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Original Research Article

Current Findings Regarding the Management of Clean Water in an Area with Agro-Zootechnical and Food Processing Activities Developed in an Urban Agglomeration and Surrounding Villages

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Abstract

The quantitative and qualitative assurance of the water shortage is one of the major challenges of the near future. This study is focused on the current and perspective plan adopted in the management of clean water sources and the quality of wastewater discharged from the local treatment plant of urban agglomerations and surrounding villages, with polluting potential generated by agro-zootechnical households and food processing companies. The research consisted of the analysis of some public data related to the monitoring and management of drinking water and wastewater during the year 2021. Six microbiological parameters and nineteen physicochemical parameters were evaluated in the case of drinking water, respectively the level of ammonium and suspended matter for the discharged wastewater from the sewage treatment plant.In carrying out laboratory analyses, the use of standardized methods was resorted to, and the analysis bulletins included the allowed values and the limit of quantification for the methods used. Data processing allowed differentiation of non-compliant tests and calculation of the degree of compliance. At the same time,the duration of water interruption was also evaluated (the quantification was made in days and the number of hours), and the effectiveness of the measures imposed by the authorities in the field, respectively the degree of remediation of technical problems that occurred at the water treatment plant during the period under study. Non-compliant tests were in alower proportion (0.34%), compared to compliant ones (99.66%). The values recorded in the case of the used water at the discharge revealed elevated exceedances of ammonium and suspended matter parameters, which confirmed the advanced stage of wear and the need to replace it with a new one, using zeolite as a sorbent. The major polluting impact of agro-zootechnical and food industry activities on surface waters in the area and the environment in general was also argued.

Keywords: Agroindustrial pollution, Wastewater, Water treatment, Zeolites

INTRODUCTION

The struggle of humankind for water is existential in nature and includes the identification of new resources, storage, transportation, distribution, as well as the economy of water. This is a continuous problem that is generated by the increase in population, as well as by the growing demands of industry and agriculture. Since ancient times, urban communities have developed along watercourses or lakes, where the lands are fertile, with flora and fauna suitable for the best possible living conditions.However, a study carried out by UNESCO shows that approximately one billion inhabitants of the planet face problems generated by potable water sources. African countries are the most affected by such issues, whereas Finland benefits from the cleanest potable water. The same relevance is attributed to data provided by the World Health Organization, which shows that 34 000 people (including 5 000 children) die every day in the world due to limited drinking water resources.The National Public Health Center shows that 60% of the population in rural areas are supplied by water from wells, and 85% of these water sources have high concentrations of nitrates and other harmful pollutants, the main source of pollution being of organic nature. The intensification of the pollution phenomenon has led to the alteration of the physical, chemical, and biological quality of clean water sources, increasing the difference between the quality of natural water sources and the quality of water requested by consumers. The rules of nature have always been defied by certain human activities, such as uncontrolled deforestation, construction in high-risk flood areas, and environmental pollution in particular, which significantly contributes to current and future natural disturbances. Agro-zootechnical activities are also accounted as a source of pollution due to the improper storage of pesticides and fertilizers.The most important water pollution sources in rural areas are still deposits near wells and traditional livestock farms, thus resulting in organic waste with a high ammonium content, which infiltrates the soil and goes directly into groundwater and surface waters (Sundara et al., 2010). In the current conditions, the number of wells with polluted water increases from one year to the next, despite the intensification of sanitary education.

Potable water is not found in a pure state, but it contains many dissolved substances, especially salts. Some of these are found in most clean water sources and in significant concentrations, and others are rare and extremely small quantities. Thus, according to extensive statistics, certain constituents must be found in the composition of drinking water, which according to the proportion can be: major (sodium, calcium, magnesium, bicarbonate, sulfate, chlorine, silicium), secondary (iron, strontium, potassium, carbonate, nitrate, fluorine, boron), minor (antimony, aluminum, arsenic, barium, bromine, cadmium, chromium, cobalt, copper, germanium, iodine, lead, lithium, manganese, molybdenum, nickel, phosphate, rubidium, selenium, titanium, uranium, vanadium, zinc) and as traces (beryllium, bismuth, cerium, cesium, gallium, gold, indium, lanthanum, niobium, platinum, gold, ruthenium, scandium, silver, thallium, thorium, tin) (Harleman and Murcott, 1999).

Water quality contributes significantly to the achievement of the main objective of the food industry, which consists of obtaining products that satisfy the growing needs and demands of society in accordance with their quantity, quality, and economic competitiveness.

The aim of this study is to analyze the polluting potential of agro-zootechnical and food industry activities on surface waters and the quality of wastewater discharged from the local tartarization station of an urban agglomeration with 6 surrounding villages.

MATERIALS AND METHODS

Studied area

The area is located in a hilly plain, at the intersection of the parallel 45°45' north latitude with the meridian 24°10' east longitude, in the center of Romania, at the intersection of the administrative boundaries of three counties. Its relief is integrated into an area with low hills (average height 380 m and maximum 500 m). The geological composition is mostly represented by chernozems and reddish-brown soils, which allow intense agricultural activity. The hydrography of the area is poorly represented, and it includes a plain stream with a low flow, which almost dries out during the hot summers. In addition, there is a network of torrential secondary valleys and underground waters, represented by a well-defined and little-exploited water table. The area has an agro-industrial economy based on crop cultivation and grazing. The industry is centered on methane gas exploitation and wood processing.From a qualitative point of view, the natural riches represented by the gas domes (Romanian history, 1997) are among the most important in Europe.The main water supply network is connected to the county water network, and it has a length of approximately 15.78 km and serves a number of 1371 households. Another source of drinking water supply for the city's population is represented by two long surface clean water intakes, with a distribution network 3 and 9 km long respectively. The district has a sewerage network that has thepotential for expansion. The wastewater treatment plant does not operate at normal parameters, but is being modernized, or possibly replaced with a new one.

Organization of the experiment

The study was carried out in 2021 and it includes two sets of analyses of some public data, related to the monitoring and management of drinking water and wastewater in the studied area. The first set consisted of the analysis of the data reported by the Public Health

Table 1. Microbiological and physicochemical determinations of potable water provided by DSP in 2021 of the investigated area

No.	Parameter	UM	Sample size determination (No.)	Non-compliant samples (No.)	Reference values	Water supply disruptions	
						Days (No.)	Hours (No.)
1.	*Escherichia coli*	Nr/100mL	926	2	0	2	8
2.	Coliform bacteria	Nr/100mL	923	3	0	3	12
3.	Enterococci	Nr/100mL	926	-	0	-	-
4.	Cl. perfringens (+ spores)	Nr/100mL	13	-	-	-	-
5.	Number of colonies at 22 C^o	UFC	920	-	-	-	-
6.	Number of colonies at 37 C^o	UFC	920	-	2	-	-
7.	Copper	mg/L	2	-	5	-	-
8.	Lead	mg/L	2	-	50	-	-
9.	Nitrite-from the water distribution network	mg/L	2	-	200	-	-
10.	Aluminium	mg/L	12	-	0.5	-	-
11.	Ammonia	mg/L	2	-	250	-	-
12.	Chlorine- end of water network	mg/L	923	12	200	12	264
13.	Iron	mg/L	2	-	50	-	-
14.	Manganese	mg/L	2	-	200	-	-
15.	Oxidisability	mg/L O2	2	-	2500	-	-
16.	Electrical conductivity	µS/cm	13	-	6,5-9,5	-	-
17.	pH	Unit. pH	13	-	Ac.C	-	-
18.	Color	-	11	-	Ac.C	-	-
19.	Smell	-	11	-	Ac.C	-	-
20.	Taste	-	11	-	Ac.C	-	-
21.	Turbidity	-	920	-	-	-	-
22.	Water hardness	-	2	-	-	-	-
23.	Radon	mg/L	1	-	-	-	-
24.	Alfa Global Activity	Bq/l	1	-	0.1	-	-
25.	Beta Global Activity	Bq/l	1	-	1.0	-	-
Total		Nr.	4721	17	-	17	284
Conformity/Nonconf.		%	99.34	0.36	-	-	-

Directorate (DSP) for microbiological and physico-chemical testing within the potable water quality monitoring plan (Table 1). The processing of the data regarding the quality of drinking water distributed to consumers in the area consisted of the centralization of the number of tests performed and the results recorded for each individual parameter. These included recording the number of non-compliant analyses, based on which the level of compliance was calculated, as well as the duration of the water interruption (that were recorded by days and the number of hours) in order to apply the measures imposed by the authorities in the field. The second set of tests was based on accessing and analyzing public data reported by authorized institutions and laboratories in the field of wastewater management and quality control. The data provided by the county laboratory of the Water Management System (SGA) was centralized. This research consisted of the analysis of the recorded values of ammonium levels and suspended matter, both representing two basic physicochemical parameters for the analysis of the water discharged from the local station and indicators of the specific pollution in the area under study (Table 2). The households and agro-zootechnical micro farms served by this station are insufficiently supported and monitored in terms of surface water and environmental pollution. The local water treatment plant had technical problems during the period of the study, which could not be remedied following the application of current legal measures. In carrying out the laboratory analyses, the methods standardized by the current legislation (Eaton et al., 2005) were specified in the analysis bulletins.

The problems generated by the inefficiency of wastewater treatment, the economic and social development achieved by the localities in the area, and the perspective of the development of agro-zootechnical activities and the food industry, require a quick solution of the local wastewater treatment station, along with the expansion of the network of surface water collection. According to the regulations regarding the administration,

Table 2. Pollution parameters of treated wastewater

Parameter	UM	Ref. val.	Exhaust port	Experiment 1		RangeExperim. (days)	Experiment 2	
				Val.	Exce. (x)		Val.	Exce. (x)
Ammonia	(mg/L)	30	Water treatment 37 days x 24 h	85.5	2.85	37	44,26	1.47
Suspended matter	(MS)	300		416	1.38		314	1.04
Ammonia	(mg/L)	30	Water treatment 70 days x 24 h	85.5	2.85	70	44,26	1.47
Suspended matter	(MS)	300		416	1.38		314	1.04
Nonconformity	(%)				100			100

Ref. val.-Reference values;Exce.–Exceedance; Range Experim.-Range between experiments

Table 3. Quality requirements of wastewater

Quality class	Technological objective	E. coli (N/100 mL)	CBO_5 (mg/L)	MTS (mg/L)	Turb. (NTU)	Other
A	Secondary water treatment, filtration and disinfection	≤ 10	≤ 10	≤ 10	≤ 5	Legionella spp. < 1 000 UFC/L in case of aerosolization. Intestinal nematodes (eggs): ≤ 1 egg/L for the irrigation of grazing, pastures or of fodder crops.
B	Secondary water treatment, filtration and disinfection	≤ 100	According to directive 91/271/CEE	According to directive 91/271/CEE	-	
C	Secondary water treatment, filtration and disinfection	≤ 1 000			-	
D	Secondary water treatment, filtration and disinfection	≤ 10 000			-	

MTS –Total suspended matter;Turb. -Turbidity; E. coli - Escherichia coli

operation and maintenance of sewage networks, the normal duration of use of a water treatment station is estimated at a minimum of 10 years, this period being significantly exceeded in the case of the station evaluated in this study.

RESULTS AND DISCUSSIONS

The set of individual and average data recorded in the first part of the experiment is centralized in Table 3. Differences from the degrees of conformity established by the legal standards were constantly reported in 2 of the 6 microbiological parameters tested. The parameters which were above the normal limits in several determinations were *Escherichia coli* (2) and coliform bacteria (3), without being of pathological significance. Regarding the physicochemical parameters, we only reported non-compliant tests for the evaluation of residual chlorine at the end of the network (12). The observed exceedances were not important in terms of the number of samples, individually this was given by 2, 3 and 12 tests respectively, adding to a total of 17 tests. The distribution of non-compliant tests showed the predominance of above-standard values in the case of the residual chlorine parameter at the end of the network (12), followed by *Coliform bacteria* (3) and *E. coli* (2). Since the exceedances registered only 0.34%, major relevance was attributed to the general degree of compliance, which reached 99.66%. The water supply interruptions were of short duration and were quickly and correctly resolved.The water supply interruption added up to a total of 17 days (interruption cycles), a total duration of 284 hours, falling between 1 and a maximum of 7 hours at a time. Following the consultation of 14 test reports (analysis), we found very low percentages of non-compliance (below 1%) which were found only in the case of 2 tests for the total microbial flora.

The results obtained in the case of the 2nd research set are presented in Table 2 and include the synthesis of the data recorded during the monitorization of the local wastewater treatment plant by the official SGA laboratory. According to the test reports, exceedances were recorded for the parameters ammonium (by 2.85 times at the first determination, respectively by 1.47 times at the second determination) and suspended matter (by 1.38 times at the first determination, respectively by 1.04 times at the second determination). The duration of operation (purification) of the station lasted 37 days in the case of the first test and 70 days in the case of the second test. The worrying thing is that the same parameters had high values even after the interval of 37 and 70 days respectively.

This evolution of the recorded values shows that the remediation of the technical problems affecting the wastewater treatment plant was not successful, even after the application of the measures provided by the current legislation. At the same time, the households and micro-farms in the monitored area have mixed agro-zootechnical activities with an important polluting potential on surface waters and the environment. On the other hand, the precarious character of some accessible programs specific to areas with suburban agglomerations is well known. Initially, this station was analyzed with regard to a possible rehabilitation, but this proposal was abandoned and efforts are being made to replace it with a new treatment plant thatperforms at the level of current requirements, , using zeolite as a sorbent.

According to the consulted data, the area under study is recognized to have an important amount of inorganic and organic pollutants extremely dangerous to the environment (Micle et al., 2018). The rapid growth rate of pollution levels in this area is largely generated by the continuous growth of chemicalization, intensification, and uncontrolled automation of the agricultural sector and the food industry. All this is added to the considerable increase in the urban population and implicitly of the transport, industrial and energetic activities, the expansion and technological diversification in general, and the increase of the incidents generated by the nuclear waste deposits. In general, when the concentration of pollutants exceeds certain limits and seriously endangers the health of the environment and people, effective remedial actions are required (Passaglia et al., 2018). Remedial measures are mainly based on the extraction of pollutants from soils and water sources, or their reduction through mobilization and/or stabilization *in situ*, respectively through wastewater treatment (Annelies et al., 2002). In terms of food safety, microbiological parameters are of major interest, where water is mainly used for sanitation, and when water is included as an ingredient in food composition, physicochemical parameters become equally important (Harleman and Murcott, 1999).

The frequency of sampling and analysis depends on the water source, whether it comes from the public network or from its own installations. Over time, a series of materials and techniques were used in environmental depollution. These technological processes can generate various problems, such as the discharge of insufficiently treated wastewater, which was the case of the current wastewater treatment plant; older pollutants generated by certain commercial companies over time; discharges of residual water from agro-zootechnical works carried out in some farms or agro-zootechnical complexes.

The impact of these sources of pollution is exerted mainly on surface waters, and on the monitorization of water drainage in surface flows.The expertise of the county inspection and the data provided by the analyses of water and sewage systems are used. The situation of rural localities, where few public water pumping systems operate, some of which operate at the limit of the law, is still a major challenge for clean water management (Sundara et al., 2010). Table 1, 2

It is recommended that the wastewater treatment cycles be permanently optimized, implementing sustainable projects (Ognean et al., 2022). Regarding the evolution of the quality of the wastewater discharged into the sewage treatment plant effluents, the technology must be adopted to ensure its inclusion in the basic physicochemical parameters, such as biochemical oxygen consumption per 5 days (CBO5), chemical oxygen consumption - dichromate method potassium (CCOCr), nitrates (Nt), suspended matter (MS) in the legally accepted standards for discharge into the emissary. Moreover, wastewater treatment technologies must respond to the challenges of sustainable development (Ognean et al., 2022), regarding the scarcity and conservation of water resources, demographic growth, related costs, constraints and increasingly strict regulations regarding environmental protection. In the pollution of surface waters with organic substances, nutrients and various dangerous substances a great contribution is attributed to agricultural activities, along with industrial and household activities (Ionescu, 2008). This type of pollution, mainly caused by direct or indirect emissions of insufficiently purified or untreated wastewater from agricultural sources, produces changes in the oxygen balance of surface waters, thus affecting the ecological balance of the waters. Improving clean water management must include improving the processes of implementation, monitoring and evaluation of strategies in the field of water supply, sanitation and wastewater treatment, along with optimizing the knowledge and skills of personnel in the field (Annelies et al., 2002; Popa et al., 2012).

Based on the mentioned legal provisions, the recovered water is indicated for the irrigation of several types of crops, such as food crops consumed raw, i.e. the crops that are intended for human consumption in a raw or unprocessed state; processed food crops, the crops that are intended for human consumption only after they have undergone a processing procedure (for example cooking or industrial processing); non-food crops, i.e. crops not intended for human consumption (e.g. pasture and forage, fiber, ornamentals, seed crops, energy crops and turf).

CONCLUSION

Based on the documentation carried out and the results of the undertakenresearch,the following conclusion could be drawn regarding the physicochemical and microbiological monitoring of the quality of potable water and wastewater discharged from the treatment plant of an agro-zootechnical and food processing area. The potable water quality fell within the current legislative standards for most of the tested parameters, with slight compliance deviations being reported for two out of six microbiological parameters (*Escherichia coli* and coliform bacteria), respectively for one (residual chlorine at the end of the network) out of 19 tested physicochemical parameters. For drinking water, the proportion of non-compliant tests (0.34%) was not important, but of compliant ones (99.66%), the problems were quickly and correctly resolved, with short-term water interruptions (17 days, between 1-7 hours). The wastewater discharged from the local treatment plant illustrated values recorded at two outlets, respectively two successive monitorings were recorded exceeding the ammonium and suspended matter parameters, which were also maintained at the second test at an interval of 37, respectively 70 days, indicating an advanced stage of wear of this station, being proposed for replacement with a new one. The analysis and quantifications that were carried out also revealed the major polluting impact of agro-zootechnical and food industry activities on surface waters in the evaluated area. The possibilities of using domestic, industrial or agricultural wastewater, after being discharged from treatment plants, can no longer be repurified by conventional methods, but by modern methods based on electrochemical purification techniques, of the electro-Fenton type, were also argued.

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