INFLUENCE OF HYDROCLIMATIC RISK FACTORS ON THE RIVER POLLUTION PHENOMENON

INFLUENŢA FACTORILOR DE RISC HIDROCLIMATIC ASUPRA FENOMENULUI DE POLUARE AL RÂURILOR

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Abstract. *The paper presents an analysis of the river pollution phenomena in the Trotuş River Basin. The Trotuş River area has been affected by multiple floods over the past 28 years (significant in 2004, 2005, 2011 and 2016). The most important categories of pollutant pressures in the Trotuş Hydrographic Basin are punctual, diffuse and hydromorphological. The most significant point sources of pollution in the river basin are of domestic, industrial and agricultural type. The pollutants that affected the watercourses in the Trotuş catchment area during the study period were petroleum products (51.2%) and organic substances (21.4%). The remaining 27.4% of pollutants are ammonium, ammonia, hydrogen sulphide, heavy metals, cyanide, urea, detergents, ash, phosphorus, etc*.
Key words: pollution, riverine environment, floods, degradation

Rezumat. *Lucrarea prezintă o analiză a fenomenelor de poluare a râurilor din bazinul hidrografic al râului Trotuş. Arealul râului Trotuş a fost afectat de multiple viituri în ultimii 28 ani (semnificative cele din 2004, 2005, 2011 şi 2016). Cele mai importante categorii de presiuni poluante din Bazinul Hidrografic Trotuş sunt de tip punctiform, difuze şi hidromorfologice. Sursele punctiforme de poluare cele mai semnificative în bazinul hidrografic sunt de tip menajere, industriale şi agricole. Substanţele poluante care au afectat major cursurile de apă din bazinul hidrografic Trotuş pe perioada de studiu au fost produsele petroliere (51,2%) şi substanţele organice (21,4%). Restul de 27,4% dintre poluanţi sunt reprezentaţi de amoniu, amoniac, hidrogen sulfurat, metale grele, cianuri, uree, detergenţi, cenuşă, fosfor etc.*
Cuvinte cheie: poluare, mediu riveran, inundaţie, degradare

INTRODUCTION

The hydrological regime of rivers in the Siret River basin is characterized in the last period of time by the high frequency of floods. River quality parameters are influenced by a complex of pollutants. For the purpose of establishing appropriate measures for the protection and warning of surface water pollution, the individual impacts of each source of pollution on hydrographic basin, river stretches, or geographic areas shall be taken into account. The

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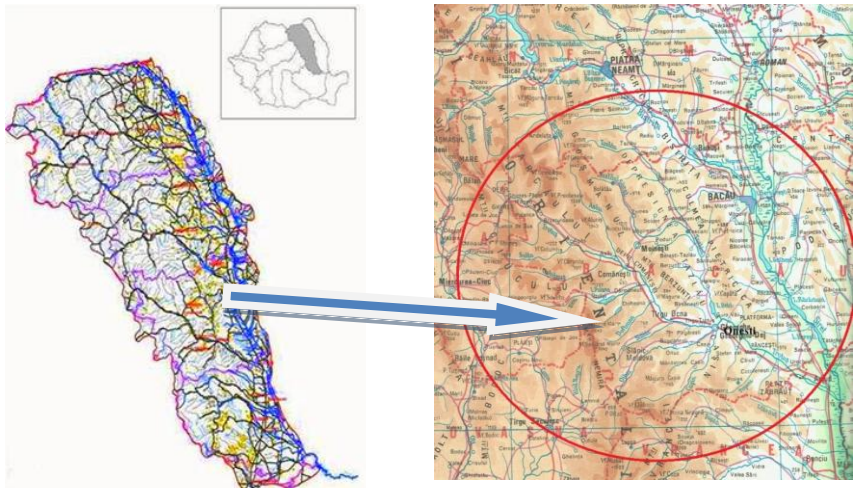
pollutant transport vector in a river, the water velocity in this case, can cause local, regional and even transfrontier pollution (Avram, 2016).

Water quality from surface sources is adversely affected by pollution induced especially by human activity. As a result of the increase in the degree of pollution, the ability to use surface water, which could be used especially for drinking purposes, is restricted. Human health and the equilibrium of aquatic ecosystems are heavily affected by the high water pollution from rivers and lakes. For these reasons, maintaining water quality in surface courses in line with environmental protection requirements is mandatory, through sustainable water management policies and programs (Avram, 2016).

MATERIAL AND METHOD

The research was conducted in the Trotuş River basin. The research material was collected from the Siret basin and customized on the Trotuş River basin. The hydrographic basin of the Trotuş River is located in the relief area of the Oriental Carpathians. It goes through the geomorphological units of the Ciucului, Tarcăului, Comăneştii and Tazlău - Caşin depressions (fig. 1). The Trotuş River flows into the Siret River downstream of Adjud.



a b

Fig. 1 Framing of the study area (BH Trotuş) in the Siret catchment area:
a - the Siret catchment area; b - location of the area in the East Carpathians
(http://www.rowater.ro/dasiret/Sinteza%calitate.20raurilor/Forms/AllItems.aspx.jpg)

The Trotuş River has its springs in the Ciuc Mountains at an altitude of 1360 m and has a main north-south direction. The tributaries of the Trotuş River in the analyzed sector are (Ujvari 1972): on the right: Ciugheş, Cotumba, Grohotiş, Sulita, Ciobănuş, Supan, Uz, Dofteana, Slănic, Nicoreşti, Oituz, Caşin etc.; on the left: Brusturoasa, Camenca, Agăş, Seaca, Asău, Urmeniş, Plopul, Vâlcele, Tazlău.

The hydrographic basin of the Trotuş stream has an area of 4.440 km^2. The length of the river is 158 km. The average altitude of the river basin varies from springs to spills up to 1140 - 734 m. The Trotuş River and tributaries are monitored by 21 hydrometric stations. Monitoring parameters have been determined flow parameters (liquid and solid flows, levels, ice, etc.) for a period of 40-60 years.

The data collected consists of hydrological, hydrological, topographic, geotechnical studies, state of exploitation of the regulation and shore defence structures. Studies and research are conducted over a period of about 20 years. The theoretical and experimental research was carried out in the following areas.

Primary data was processed using the statistical calculation programs and hydrological, hydraulic and pollutant computing programs applicable to the case study.

RESULTS AND DISCUSSIONS

The riparian of river area is vulnerable to pollution from water courses. Floods amplify the intensity of the pollution phenomenon through the transport vector, the water velocity, and the increased capacity of incorporating pollutants from different sources. Pollution sources are classified according to their spatial distribution characteristics as point sources, non-point sources, and internal sources discharged into rivers. Point sources of pollution include mainly industrial and domestic wastewater from urban areas. Non-urban sources include pollutants from surface leakage on farmland, forests, meadows, riparian lands, etc.

For the analysis of water quality data control sections were monitored on the Trotuş River and the Tazlău River for a period of 10 years 2006-2016. These data were taken from the Siret Regional Water Monitoring Program.

The Trotuş River and its tributaries have a major role to play in the pollution, collecting domestic and industrial waste water and leakage from farmland. Pollution sources that influence the quality of the Trotuş River water and the tributaries come from natural and human pollution. A predominant role is played by accidental pollution caused by flood plains. Floods are a transport vector of pollutants, which transforms local pollution into regional pollution. Inappropriate and excessive use of fertilizers and pesticides on agricultural land leads to a phenomenon of aggressive pollution on surface and underground water. The main tributaries of the Trotuş River are urban waste water collectors, which have a negative influence on the quality of the water.

The most important pressure categories in the Trotuş Hydrographic Basin are punctual, diffuse and hydromorphological. The pollution sources of the Trotuş Hydrographic Basin can be classified as follows:

• point sources of significant pollution, represented by the sources: domestic, industrial and agricultural,

• diffuse pollution sources, mainly represented by chemical fertilizers used in agriculture, rural agglomerations and the urban environment with a low percentage of population connection to the sewerage network.

The pollutants that affected the watercourses in the Trotuş catchment area in most cases were petroleum products 51.2% and organic substances 21.4%, the

remaining 27.4% being ammonium, ammonia, hydrogen sulphide, heavy metals, cyanides, urea, detergents, ash, phosphorus, suspensions (ABA Bacau, 2016).

The oil exploitation of the Tazlăul Sărat river basin influences the balance of the pollutants on the Trotuş River (fig. 2). The oil activity in the Moineşti area affects the Tazlăul Sărat, Tazlău and Trotuş watercourses, as well as the groundwaters in the area, through the accidental spills of oil products and salty waters. The Tazlăul Sărat River has frequent accidental pollution with petroleum products, in most cases due to the rupture of transport pipelines. Some of the oil pipelines have an out-of-service life.

Studies and research over the last few years have shown the continued change in water quality parameters in the Trotuş River and its tributaries. In the monitoring sections of the Trotuş River, the value of the main pollutants was analyzed over time intervals (http://apesiret.uvp.ro). The obtained values were compared with the maximum admitted by the national and European standards. Tables 1 and 2, show the values of the concentrations of the water quality chemical indicators determined in the measurement sections Tg. Ocna and Vrânceni on the Trotuş River. The data were compared with the maximum admissible concentrations established by Order no. 161/2006 and the Water Framework Directive 2000/60 / EC (Mănescu, 2013).

Analysis of the measured and processed values in the monitoring section Tg. Ocna indicates annual variation in pollutant concentrations and exceeded the maximum admissible values. The most serious situation is represented by ammonium, nitrates and phosphates, which indicate a domestic and agricultural pollution in the Trotuş catchment area.

a b

Fig. 2 Tazlăul Salat river pollution risk zones: a - oil pipelines exposed by floods in June 2016; b - oil pipelines uncovered by the river infiltration stream (Avram, 2016).

The N-NH4, N-NO2, P-PO4 quality indicators indicate the quality of the Trotus River water quality in the monitoring section Tg. Ocna in grade 4 and 5 during the study period, depending on the hydrological regime of the watercourse. The CBO5 indicator fits the quality class III quality monitoring section within the limit imposed by Order no. 161/2006.

The analysis of the measured and processed values in the monitoring section Vrânceni indicates the annual variation of the concentrations of the pollutant, the exceeding of the maximum admissible values by the norms, but also the influence of the diffusion process on the transport length.

Table 1

Analysis of chemical indicators determined in control section Tg. Ocna, Trotuş River (Mănescu, 2013, ABA Siret Bacău 2010)

Year	OD (mg/L)	CBO_5 (mg/L)	CCO-Mn (mg/L)	CCO-Cr (mg/L)	$N\text{-}NH_4$ (mg/L)	$N\text{-}NO_2$ (mg/L)	N-NO3 (mg/L)	$P\text{-}PO_4$ (mg/L)
2007	14.52	12.41	5.45	13.65	1. 58	0.3	4.64	0.26
2008	13.25	13.61	3.31	11.24	1.76	0.13	5.93	0.40
2009	15.89	13.17	5.12	17.05	1.67	0.52	5.7	0.55
2010	16.17	14.56	6.65	23.3	2.61	0.611	5.9	0.75
2011	16.63	12.58	4.78	14.55	1.65	0.615	5.76	0. 68
Color code for the water quality class: Blue - Class I; Green - Class II; Rose - Class III; Orange - Class IV; Red - Class V								

Table 2

Analysis of chemical indicators determined in control section Vranceni, Trotuş River (Mănescu, 2013, ABA Siret Bacău 2010)

Year	OD (mg/L)	CBO_5 (mg/L)	CCO-Mn (mg/L)	CCO-Cr (mg/L)	$N\text{-}NH_4$ (mg/L)	$N\text{-}NO_2$ (mg/L)	N-NO3 (mg/L)	$P\text{-}PO_4$ (mg/L)
2007	13.75	12.21	5.33	11.67	1. 45	0.26	4.02	0.21
2008	13.46	13.91	3.45	13.44	1.12	0.19	5.36	0.43
2009	15.70	12.37	5.02	16.04	1.49	0.61	5.72	0.31
2010	16.54	13.54	6.81	23.31	1.2	0.59	5.5	0.28
2011	16.69	11.53	4.78	14.59	1.47	0.57	5.34	0.3
Color code for the water quality class: Blue - Class I; Green - Class II; Rose - Class III; Orange - Class IV; Red - Class V.								

The most serious situation is represented by ammonia, nitrates and phosphates, which is the fourth and fifth grade monitoring section during the study period. This shows domestic and agricultural pollution in the Trotuş catchment area. The determined values are: at N-NH4 of 1.12-1.49 mg/L, at N-NO2 0.57-0.61 mg/L, at P-PO4 0.21-0.3 mg/L, etc. Indicates a classification of the water quality of the Trotuş River in the monitoring section Tg. Ocna in grade 4 and 5 during the study period, depending on the hydrological regime of the watercourse.

The presence of human-type pollution is particularly evident in the Trout River basin over the last 25 years. The most obvious pollution processes in the riparian area are represented by (Avram, 2016, Mănescu, 2013):

- pollution with biological material resulting from uncontrolled forest felling;
- pollutant pollution from eroded soil transport from deforested slopes and agricultural degrading soil; oil pollution from oil operations;
- household waste pollution from localities without sewerage systems and treatment plants; pollution with household waste from localities without landfills.

Hydroclimatic risk factors significantly influence the transport of pollutants on rivers and contribute to the decrease or increase of their concentration on the length of the river. Significant hydroclimatic risk factors for the transport of pollutants are:

- reduced capacity of major river transit in case of high-floods; the flood trains waste in the major bed and integrates them into the waterway with their long-distance transport;

- the morphological modification of the river bed, formation of sedimentation zones, erosion of the shore, blocking of the bed, etc.; erosion zones adversely affect the stability of the constructions and installations in the riverbed, with the occurrence of pollution phenomena (the oil pipeline on the Tazlăul Sărat river);

- increasing the transport of biological material in the bed (branches, wood waste, trees, etc.), which causes the flow of the rivers and bridges to be blocked; pollution caused by wood is characteristic of the Trotuş River Basin;

- uncontrolled deforestation that has intensified rainfall-drainage and river water concentration; This situation contributes to a rapid movement of pollutants on the soil surface and their concentration.

CONCLUSIONS

1. The territory of the Trotuş catchment area has been affected in the last 25 years by disastrous hydrological phenomena, which have greatly influenced the morphology of the rivers, with important influences on the riparian environment and, in particular, the transport of pollutants.

2. The sources of pollution in the Trotuş River basin are natural and human, where both types have developed over the last 25 years with a negative influence on water quality parameters in the rivers and on the riparian area.

3. The floods produced over the past 25 years on the Trotuş River and its tributaries have influenced and intensified the transport of pollutants, in which the riparian habitat suffered extremely destructive effects.

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