovaca, **31**, 2000, p. 117.
13.FRANKOVÁ, H., CMIELOVÁ, L., KLIMKO, T., LACKOVÁ, E., ANDRÁŠ, P., Carpath. J. Earth Env., **7**, no. 4, 2012, p. 79.
14.HUCKO, P., Vodohospodársky spravodaj, **3-4**, 2005, p. 37.
15.ITICESCU, C., GEORGESCU, L.P., TOPA, C.M., Carpath. J. Earth Env., **8**, 2013, p. 155.
16.KILIC TASELI, B., Carpath. J. Earth Env., **8**, 2013, p. 125.
17.ROMANESCU, G., COJOCARU, I., Environ. Eng. Manag. J., **9**, no. 6, 2010, p. 795.
18.ROMANESCU, G., CRETU, M.A., SANDU, I.G., PAUN, E., SANDU, I., Rev. Chim. (Bucharest), **64**, no. 12, 2013, p. 1416.
19.ROMANESCU, G., PAUN, E., SANDU, I., JORA, I., PANAITESCU, E., MACHIDON, O., STOLERIU, C., Rev. Chim. (Bucharest), **65**, no. 4, 2014, p. 401.
20.ROMANESCU, G., SANDU, I., STOLERIU, C., SANDU, I.G., Rev. Chim. (Bucharest), **63**, no. 3, 2014, p. 344.
21.ROMANESCU, G., TARNOVAN, A., SANDU, I.G., COJOC, G.M., DASCALITA, D., SANDU, I., Rev. Chim. (Bucharest), **65**, no. 10, 2014, p. 1168.
22.STUMBEA, D., CHICO', M., Scientific Annals of the "Alexandru Ioan Cuza" University Iaşi, Geology Series, **58**, no. 1, 2012, p. 23.
23.WRAGG, J., PALUMBO-ROE, B., Contaminant mobility as a result of sediment inundation: Literature review and laboratory scale pilot study on mining contaminated sediments. British Geological Survey, Open Report, OR/11/051, 2011, p. 101.
24.FARNSWORTH, K.L., MILLIMAN, J.D., Global Planet. Change, **39**, 2003, p. 53.
25.GABITSINASHVILI, G., NAMGALADZE, D., UVO, C.B., Environ. Eng. Manag. J., **6**, no. 1, 2007, p. 37.
26.JOLIN, C., DIACONESCU, D., NEAGOE, M., SAULESCU, R., Environ. Eng. Manag. J., **8**, no. 4, 2009, p. 837.
27.ROMANESCU, G., NISTOR, I., Nat. Hazards **57**, 2011, p. 345.
28.ROMANESCU, G., JORA, I., STOLERIU, C., Carpath. J. Earth Env., **6**, no. 1, 2011, p. 119.
29.SOHAIL, A., WATANABE, K., TAKEUCHI, S., Water Resour. Manag., **22**, no. 1, 2008, p. 1.
30.SOLÍN, ., FERANEC, J., NOVÁČK, J., Nat. Hazards, **56**, no. 1, 2011, p. 195.
31.CIRTINA, D., PASARE, M., Rev. Chim. (Bucharest), **65**, no. 6, 2014, p. 737.
32.ARPENTI, M.B., NEGREANU-PIRJOL, T., EHLINGER, T.J., PARASCHIV, G-M., TOFAN, L., Rev. Chim. (Bucharest), **65**, no. 9, 2014, p. 1108.
33.BARBULESCU A., BARBES L. 2013. Assessment of Techirghiol Lake Surface Water Quality Using Statistical Analysis. Rev. Chim. (Bucharest), **64**, no. 8, 2013, p. 868.
34.ROMANESCU G. WIT Transaction on Ecology and the Environment, **125**, 2009, p. 439.
35.A.B.A.S., Raport. Administraţia Bazinală de Apă Siret, Bacau, 2014, p.120.
36.GEORGESCU, A.M., GEORGESCU, S.C., Hidraulica retelelor de conducte si masini hidraulice. Editura Printech, Bucharest, 2007.
37.MARUSIC, G., SANDU, I., FILOTE, C., BESLIU, V., SEVCENCO, N., STEFANESCU, B., VASILACHE, V., CRETU, M.-A**.,** Rev. Chim. (Bucharest), 66, no. 4, 2015, p. 503

Manuscript received: 18.01.2015