"Babeș-Bolyai" University Cluj-Napoca

Faculty of Environmental Science and Engineering

Doctoral school the environmental science

PhD Thesis Summary

Security of water sources from Cluj-Napoca area

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Cluj-Napoca

2024

Content

1. Introduction

1.1 Pointing the study issue

We suggest that the safety of water supply is based on 3 pillars/coordinates: accessibility, quantity and quality, figure 1. Affecting any of the 3 elements involves risks for the beneficiaries.

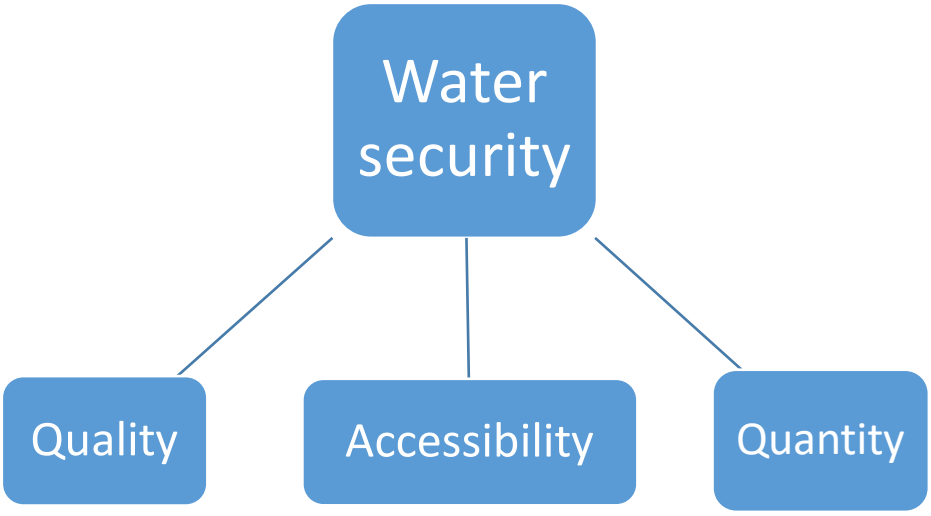

Figure 1. Pillars on which water security is based

This thesis aims to develop an integrated material, which identifies the main threats regarding water safety in the target area, evaluating their impact, and finally, suggest some solutions to reduce risks, and integrate solutions in a water security strategy.

At a preliminary analysis, some threats can be identified against water sources, including: climate change (glacier melting, rivers and lakes reducing in size), physical security (terrorism, excessive deforestation), lack of water sources diversity, pollution (from various sources such as agriculture, various industries, etc.), water waste (corroborated with demographic growth and migration from rural to urban - a fact that increases pressure on the water supply), corruption, political interests (some states withdrawal from the Paris Agreement on reducing greenhouse gas emissions), legislative deficiencies or monitoring of punctual water sources in localities where there is no classic centralized system, etc.

1.2 Overview of case stydy area

Water security from a certain area requires a conjugated effort of several entities: public authorities, legal entities and individuals. For this reason, the overlap of the study area at a Romanian water unit or a water company that serves a certain area is improper. Thus, for practical reasons, the present thesis will be limited to the area served by the Someș Water Company, with an emphasis on the area of Cluj-Napoca.

In 1882 the water and sewerage plant that had in the heritage of the "Bărnuți" Garden (1,700 m^3/day) was set up. In 1900, the underground source type "Florești", was put into operation, thus increasing the production to 7,500 m^3/day. In 1973, with the inauguration of the treatment station in Gilău, the main water source of the city became Lake Gilău, with approx. 60,000 m^3/day. On May 7, 2009, the Tarnița water intake tower was inaugurated, figure 2, this lake, with a volume of 70 million m^3, thus becoming the main source of raw water system, at the expense of Lake Gilău, which was kept "in reserve ".

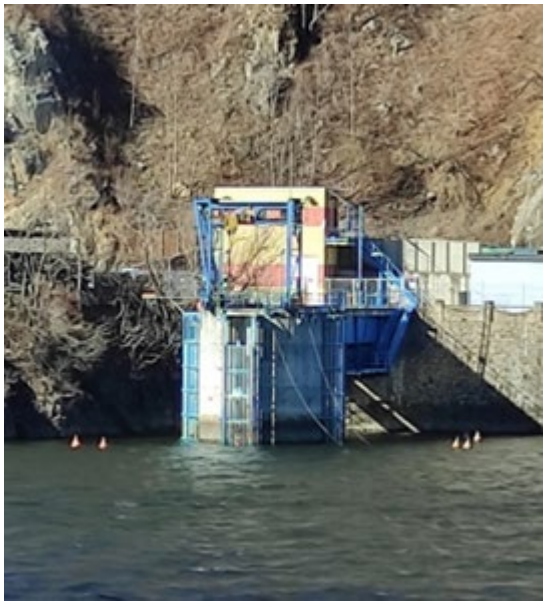

Figura 2. Water intake tower in Lake Tarnița (2024)

Conform Hidroconstrucția (2020): în amonte de municipiul Cluj-Napoca există o înșiruire de 5 lacuri cu volume diferite: Fântânele (212 mil. m^3), Tarnița (70 mil. m^3), Someșul Cald (7,5 mil. m^3), Gilău 4 mil. m^3 și Florești 2 (1 mil. m^3), așa cum reiese din figura 3.

According to Hidroconstruction (2020): upstream of Cluj-Napoca municipality there is a line of 5 lakes with different volumes: Fântânele (212 million m^3), Tarnița (70 million m^3), Someșul Cald (7.5 million m^3), Gilău (4 million m^3) and Florești 2 (1 million m^3) as shown in Figure 3

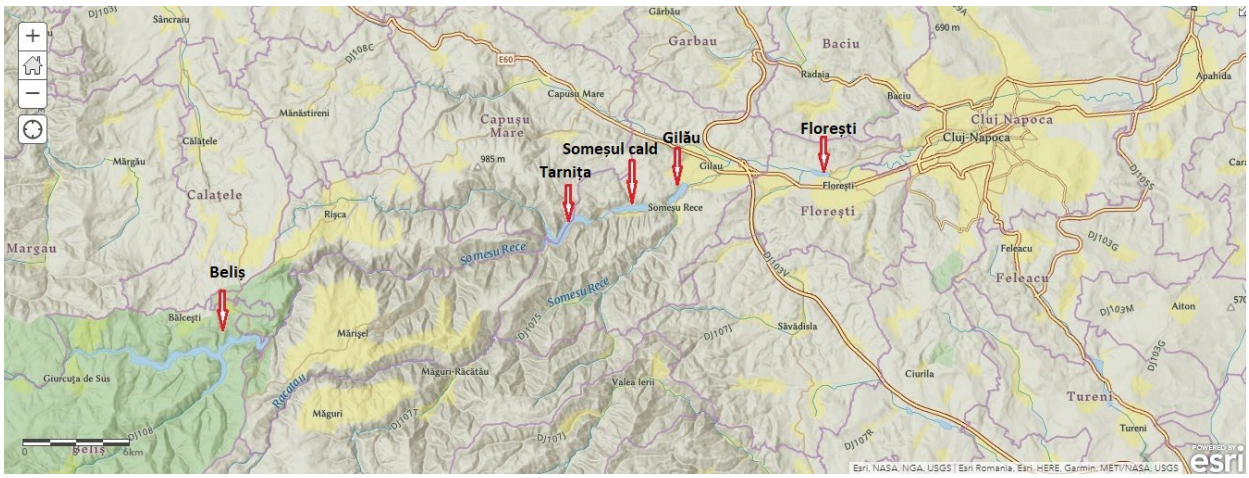

Figure 3. Lakes upstream of Cluj-Napoca

2. The study objectives

The main objective consists of poiting out and evaluating the water security threats in the target area, and identifying means to control/reduce of the related risks. In addition, we propose the development of a water sources national security strategy in Romania.

2.1 The significance of the study

Until the present time, there is no study that highlights in a structured way the threats to the water sources in the area served by the Someș-Tisa basin water administration (Abast) or the Someș Water Company (CAS). The author's intention is that the present thesis will be a source of information and observations, and it will be made available to the competent authorities, in order to develop future strategies.

2.2 Research methods

In order to achieve the established objectives, open sources and specialized literature were consulted. In addition, public data were requested to the relevant authorities. Subsequently, the author identified the risks that may arise on water security in the area of interest, which he evaluated from the perspective of probability and impact, thus creating a risk matrix. Subsequently, solutions were suggested to mitigate the identified risks.

3. Results

Sugerăm ca riscurile să fie cuantificate în funcție de probabilitatea de apariție și de impactul pe care l-ar putea avea în cazul în care s-ar materializa. Pentru a-i clasifica, acestora le-au fost atribuite următoarele scoruri: 0-20 pentru valori foarte mici, 21-40 pentru valori mici, 41-60 pentru valori medii, 61-80 pentru valori mari și 81-100 pentru valori foarte mari, tabelul 1.

We suggest that risks must be quantified according to the probability of occurrence and the impact it could have if materialized. To classify them, the following scores were assigned: 0-20 for very low values, 21-40 for small values, 41-60 for average values, 61-80 for high values and 81-100 for very high values, Table 1.

Table 1. Classification of probability of occurrence and impact (Susenoa, Wibowo, & Setiadji, 2015)

The probability of occurrence	Impact score
Very small	0-20
Smal	21-40
Medium	41-60
High	61-80
Very high	81-100

Scorul final este dat de media aritmetică dintre indicii probabilității de apariție și impact, rezultatul fiind clasificat în 5 clase: A, B, C, D și E, conform tabelului 2.

The final score is given by the arithmetic mean between the probability of appearance and impact, the result being classified into 5 categories: A, B, C, D and E, according to table 2

Table 2. Risk classification (Susenoa, Wibowo, & Setiadji, 2015)

Risk	Interpretation	Classification
High impact/ high probability	**Very high** **They are the highest risks to which special attention should be given.**	**A** **80-100**
High Impact / Average probability	**High** These risks have either a high probability of occurrence or a significant impact	**B** **60-80**

Average Impact / High Probability		
Average impact / Average Probability	**Medium** There is an average chance that risks with a noticeable impact to appear.	**C 40-60**
Average impact / Low Probability Low impact / Average probability	**Low** These risks may occur in some situations and have a low or medium impact.	**D 20-40**
Low impact / Low Probability	**Negligible 0-20** These are risks with low probability of occurrence and low impact. That is why they can be neglected.	**E 0-20**

3.1 Legislative deficiencies.

Because the Romanian national legislation is harmonized with the European legislation, possible legislative deficiencies or procedural issues would be hardly corrected, because such changes must come from the legislator.

The water regulation regime in Romania is given by a series of laws, Government decisions, EU directives, etc. Among the most representative are the Law of Water 107/1996 and GD 930 of August 11, 2005 for the approval of the special norms regarding the character and size of the sanitary and hydrogeological protection areas.

Thus, for the sanitary protection of the water sources, classified protection areas were instituted as follows:

a) the area of sanitary protection with severe regime - comprises the land around all underground or surface water sources and their related catchments. In these perimeters it is forbidden to carry out activities that could lead to contamination or impurification of the water sources.

b) the sanitary protection area with restriction regime - is around the area of sanitary protection with severe regime. Depending on the local specificity, specific measures are applied in order to eliminate the danger of altering the water quality.

c) the hydrogeological protection perimeter – represents the surface between the supply and discharge areas to the surface and/in the underground such as: springs, drains or boreholes. The role of this perimeter is to ensure protection against polluting

substances that are difficult to degradable or non-degradable, as well as to restore the flow taken through catchment activities.

Pentru lacul Tarnița, lățimea zonei de protecție este de 25 m, conform legislației în vigoare.

În ceea ce privește frontul de captare din Florești și proiectele care l-ar putea influența, amintim unele dintre cele mai importante normative legale aflate în vigoare menite să-i asigure protecția față de asemenea intenții:

- dimensiunea zonei de protecție sanitară cu regim sever se calculează astfel încât să se asigure un timp de tranzit în subteran al apei de cel puțin 20 de zile. Dacă nu există suficiente date pentru a face calculul respectiv, zona de protecție sanitară cu regim sever va avea următoarele dimensiuni: 50 m în amonte, 20 m în aval și 20 m de o parte si de alta a captării, pe direcția de curgere a apei în subteran.
- dimensiunea zonei de protecție cu regim de restricție se calculează astfel încât să se asigure un timp de tranzit în subteran al apei de cel puțin 50 de zile între punctele de infiltrare și cele de captare.

For Lake Tarnița, the width of the protection zone is 25 m, according to the legislation in force. Regarding the capture front in Florești and the projects that could influence it, we mention some of the most important legal regulations in force designed to ensure its protection against such intentions: - the size of the sanitary protection zone with severe regime is calculated in such a way as to ensure an underground transit time of the water of at least 20 days. If there is not enough data to make the respective calculation, the sanitary protection zone with severe regime will have the following dimensions: 50 m upstream, 20 m downstream and 20 m on either side of the catchment, in the direction of water flow underground. - the size of the protection zone with restriction regime is calculated in such a way as to ensure an underground transit time of the water of at least 50 days between the infiltration and capture points.

3.2 Pollution

To better understand this threat, we will begin by defining and characterizing it. Thus, we can characterize the pollution as point-like (coming from a single source) or diffuse (when the sources of pollution cannot be precisely identified). For an in-depth evaluation of the water quality, information was requested from both the Someș Water Company and the Romanian Waters (ABAST). The data obtained from Romanian Waters indicate exceedances of the indicators: coliforms, faecal streptococci and petroleum

hydrocarbons (Polycyclic aromatic hydrocarbons – generically referred to in the international specialized literature as PAHs). According to CDC (2009), they are produced by burning coal, oil or its derivatives, gas, wood, garbage or tobacco.

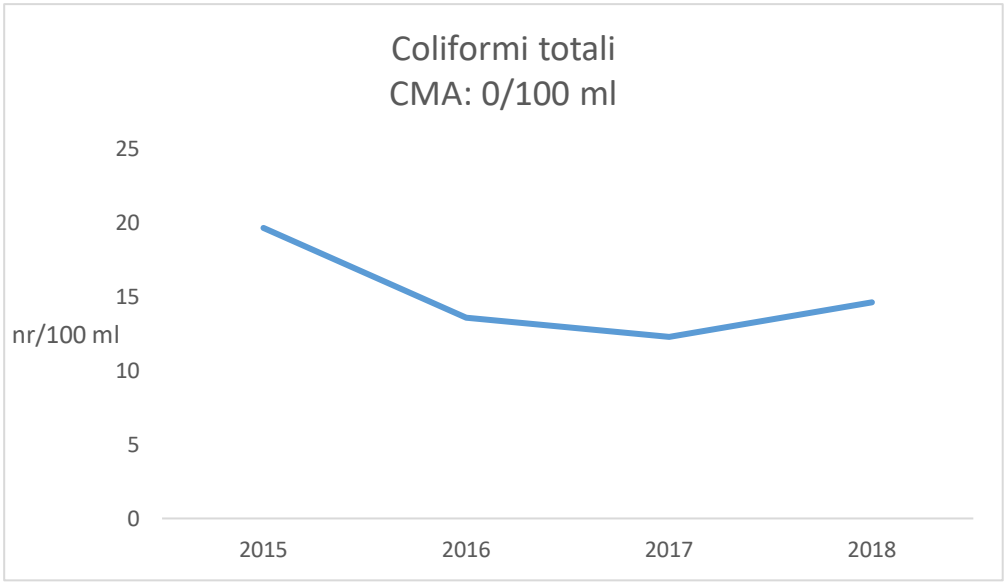

Figure 4. Total coliforms

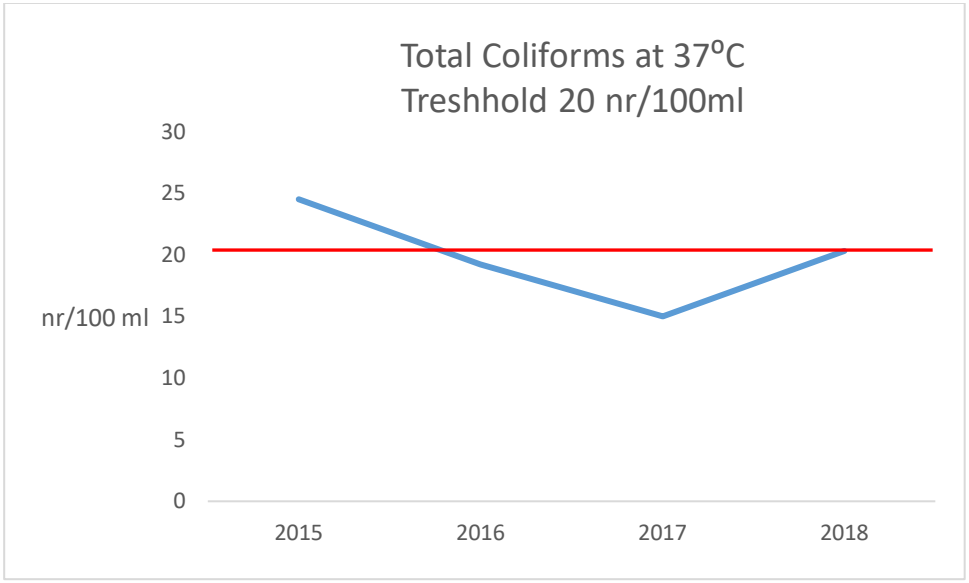

Figure 5. Total coliforms at 37 °C

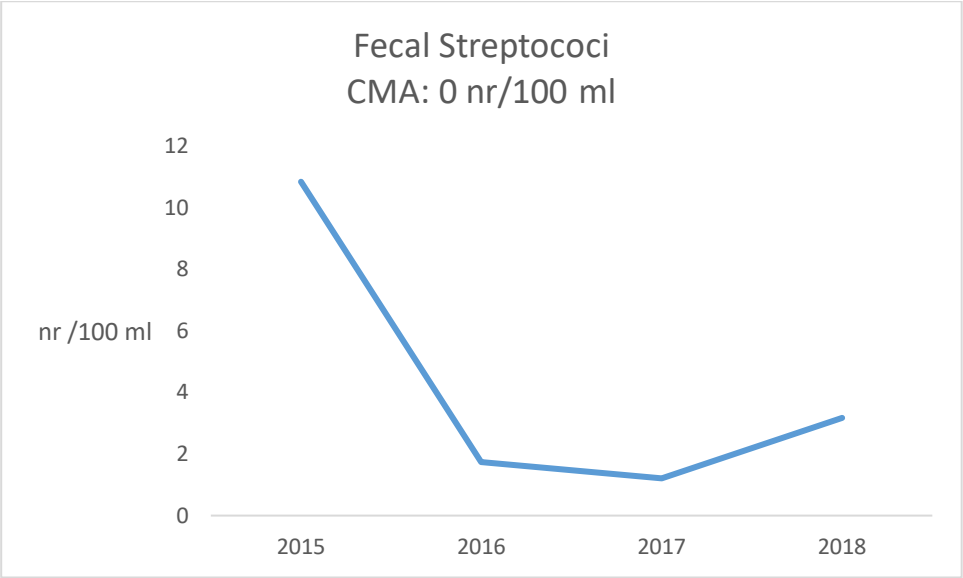

Figure 6. Fecal Streptococci

On the other hand, the data received from the Someș Water Company (sample sampling point - after the Gilău water treatment station) revealed the fact that there is no biological pollution, the parameters falling within the legal limits. Furthermore, no exceedances of the maximum allowed concentrations for polycyclic aromatic hydrocarbons were identified, despite the fact that prior to the treatment process, the average concentration was above 58 µg/L.

3.3 Global changes

Data posted by the National Administration of Meteorology and Hydrology (2016) suggests that the average temperatures will increase in the future on the territory of Romania (figure 7), as an effect of global warming. Moreover, the level of precipitation is expected to decrease (figure 8). The two combined phenomena will have an impact on the amount of water that will be available in the future, meaning that there is a possibility that the supply of the lakes upstream of the Cluj-Napoca municipality will decrease.

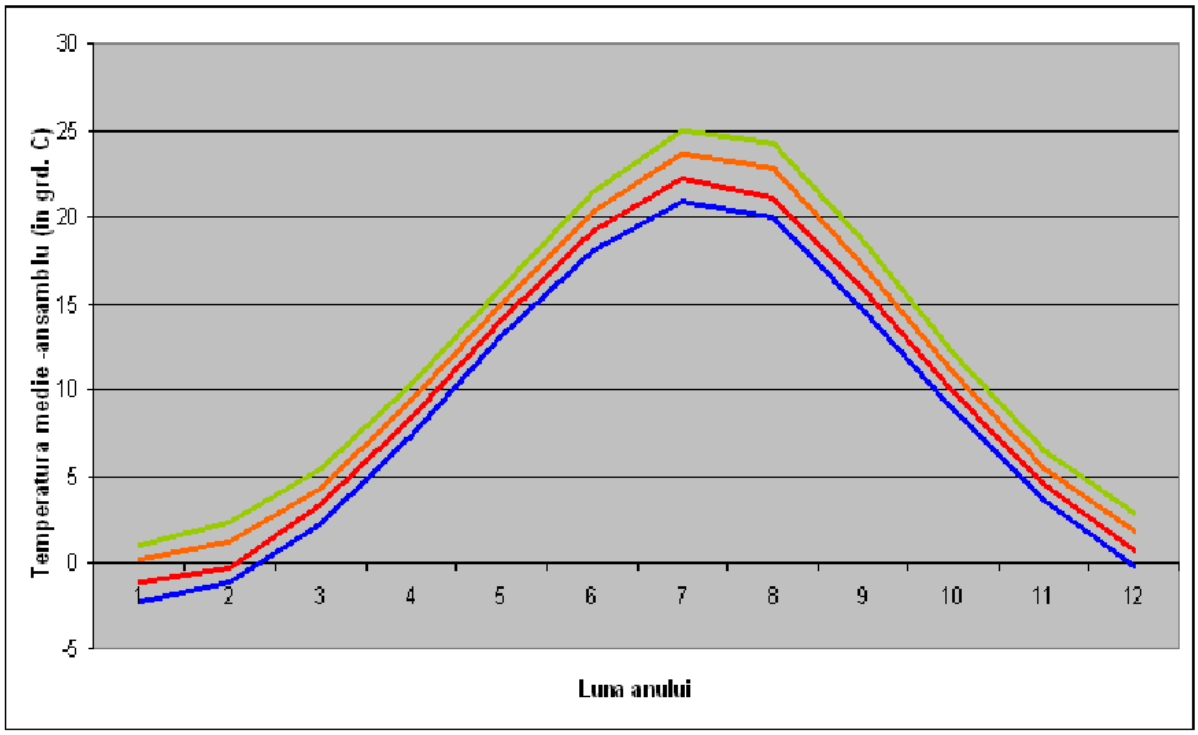

Figure 7 Temperature in the intervals 1961-1990 (blue), 2001-2030 (red), 2031-2060 (orange) and 2061-2090 (green) in the case of the average for Romania (17 climate models extracted from the CMPI3 database – Couple model intercomparison project were used). (ANMH, 2016)

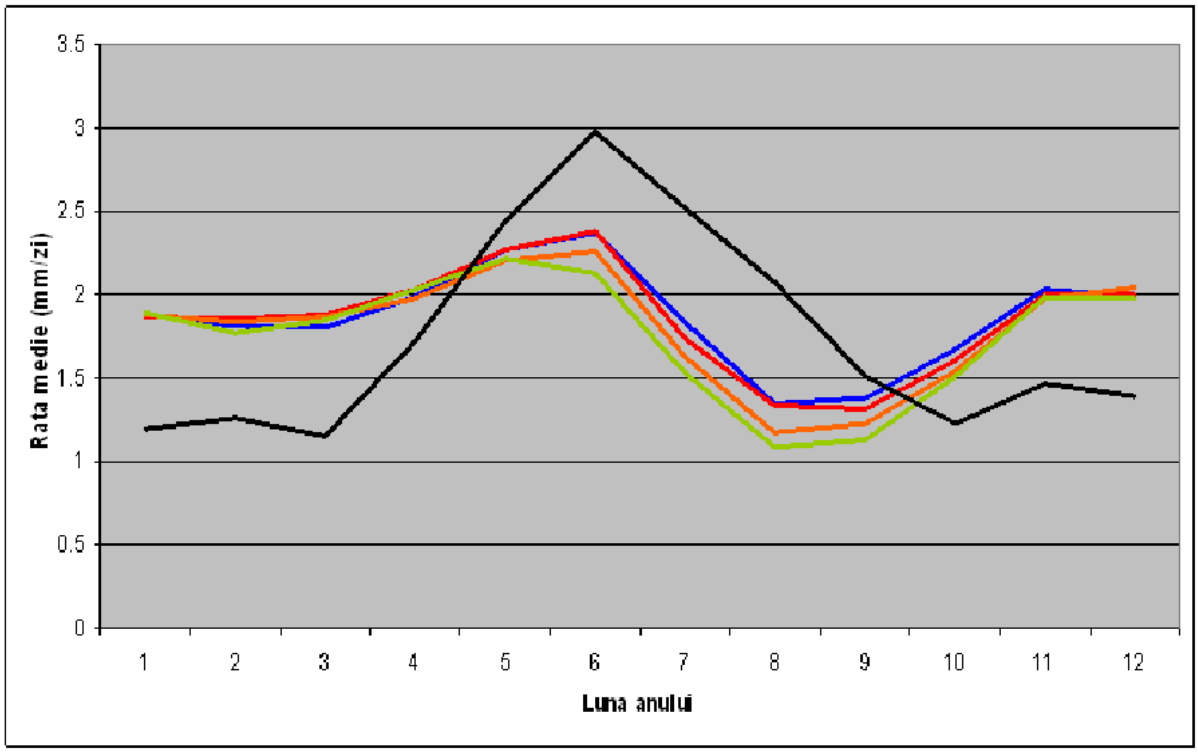

Figure 8. Precipitation in the intervals 1961-1990 (blue), 2001-2030 (red), 2031-2060 (orange) and 2061-2090 (green) in the case of the monthly average, for Romania. The black color represents the seasonal cycle of the daily precipitation rate for Romania (17 climate models extracted from the CMPI3 database – Couple model intercomparison project were used) (ANMH, 2016)

Regarding regional rainfall forecasting, despite the previously presented data, Bojariu et al (2015) suggest that global climate models tend to overestimate precipitation in the cold season and underestimate it in the warm season.

According to the code of good agricultural practices (2014) published by the National Meteorology Agency, the level of precipitation for the counties of Cluj and Sălaj will be approximately the same for the period 2021-2050 compared to the period 1971-2000, respectively an increase of 1.5-3.0% of the average annual amounts and a decrease of 1 -3% for summer ones. However, much sharper decreases are expected in the south and southeast of the country (up to 6% for annual amounts and up to 7% for summer). In conclusion, in the case of precipitation, the uncertainties are quite high, although slight increases in annual and winter precipitation amounts are estimated, as well as a slight decrease in summer. While it appears that climate change will not necessarily cause a problem in the target area, it remains to be seen whether the way water is used will put pressure on the amount of available water, especially during the summer time.

3.4 Water waste / Lack of sustainability

To make an analysis of the water requireents in the area served by Compania de Apa Someș, we must take a look at the beneficiaries. Thus, the 2011 census shows that the population of Cluj county was 691,106 inhabitants and that of Sălaj 224,384. Moreover, according to the data from the presentation film of the Someș Water Company, it serves approx. 750,000 people in the two counties. The main source of water remains Lake Tarnița. A special case is Lake Vârșolț, which supplies water to the municipality of Zalău and the town of Șimleul Silvaniei. Since it is vulnerable to pollution from agricultural activity, it has been considered (for a long time) to supply the area with water from Lake Tarnița, which will demand even more of this water source. Moreover, Cluj-Napoca and its metropolitan area continue to be a regional pole that attracts more and more people. According to the respective institution, the maximum treatment capacity of the Gilău station is 3,000 l/s, i.e. 259,200 m^3/day (7,776,000 m^3/month). Data obtained from the Someș Water Company presented in the first two columns of table 3 highlight the fact that, at the level of the municipality of Cluj-Napoca, water consumption decreased between 2008 and 2016, after which it increased slightly (figure 9). In 2019, consumption stood at approx. 84.31% compared to the value of 2008. The Someș Water Company has not issued a point of view regarding the increase in water consumption in Cluj-Napoca

over the next 10 years, but it forecasts that the average water consumption (l/person/day) will not change.

Table 3. Annual water consumption in Cluj-Napoca municipality

Year	Water consumed m^3	Population according to Eurostat[1]
2008	23.729.626	692021
2009	22.220.243	690590
2010	20.934.500	692339
2011	20.319.661	694136
2012	20.055.089	693608
2013	19.435.516	697457
2014	19.314.516	698929
2015	19.375.600	700655
2016	19.591.624	701258
2017	19.829.765	702771
2018	19.834.418	704759
2019	20.008.422	706905

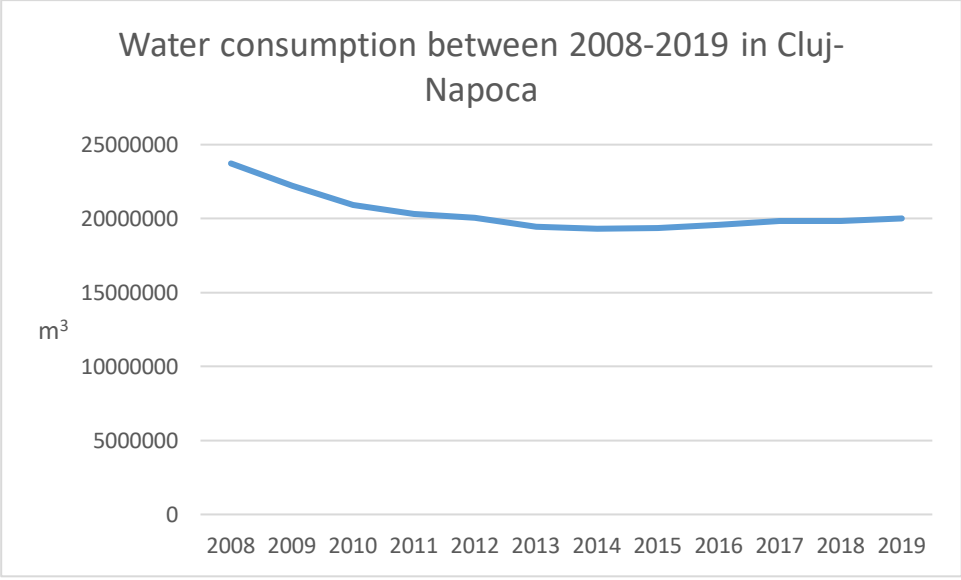

Figura 9. Water consumpion in Cluj-Napoca

As can be seen in figure 17, in 2017 water consumption changed its downward trend. One explanation would be the connection of more customers to the distribution

[1] https://ec.europa.eu/eurostat

network. Thus, we can conclude that, at present, we have both the necessary water resources (volume) and the possibility to treat the required amount.

3.5 Corruption

Definition: in the explanatory dictionary of the Romanian language, this term is described as: "State of deviation from morality, honor, duty".

Possible implications: Most of the time, the main reason why some people resort to acts of corruption is given by the easy gain of some undue benefits (money, positions, etc.). Logically, for one entity to win, it is necessary for another to lose. In terms of corruption in the state apparatus, the loss is directly or indirectly suffered by the citizens, and this is described as "harm". Let's imagine that an invested person (on political criteria) allocates some works directly (under emergency reasons) to certain companies owned by some close ones. There is a risk that they will be overpriced, or not made according to quality standards (by using low-quality materials, etc.), which would ultimately lead to the loss of sums of money intended to ensure security at floods or to remove their effects.

Another manifestation of corruption is the promotion to certain key positions of amateurs, a fact that leads to a loss of expertise and a poor quality managerial act. The risk that the implementation of a large-scale project will be affected by a number of factors is of interest, such as: bureaucracy, the dilettantism of the members of the project implementation team as well as the employees of the other institutions related to the project, the availability of funds necessary for co-financing, corruption, political interests, etc.

3.6 Diversity of water sources: focusing on one, two or more water sources

Regarding the diversity of water sources, the Someș Water Company uses Tarnița Lake as its main source in the Cluj-Napoca area. The Gilău source is maintained as a reserve, while the Someșul Cald Lake represents a reserve for cases when turbidity is exceeded or when accidental pollution occurs in the Gilău reservoir. In addition, the underground catchment in Florești, where the Water Museum is located, is still used.

A report of the Directorate of Public Health (2010) mentioned the fact that 98.28% of the water consumed in the target area comes from the Tarnița lake while 1.78% of the water was obtained from the Florești catchment.

In 2021[2], the water distributed to the beneficiaries came predominantly from Lake Tarnița, in a percentage between 79.32% and 94.61% (figure 19), except for September, when it supplied just over 25%, a month in which 70.4 % of the water was captured from Lake Gilău. Moreover, the water from this lake was used only in October, in proportion of 12.52% and in May, in proportion of 1.24%. Someșul Cald spring is accessed monthly, but in small percentages, between 1.69% and 11.69%, with a higher degree of use in summer. The Florești catchment has a constant, but small, contribution to the total water supplied to citizens, varying between 1.29% and 2.71%.

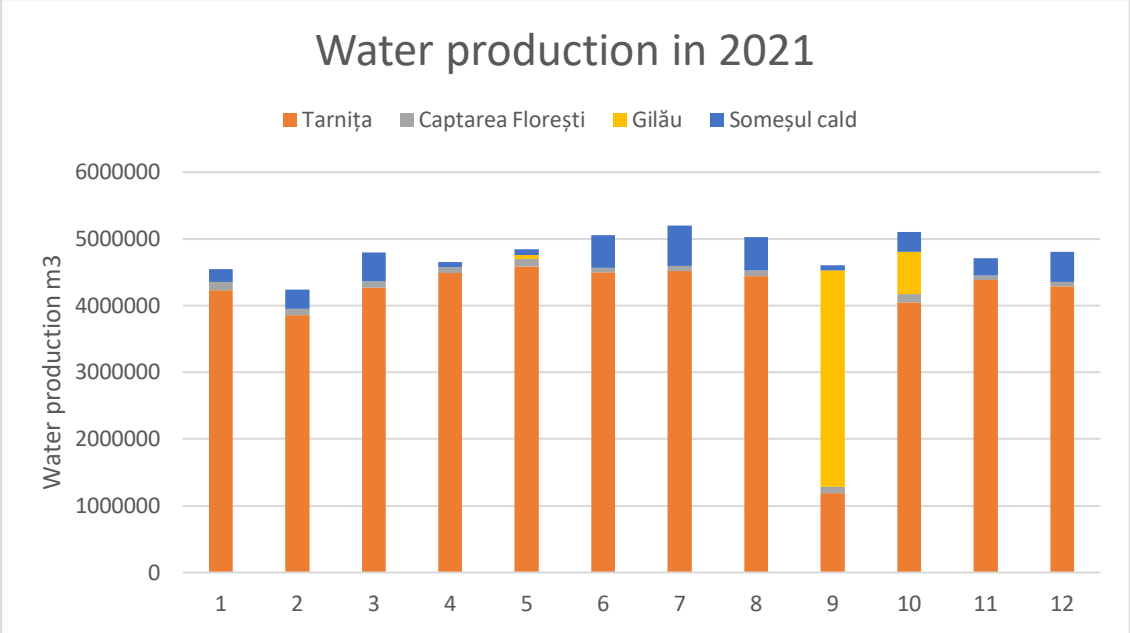

Figure 10. Water production in 2021

On the other hand, according to other data received from the Someș Water Company, the capacity of the Florești source is directly influenced by the ammount of precipitation, the level of the Someș Mic river. The production oscillates between 650-850 l/s. Additionally, they state that this source has an annualy contribution of 25% to the total water supplied in the distribution network. Our conclusion is that the Florești source operates at a low level, but its potential is much higher, meaning that it can make a major contribution to securing the supply of water to the population. The county authorities signed a financing contract for the modernization of the Florești underground source, which involves the rehabilitation of over 100 wells, over 19 kilometers of drains and pipes, the restoration of the chlorination system and the implementation of a new SCADA monitoring and control system. The financing is predominantly European, and the project

[2] Puse la dispoziția autorulilor ca urmare a solicitării nr. 25773 din 15 iunie 2022

must be completed in 2024[3]. According to the beneficiary [4], these works will not lead to an increase in production capacity.

3.7 Physical security: terrorism

Terrorism, according to the Oxford dictionary (2019), is "the illegal use of violence or intimidation, predominantly against the civilian population, to achieve political goals".

The motivation of such attacks can be: ideological, religious, cultural, psychological, etc. Ussualy terrorist attacks targets governments, personalities, different economic agents with a strategic import, national symbols or the civilian population. This does not exclude the possibility that drinking water sources are also a possible target.

According to Peter Gleick (2006), a terrorist attack on a drinking water infrastructure can be carried out directly, by contamination with poison or pathogens. The purpose can be multiple: a large number of human victims, alteration of water quality, destruction of the purification or distribution system.

Evaluating the impact of such a terrorist attack is difficult to quantify, for several reasons: the nature of the chemical or biological substances used, the dilution of toxic substances, the resistance of some people to certain chemical/biological factors, the reaction time of the authorities as well as crisis management (the capabilities providing drinking water from other sources, treating sick people), etc. "Strategic" / restricted areas are easily accessible. Many of the existing dams can be visited, some of them are tourist attractions, the reservoirs are used by the population as a place of recreation, etc. Public perception plays an important role. In the case of natural calamities, people accepts the idea of damage and human casualties. On the other hand, in the case of man-made disasters, public reactions are much harsher / polarized. Thus, the pressure on the authorities is much greater in terms of security and especially how to intervene such events. Thus, the in/ability of the competent authorities, including political/decision makers to manage such a situation can lead to policy change at the highest level. An example of a crisis caused by human factors was the "Collective" case, followed by the Government resignation.

Possible targets related to water security:

- **Infrastructure:** Traditionalyl terrorist attacks could targer the physical infrastructure: storage dams and distribution systems. Due to the fact that dams are

[3] https://www.zcj.ro/administratie/incep-lucrarile-de-modernizare-a-sursei-de-apa-subterana-floresti-investitie-de-66-mi-lei-fonduri-europene--235191.html

[4] Puse la dispoziția autorilor ca urmare a solicitării nr 9152 din 18 martie 2024

usually robust constructions made of concrete, stone, rebar, etc., an attack with small explosive devices has little chance of causing significant damage. If an attack on a dam were to completely compromise it, the loss of human life could be significant, due to the fact that there are currently human settlements downstream of such constructions.

Additionally, there would be great difficulties in the supply of drinking water. The ability to generate electricity would also be affected.

Terrorist attacks would have a maximum impact if there are no parallel systems to ensure operation continuity, for example: there is only one water main that supplies the only treatment station that serves a certain area.

- **IT network:** A cyber attack leading to loss of control in the catchment area, treatment, pumping and flow regulation systems could lead to serious compromise of water supply capability or alteration of its quality. According to John Heilprin (2005), control systems or SCADA (supervisory control and data acquisition) systems were built without paying particular attention to their security, which means they are vulnerable to a cyber attack.
- **Biological or chemical attacks:** most of the time, such a scenario implies terrorists using some pathogenic or chemical agents, which are introduced into the water saource, water treatment plant or distribution network.

However, this is not as easy as it seems at first glance. Thus, the chemical or biological substances used must have certain characteristics for the threat to materialize. So they would would have to be:

- produced/dispersed in a sufficiently large quantity to represent a risk to human health;
- dispersable by the carrier vector: be soluble, stable in the aquatic environment;
- infectious, virulent or toxic, so as to affect as many people as possible over a wide area;
- resistant to certain treatment technologies and last a long time in the carrier environment, in order to reach the target. The Environmental Protection Agency (2002) exemplifies in table 4, some of such substances, possible sources as well as the level of limited acces.

Tabel 4. Contaminanți chimici și biologici. Surse, acces și restricții (EPA, 2002)

Type	Example	Source	Limited Acces

Biological contaminants			
Bacterias	Bacillus anthracis, Brucella spp., Burkholderia spp., Campylobacter spp., Clostridium perfringens, E. coli O157:H7, Francisella tularensis, Salmonella typhi, Shigella spp., Vibrio cholerae	Natural sources, laboratories and programs sponsored by governments	Yes, for certain biological agents
Viruses	Enteroviruses, hepatitis virus, smallpox	Natural sources, laboratories and programs sponsored by governments	Yes, for certain biological agents
Parasites	Cryptosporidium parvum, Entamoeba histolytica, Toxoplasma gondii	Natural sources, laboratories	Does not exist
Inorganic substances			
Corrosive / caustic	Hydrochloric acid, sulfuric acid, sodium hydroxide	Trade, industry	Does not exist
Cyanide salts or cyanogens	Sodium cyanide, potassium cyanide, cyanogen chloride	Suppliers, industry (galvanic)	Yes
Metals	Mercury, lead, osmium and their salts, organic compounds and complex (even	Industry, laboratories, suppliers	Yes

	those of iron, cobalt, copper are toxic at high doses)		
Oxyanion	Arsenate, arsenite, selenite salts, organoarsenic, organoselenium compounds	Trade, industry, laboratories or various suppliers	Yes
Organic chemicals			
Fluorinated organics	Sodium trifluoroacetate (a rat poison), fluoroalcohols, fluorinated surfactants	Industry, laboratories or various suppliers	Yes
Hydrocarbons and their oxygenates and/or halogenated derivatives	Paint thinners, gasoline, kerosene, ketones, alcohols, ethers (eg methyl tert-butyl ether or MTBE), halohydrocarbons (eg dichloromethane, tetrachloroethene)	Trade, industry, laboratories or various suppliers	No
Chemicals that affect the senses	Thiols (eg, mercaptoacetic acid, mercaptoethanol), amines (eg cadaverine, putrescein), inorganic esters (eg trimethylphosphite,	Laboratory, suppliers military warehouses	Yes

	dimethylsulphate, acrolein)		
Organic substances, miscible with water	Acetone, methanol, ethylene glycol (antifreeze), phenols, detergents	Trade, industry, laboratories or various suppliers	No
Pesticides other than insecticides	Herbicides (eg chlorophenoxy or atrazine derivatives) rodenticides (eg zinc phosphide)	Commerce, industry, agriculture, laboratory	Yes
Pharmaceutical products	Cardiac glycosides, some alkaloids, antineoplastic chemotherapy, anticoagulants. Illegal drugs such as LSD, PCP and heroin	Laboratory, supplier, pharmacy, some natural sources	Yes
Chemical agents with potential / military use			
Chemical weapons	Organophosphate nerve agents (eg, sarin, tabun, VX) alkyl chloride amines and thioethers, respectively	Suppliers, military depots, some laborator	Yes
Biotoxins			
Biologically produced toxins	Biotoxins from bacteria, plants, fungi, poisons of marine or terrestrial animals. Examples include ricin,	industry, pharmacies, laboratories, some natural sources or military research	Yes

	saxitoxin, botulinum toxins, mycotoxins T-2, microcystins	programs of some governments	
Radiological contaminants			
Radionuclides	It does not refer to nuclear weapons. Radionuclides can be used in medical devices and industrial irradiators (Cesium-137 Iridium-192, Cobalt-60, Strontium-90). Class includes both metals and salts.	Laboratories, state sources or waste treatment plants	Yes

Regarding the dams located upstream of Cluj-Napoca, according to Hidroelectrica SA, the data on the security/security measures of the dams in Romania as well as the data on the physical status of the constructions cannot be disseminated to the public.

3.8 Physical security / protection

In order to observe the protection measures of the Tarnița dam and the catchment outlet, on 28.07.2019 a trip to the area was carried out, where the following aspects were observed:

- Car access is prohibited on the servitute road to the capture tower (probably with the exception of riverside residents). At the intersection with DJ107P, there is a checkpoint where a security guard was operating at the time (who was not equipped with self-defense / immobilization equipment, etc., wearing only the employer's insignia). The employee in question allowed the access of some vehicles on the road leading to the pumping station against some sums of money. Within 30 minutes, approx. 5 cars, two of which were equipped with trailers containing sky-jets. Moreover, upon request, that employee nonchalantly provided data about the precise location of the water main in the area (supply pipe), including to unknown persons.

- Although the local control and maintenance center is equipped with a fence, both the access gate to the complex and the entrance door to the station were open (figure 11), thus facilitating unauthorized access by unauthorized persons.

The actual construction of the intake was surrounded by a system of buoys located approx. 5 m of construction, a system that does not offer any kind of physical protection if access is attempted from the water. Moreover, several motorized boats were observed in the area carrying out recreational activities, which, in addition to polluting the water, can easily reach the prohibited perimeter.

A first conclusion would be that physical protection is extremely deficient. There is thus a contest of elements that, when added up, can generate great risks on the supply of water to the treatment plant: corruption, lack of professionalism, non-compliance with minimum security standards, etc.

Figure 11. Access to the pumping station (open gate and door)

3.9 Deforestation

Unfortunately, the phenomenon of massive deforestation continues to manifest itself in Romania, one of the most affected areas being the Apuseni mountains.

The existence of forests has a beneficial cumulative effect on the stability of an ecosystem. The presence of trees moderates the components of the hydrological cycle by increasing the level of evapotranspiration and water retention in the soil. They retain moisture in the soil better than grasses whose level of evapotranspiration is low. More

evapotranspiration means more moisture, so more clouds form. In the case of heavy rains, a forested area will facilitate the infiltration of water into the soil, meaning that it will be captured by the receiver over time, without causing flooding or destruction. On the other hand, the presence of grassy vegetation, or worse, the total lack of vegetation, leads to the emergence of the phenomenon of stringing, affecting both the soil, the water quality (through a load of organic material or human waste) that reaches the riverbeds.

From a hydrographic perspective, in the case of rains, the lack of trees leads to the massive loading of rivers in a short period of time, which leads to floods and pressure on catchment dams. Thus, instead of a constant and reliable supply, in a deforested area we can talk about too much water, followed by too little water. The presence of trees also leads to better mixing of air currents. This reduces the perceived temperature, which is higher in grassy areas where the air is drier. Last but not least, trees fix more CO_2 than grasses, which is why their absence accelerates the process of global warming.

It is difficult to quantify the effect of deforestation in the area of the Apuseni mountains on Cluj's water source, especially since the phenomenon is a dynamic one. If the impact on evapo-transpiration can be low due to the small surface of the area, in case of heavy rains we can talk about floods, situations in which water with a level loaded with organic material and pollutants can reach the reservoir. Moreover, the lack of vegetation to favor the infiltration and preservation of moisture in the soil would accentuate the decrease in the level of the water sources, especially during periods of drought.

3.10 Risk quantification and classification.

To develop the risk matrix, I assigned each risk a score for the probability of materialization and another for the impact it can generate, centralized in table 10.

Thus, the risk associated with legislative deficiencies was assigned a low probability of occurrence, score 20, and a medium impact, score 50, but it could vary depending on the change that would bring it. This could be a small one, but it could also have big implications, because the legislative change is a systemic one, on the surface of the entire European Union.

Regarding the risk of pollution, it was assigned an average probability of occurrence, score 50. The reasons are multiple, among them non-compliance with legal provisions: the use of motorized boats on the surface, the lakes used as a water source,

the construction of buildings in the immediate vicinity their vicinity, the discharge of household water directly into lakes, non-compliant agricultural practices, a poor education of those who carry out activities in the area, etc. Moreover, with regard to capturing Florești, there are constant proposals from certain entities that the area should also have the utility of a space for a promenade or bicycle transport from Florești to Cluj-Napoca. Moreover, in the northern vicinity of the area, the Cluj-Napoca municipality belt would be built, which will connect the city to the Transilvania highway.

The risk associated with climate change has a very high probability of materializing, score 80, the consequences being visible not only in Romania, but everywhere in the world. Regarding the impact it might have in the area that is the subject of this work, it was classified as small, score 40, but bordering on medium. The explanation is based on the fact that the hydrological studies do not forecast the reduction of precipitation and implicitly the decrease of the main water sources.

Water waste was assigned a low probability of materialization, score 20, due to water metering, upgrading of existing networks and construction of new ones. The impact was assigned a low score of 25 due to the fact that there is currently sufficient water to serve the beneficiaries.

The risk associated with corruption is difficult to assess. The probability of materialization remains high, score 60, a fact also mentioned in international reports. The impact may vary, depending on the seriousness of the acts of corruption. For the time being, we suggest a low impact, score 20. On the other hand, if the ability to deliver optimal and timely results is affected by such practices, the impact could increase to a high or very high level.

Regarding the lack of diversity of water sources, the probability of the occurrence of such a problem is low, score 20, due to the 3 lakes available to supply water to the Gilău treatment plant, which, in time, will serve the population of Cluj and Sălaj counties. Impact is assigned a low score of 40, bordering on medium, due to the fact that the literature provides numerous examples where a single source can satisfy the quantity and quality requirements of the citizens served.

According to the Romanian Intelligence Service, the probability of a terrorist attack is low, which is why it is assigned a score of 10. Despite this, the physical protection systems of some elements part of the water infrastructure (dams, mains, water basins), are non-existent or leave much to be desired. As for the impact it could have on water

security, it can vary depending on the nature of a possible attack, so the score could take values between 1 and 100 (if removing from use of dams, treatment plant or transport mains.). Thus, we suggest an average value, score 50.

Regarding deforestation, the probability of materialization is average, score 50, this phenomenon being often encountered in the Apuseni mountains. The impact that such practices can have is relatively low, score 30, mainly affecting the soil in the vicinity of the lakes, which would lead to potential seepage phenomena and implicitly, to the loading of waters with organic material. Secondly, it leads to the modification of the components of the hydrological cycle, thus reducing the supply capacity of the lakes.

Tabel 5. Clasificarea riscurilor dintr-o perspectivă a probabilității și impactului

Nr. crt.	Risk	The probability of occurrence		Impact		Degree of risk exposure	
		Probability	Score	Probability	Score	Probability	Score
1	Legislative deficiencies	**Small**	20	**May vary**	50	**D**	35
2	Pollution	**Medium**	50	**Very small**	10	**C**	30
3	Climatic changes	**Very high**	80	**Small**	40	**B**	60
4	Water waste / Lack of sustainability	**Small**	20	**Small**	25	**D**	22
5	Corruption	**High**	60	**May vary**	20	**C**	40
6	Lack of diversity of water sources	**Very small**	10	**Small**	40	**D**	25
7	Terrorism	**Very small**	10	**May vary**	50	**D**	30
8	Deforestation	**Medium**	50	**Small**	30	**C**	40

As can be seen in the risk matrix (figure 12), there are no risks that can be found at the two extremes. Half of the identified risks (waste/lack of sustainability, legislative deficiencies, terrorism and lack of diversity of water sources) may occur in some situations and have a low or medium impact. Risks that have a medium chance of occurring and having a noticeable impact are deforestation, pollution and corruption.

Climate change is the risk that scored the highest, therefore would require the most attention / the most resources used to reduce it.

		IMPACT				
PROBABILITY		Very small	Small	Medium	High	Very high
	Very small			Terrorism		
	Small		Water waste / Lack of sustainability Lack of diversity of water sources	Legislative deficiencies		
	Medium	Pollution	Deforestation			
	High		Corruption			
	Very high		Climate changes			

Figure 12. Risk matrix

4. Discussions

4.1 Measures to counteract legislative deficiencies

It is difficult to argue that the legislation in force, harmonized with the Community legislation, has obvious deficiencies that represent an immediate risk to water security. There were occasional requests regarding the lack of measures to increase the security of environmental workers (eg employees in charge of forest protection requested firearms to protect themselves in the exercise of their duties).

On the other hand, in Romania there is a problem of compliance, control and application of coercive measures in almost any field. Failure to comply with the legal provisions results either from ignorance of the law or from bad will. If an education of citizens can solve the first premise, the willful violation of the law for personal gain must be identified and punished according to the law.

Control activities are important because they ensure compliance with legal provisions and can require corrective action where appropriate. The effort to identify non-compliant situations should not only be of the authorized inspectors, but also of citizens or other involved factors, who can signal such events in time.

Regarding possible legislative deficiencies, the authorities directly or indirectly involved in water security are the most competent to identify them and signal them to the legislators, who are in a position to decide/adopt additional measures

4.2 Pollution control measures

Water pollution prevention requires measures adrerssing water sources and the distribution system.

Thus, in order to reduce the pollution of source lakes, the following measures can be implemented:

- Educating the riverside population and informing tourists about the effects of pollution and the importance of individual effort to preserve the quality of the water they consume.

- Implementation of efficient waste management in its vicinity, to reduce the amount of waste that ends up in the lake. Representative in this sense are the plastic waste that

has an immediate visual impact and that could be selectively collected easily, with a view to further recovery.

- The connection to a sewage system of all housing units in the area, in order to avoid situations in which the waste water ends up either directly in the lake or indirectly, from various septic tanks. Water safety from the consumer's perspective does not only mean that it meets legal parameters when it leaves the treatment plant, but that the water is of good quality and safe for consumption when it reaches the tap. Thus, it is equally important that pollution / contamination does not occur in the distribution system. For this desired to happen, the old pipes and components must be replaced with new ones, made of materials that do not degrade in water and that reduce the formation of bio-filmt.

The competent authorities (Romanian Waters or the Environmental Guard) must intensify their control activities aimed at identifying polluting entities, regardless of whether they are individuals or economic operators. If non-compliant practices are identified, fines must be applied according to the "Polluter pays" principle and the necessary ecological and sanitary remedial measures initiated.

Additionally, cleaning the source lakes must be carried out regularly. Such initiatives are usually being done by citizen or NGOs.

Furthermore, a good solution would be to initiate and accelerate research-development activities, in order to optimize water treatment processes, by making them more economical and more efficient, more precise, and require less operation energy.

Last but not least, water operators must ensure that the treated water meets the legal parameters to be discharged into natural receivers, as these could represent water sources for downstream users. For this reason, treatment plants must be modernized and expanded to process a large volume of water. In order not to put additional and irrelevant pressure on these stations, rainwater collection systems must not mix with sewage systems. In the future, where this is possible, collecting channels can be built to discharge into treatment ponds, such solutions being simple and can be found in countries like England or the Netherlands.

It is important to know that, in 2004, when Romania was in the process of joining the European Union, a strategy was developed to implement the provisions of Directive 76/464/EEC regarding the pollution caused by certain hazardous substances discharged into the environment aquatic. The strategy (2004) has 5 points:

1) Reduction of heavy metals in discharges, a measure that involves:

- Gradual elimination of the causes leading to the discharge of wastewater containing Hg.
- Total modernization of water intake and sewage systems of industrial units that continue to use heavy metals.
- Modernization of water and sewage systems, including industrial wastewater pre-treatment stations, in those units where heavy metal concentrations were exceeded in wastewater discharged into the receiver or into the sewage network or which were close to the limit values. The measures concern the following metals: Hg, Cd, Zn, Cu, Ni, Cr, Fe, Ag, Mn, Co, Pb, Al and As.

2) Reducing the amount of pesticides in discharges. The measure targets the following substances: hexachlorocyclohexane (HCH, lindane), DDT, aldrin, dieldrin, endrin and isodrin. DDT was banned from being produced, sold or used in 1995 and the drins (aldrin, dieldrin, endrin, isodrin) in 1972. As for DDT, 6641 kg were identified and inventoried in 250 places located on the national territory, which was then stored according to the regulations regarding the hazardous waste regime.

3) Reducing the amount of chlorinated solvents discharged into waste water. The substances concerned are: carbon tetrachloride (its production is prohibited in Romania), trichlorethylene and perchlorethylene (whose use was gradually reduced until 2007), chloroform and ethylene chloride. Discharging them into sewage networks is prohibited.

4) Reduction of wood impregnation agents discharged into wastewater. The measure targets pentachlorophenol (PCP), which has been banned since 2008, and its presence in sewage networks is prohibited.

5) Reduction of discharges into sewers of some chlorine-containing by-products. The following compounds are targeted: hexachlorobenzene, hexachlorobutadiene and trichlorobenzene. Their presence in sewage networks is prohibited.

From the report of the Ministry of the Environment (2021), many potential sources of pollution (agricultural or industrial) have been identified accros the national teritory, as can be seen in figure 13. Near the water sources used by Compania de Apa Someș there are industrial and some agriculture sources of pollution.

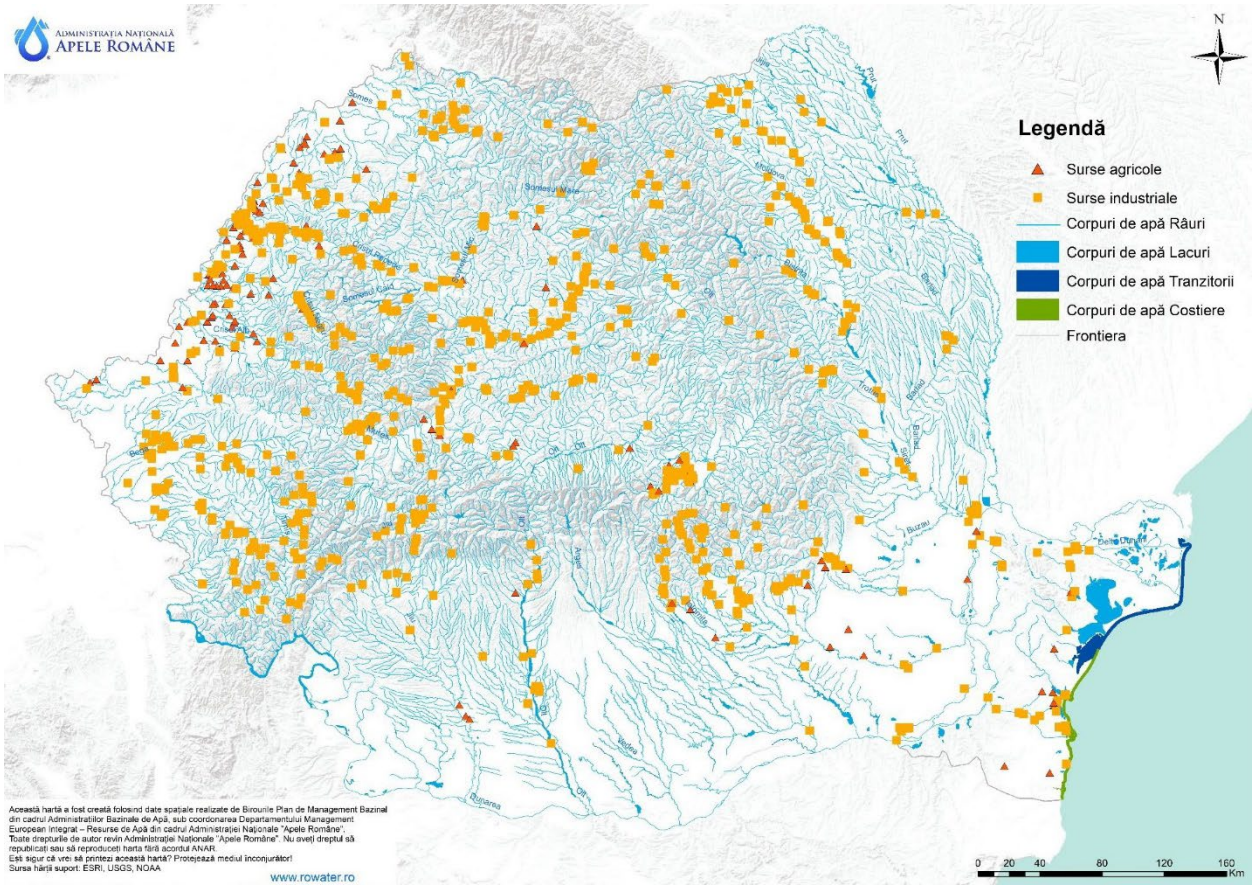

Figure 13. Point sources (agricultural and industrial) with significant pollution potential - (Ministerul Mediului A. ș., 2021)

4.3 Measures to counteract climate change

Considering the global impact generated, measures to reduce this risk must be implemented at the macro level, by all states, depending on resources and capabilities. Moreover, the financially powerful states must support the poor ones, especially since, most of the time, they use outdated technologies that generate greenhouse gases.

We believe that the following measures would have the greatest impact on reducing global warming: increasing the share of renewable energy sources, replacing fossil fuels with ecological ones. Moreover, the wood exploitation must be done in a sustainable way concurrently with massive afforestation. Such activities would make a significant contribution to controlling CO2 in the atmosphere.

An important measure is educating the population, at all levels, regarding the impact that climate change produces. To be effective, such activities must be age-appropriate for the target population and must clearly highlight how it can directly affect them, so as not to generate abstract discussions and hostile reactions. Research and development of new technologies is a crucial measure to support policies that combat global warming. The results of such innovation activities must generate products and

technologies that require fewer manufacturing resources, have lower energy consumption, have a longer life span, pollute as little as possible, and finally, have a high degree of recycling and reuse of its components.

On a local level, citizens can make their contribution to address global warming by reducing energy consumption, using means of transport that pollute as little as possible or thermal insulation of homes. The authorities involved in the water industry can contribute in turn, on the one hand by reducing the energy consumed, and on the other by increasing efforts to become energy producers (installation of solar panels, turbines for hydropower generation, capture and valorization of biogas, etc.).

4.4 Measures to combat water waste

In order to reduce water consumption, we suggest a series of measures, which should be put into practice either by the beneficiaries or by the authorities.

Thus, citizens can reduce their consumption by: using products that consume little water, economical use of water for personal hygiene, repairing/changing faulty faucets, using washing machines or dishes with maximum efficiency, washing dishes, fruits or vegetables in a bowl instead of under running water, using dual-flush toilets or washing personal cars using a bucket and sponge.

People who live in houses can implement additional measures such as: collecting rainwater to use it for irrigation, paving the yard with paving that favors rain water infiltration and protects the soil during droughts, planting some species of trees/shrubs/flowers that consumes small ammount of water.

Furthermore "grey water" cand be treated and reusued for agricultural/irrigation purposes.

Local authorities can contribute to the reduction of waste/consumption through the decision-making act at their disposal. Thus, they can authorize new housing projects only after ensuring that future owners will benefit from all utilities, including water, at a satisfactory level, especially in areas where there is already pressure on existing systems. In the case of larger residential complexes, which have green spaces that need to be irrigated or a swimming pool, the issuance of the construction permit can be conditioned on the implementation of rain water collecting systems and gray water purification

systems. In addition, local authorities can require that all new buildings be fitted with equipment that consumes small ammount of water as well as anti-flood systems.

The Someș Water Company can in turn contribute to reducing waste through various measures. The most practical would be activities to raise public awareness of the need for responsible water use. Moreover, ensuring that all beneficiaries have meters would encourage them to be more responsible with their own budgets. Of course, the biggest impact would be the elimination / maximum reduction of the losses caused by the outdated infrastructure. Thus, CAS together with local authorities can implement projects, including with European funding, to ensure the complete and periodic replacement of old pipes.

Moreover, new technologies can be implemented that allow early and accurate identification of network failures, to reduce intervention time and wasted water. Another measure regarding water delivery during drought would be collaboration between neighboring water companies to ensure sustainable use of sources. For example, the Someș Water Company could collaborate with its counterparts in Turda, (Aries Water Company), in Bihor or Satu Mare. Of course, this is only possible if the distribution networks interconnect with each other, similar to gas or power networks. In the last instance, the Water Companies together with Romanian Waters can decide to resort to rationalization measures when the situations require it. National authorities can require that only products with low water consumption be sold on the market. Moreover, they can lay the foundations for financing projects that support the implementation of systems that purify gray water in order to reuse it for irrigation. Moreover, the concept of "green house" can be rethought, so as not to be limited only to the consumption of electricity/thermal energy that have a counterpart in CO_2 emissions. A critical point in the state's investment projects is the irrigation systems. Their goal is to ensure food security, especially in the current geopolitical context and global warming. From a water security point of view, the implementation of such systems using different sources, even of lower quality, would reduce the pressure on drinking water sources. Furthermore, funding agricultural and technological research/development could lead to the establishment of crops that require less water. In addition, the state could require industrial operators to implement advanced technologies to meet not only legal emissions regulations, but also to reduce their water consumption and CO_2 emissions, of course, without compromising on product quality or on-site hygiene for work.

4.5 Anti-corruption measures

This subject is a sensitive one, and risk reduction has two components: prevention and criminal investigation, which is the prerogative of the National Anticorruption Directorate.

Prevention can be done through a series of measures, but in order for them to be implemented, it is necessary to have political support and consensus in this regard. Thus, hiring, promoting and appointment the top management of institutions must be based on skills, meritocracy and transparency. Also, the activity of the employees must be carried out based on solid principles such as: professionalism, honesty, good faith and must be people-oriented. Also as preventive measures, controls and external audit activities can be carried out, which ensure a fresh vision.

On the other hand, if the risk materializes in acts of corruption, addressing them must be ensured as quickly as possible, both to limit the consequences and to discourage similar acts

4.6 Measures to combat the risk pose by the lack of diversity of water sources

As previously presented, in the area that is the subject of this thesis there are enough sources to provide water to the entire population.

Despite this, point underground catchments must be maintained as strategic reserves, despite the small contribution they make. It is auspicious that the authorities have recently decided to modernize and expand the Florești water source, thus recognizing its importance.

If, on one hand, there are sufficient water resources, on the other hand, only one treatment station (Gilău) is used and the existence of some physically exposed water mains, increase the risks that, in cases of force majeure, water won't reach the customers. the causes can be multiple: major breakdowns, natural disasters, sabotage or terrorism. Although the construction of treatment plants and back-up mains would contribute significantly to securing the water supply, this is not financially sustainable. It is thus appropriate that, despite the fact that the area has water resources, it should be ensured that the treatment and distribution system has the best physical or cyber protection methods.

One measure that would contribute to the effort to provide water to all citizens is to identify alternative sources for those areas that do not have centralized systems and that are not subject to the expansion projects currently underway. Such sources could be surface (rivers or lakes) as well as underground. Of course, water treatment/purification systems must be implemented in such areas, and the implemented technology must take into account the particularities of the source and the area served

4.7 Measures to counter terrorist attacks

- **Limiting physical access in the perimeter of interest**. Although it seems simple, such a solution is not at all easy, due to the size / length of the treatment / distribution / sewage / purification system. The most practical would be the construction of fences in more sensitive areas. Of course, other measures could be: burying water mains, contracting the services of security agencies, etc
- **Limiting public access to maps of water treatment / distribution systems.** According to Compania de Apa Someș SA, data regarding the entire drinking water infrastructure is strategic information and cannot be made available to the public. Such a measure of secrecy is extremely useful from the perspective of making it difficult to identify a possible target.
- **Implementation of surveillance measures:** lighting some perimeters of interest can be combined with the installation of video surveillance systems or motion sensors. Furthermore, chemicals used by treatment plants must be kept in secure areas, inaccessible to unauthorized persons.
- **Implementarea / actualizarea sistemelor informatice utilizate**. Una dintre cele mai mari amenințări de securitate ale lumii în zilele noastre este reprezentată de atacurile cibernetice. Din păcate în România, cultura de cybersecurity este una redusă, fapt care înlesnește eforturile hackerilor de a pătrunde într-un sistem informatic. Utilizarea sistemelor de protecție/securitate cyber necesită costuri constante, sume care, în lipsa unei bugetări adecvate, pot fi insuficiente, învechite sau pot lipsi cu desăvârșire. Ideal ar fi ca sistemele informatice să aibă o rețea proprie/internă, fără legături la Internet. Mai mult, este obligatoriu ca orice sistem să aibă back-up, să fie actualizat la zi, să utilizeze doar soft licențiat și să fie dotat cu un program antivirus
- **Implementation / updating the IT systems used**. One of the world's hights security threats today are cyber attacks. Unfortunately, in Romania, the cybersecurity culture is low, a fact that facilitates hackers' efforts to penetrate a computer system. The

use of cyber protection/security systems requires constant costs, amounts which, without adequate budgeting, may be insufficient, outdated or missing altogether. It would be ideal for computer systems to have their own/internal network, without links to the Internet. Moreover, it is mandatory that any system has a back-up, that is up-to-date, uses only licensed software and is equipped with an anti-virus program.

- The use of secondary, back-up systems: regardless of whether we are talking about water intake/pumping, treatment or distribution, Such secondary systems can take over, in a case of force majeure, the load of a system taken off-line by different methods, it can provide water to the population, and thus avoid a crisis of proportions.intensity
- **Implementation of early warning systems:** according to Caran and Brosnan (2000), the use of such systems allows a quick identification of possible contamination events (in the case of chemical or biological attacks), and implicitly, leads to an effective response from the authorities.
- **Reactions of the authorities** is imperative to develop advanced strategies and plans to respond to real events or misinformation.

Among the measures that could be mentioned in such a plan would be: constant, clear and real-time information of the population, temporary shutdown of the system in conjunction with the delivery of water through alternative sources, chemical, biological treatment and disinfection, additional data collection or monitoring, epidemiological studies, health interventions or a combination of these actions.

Obviously, the measures will depend on the nature of the attack, the affected population and the characteristics of the treatment system.

A key component to the success of any response will be the preparation of a plan in advance that provides guidelines for all stakeholders: beneficiaries, emergency management, law enforcement, water company personnel, community leaders, and the local media. Such a plan should be considered part of comprehensive emergency planning for a range of public health threats.

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4.8 Measures to combat deforestation

It is necessary to afforest large areas of land, in order to restore the micro-climate favoring the evapo-transpiration of plants, as well as to favor the infiltration of water underground to the detriment of the phenomena of seepage or washing of the exposed

slopes, which leads to floods, the destruction riverbeds, soil erosion, water loading with a greater amount of organic material, etc. In addition, activities must be periodically implemented to raise awareness among the population regarding the effect of deforestation in the environment and on water sources. We propose a series of measures, intended to contribute to strengthening the concept of water security, from the perspective of supply. These will be grouped into 3 major directions: water sources, treatment and distribution, to be presented in detail in Table 6. Moreover, from the studies carried out by Love and others (2023) it is clear that cleaner water production contributes significantly to water security.

Table 6. Measures proposed by the author

Item	Proposed measures
Water source	- creation of intakes in the other lakes as well - modernization and expansion of underground sources - keeping remote sources as backup sources - protecting the sources of threats
Treatment	- construction of secondary stations - creation of new, parallel flows - modernization and expansion of existing treatment plants - increasing station security
Distribuțion	- the construction of secondary water mains. - securing the existing highways - secrecy of the distribution network - efficient, innovative management - building large distribution basins along the network

The author is of the opinion that the installation of water intakes in each lake would not only increase the volume of water available, but would give the operator the opportunity to opt for the water that has the best quality at a given time, thus avoiding the limitations given by changes in the physical/chemical/biological parameters of a source at a given time, changes that would make water treatment inappropriate, or would involve high costs. Moreover, a larger volume would ensure, without emotions, water for the future customers of CAS, given the extensive expansion process of the distribution network in Sălaj county as well. Last but not least, the availability of a large volume of water (+ the treatment process) contributes to protecting consumers in the event of

chemical or biological terrorist attacks, according to the principle "the solution is dilution" (RUSI, 2010).

Underground sources must still remain a back-up solution, even if their contribution is reduced in the case of Cluj-Napoca. In the case of CAS, this is all the more important, as there is no dependence of the Florești source on the Gilău water treatment plant, the only one operating in the area. Even if the water main to Sălaj county is under construction, we believe that the Vârsolț source, which currently supplies the municipality of Zalău and the town of Șimleul Silvaniei, must be maintained as a reserve source in the future. Despite the fact that the water from this reservoir does not have the same quality as that from Lake Tarnița, it is the only major source in the area, which can be used in case the future mainline suffers a major failure. The author beliefs that authorities must implement additional measures to reduce the risk of accidental or intentional pollution of water sources (e.g. securing and expanding sanitary protection zones, improving waste and wastewater collection systems in the vicinity of water sources , increasing controls, information activities, etc.).

In addition, the intelligence services must constantly watch over the threats (hybrid or terrorist), which can target such objectives. Figure 14 shows the protection measures implemented by Hidroelectrica in an important area around the perimeter of Lake Tarnița. It is important to note that the situation in 2024 is identical to that of 2019, despite changes in the regional security context. Thus, the access road to the water capture tower is restricted by a manually opened barrier and protected by an employee of a private security company. In addition, there are information boards regarding the status of Lake Tarnița and the legal measures that regulate the area. The author proposes that the guard be provided by cadres of the gendarmerie inspectorate, the barrier be electronically opened, people have access after their identification, there should be a digital diary of the people transiting the area and the objective be video supervised by a dispatched.

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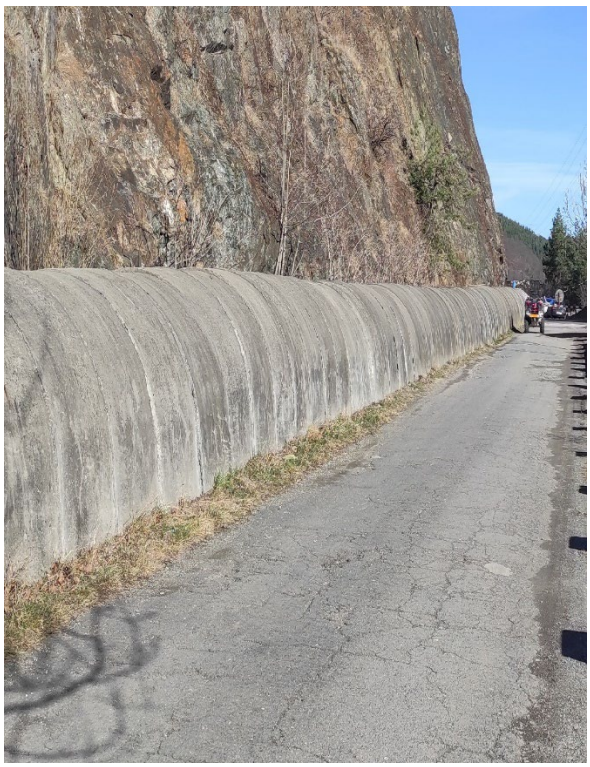
Figure 14. Protective measures - road to the capture tower

Moreover, figure 15 shows the only security measure of the buildings that operate the water collection tower, a fence equipped with a gate. What is worrying is that sometimes, the gate is open, making it easy for unauthorized people to gain access. Our proposal is for the area to be video-surveilled, and access to be made on the basis of an electronic card.

Figure 15. Protective measures - water capture tower (2024)

Regarding the treatment component, CAS prefers to use the Gilău station. Since the singularity of an element in a given system represents a vulnerability, the author suggests two courses of action: building a secondary station, which may not be economically feasible, or building parallel flows in the already existing station. Regarding water sources, treatment plants, as a component part of a strategic system, they must be subject to additional protection measures, especially against acts of sabotage or terrorism. The last systemic element that provides water to customers is the distribution system. In order to increase the security of the water supply, the author proposes a series of measures that can be implemented by the CAS. The first would be the construction of secondary water supply mains, to reduce/eliminate the risk of major outages in the event of a catastrophic failure. Currently, the water main from the intake tower is protected by a concrete tunnel (figure 17), but later it is exposed to the elements and unfettered and unauthorized access (figure 16).



Figuea 17. Tarnița water main

Figure 16. Tarnița-Sălaj water main (Someș C. d., 2018)

As much as possible, it would be ideal for them to be buried so as not to be exposed to the elements or to be difficult to access for people who want to sabotage them. However, to ensure easy maintenance, they can be placed in underground channels.

Regarding water sources and treatment plants, securing the mains must be a priority for authorities and water operators. For those that already exist, fences can be built to make it difficult to access the perimeter. Moreover, accesing routes must be subject to video surveillance and the contracting of the services of security and protection companies. Water mains must be equipped with sensors that signal faults in real time, to limit losses and facilitate intervention actions. Another suggestion would be to increase the secrecy of the distribution network. Althoughif this information is not intended for the public, there are numerous mentions in open sources regarding the projects to extend the distribution system to Sălaj county. A final suggestion made by the author is the construction of large storage tanks along the distribution network. They would bring a

balance when demand is high and represent immediate reserves in emergency situations. Of course, their location must be provided with protective measures.

4.9 Plans and strategies

The evaluation of the current situation, the risks and threats, as well as the ways to counteract them, can be part of a water security strategy, the existence of which we are not aware of in Romania.

To support the authorities in the field, the author compared the water security strategy from the USA and the one from England, in order to identify elements that could be used to develop one in Romania, through its regional or local operators. The motivation for choosing the respective case studies is based on the comparison of different visions of large and medium-sized state entities, such as the case of Romania. In short, the United States of America has developed a water security strategy with global impact, which is consistent with the policy generally pursued by the superpowers. Smaller states, such as England, have implemented a national strategy to coordinate the individual or combined efforts of water operators and other institutions to achieve the objectives.

4.9.1 National Strategy for Water Management

Romania, through the Ministry of the Environment, developed a draft of the National Strategy for Water Management (2024), which is currently following the necessary steps to be completed and ratified. In this material, the term "water security" appears twice.

The strategy consists of 8 chapters spread over 65 pages. The first presents the purpose of developing the strategy, in conjunction with the European and global context. The second chapter presents the current water situation in Romania (resources, legal and institutional framework, as well as that of the human resources involved). In the third chapter, the vision, principles and objectives of the strategy are highlighted. The 4 objectives are focused in two directions: water management and legislation, respectively the institutional organization of the profile, based on 3 specific objectives. The 4 objectives are:

- Integrated management of water resources to ensure their sustainable use. A series of recommendations from the EU as well as quantitative and qualitative water monitoring activities are presented.

- Management and protection of water resources in order to achieve and preserve the good condition of both surface and underground waters, as well as to prevent its alteration. It aims to reduce and avoid pollution of water sources. The development of a subsumed Strategy regarding water supply, waste water collection and treatment is being considered.

- Reducing water-related risks caused by climate change (water shortage and drought, erosion of banks and cliffs, floods) with impact on the population, economic activities, the environment and cultural heritage. The emphasis is on flood protection, presenting the 3 stages through which Romania will implement Directive 60/2007/C.E. regarding flood risk assessment and management.

- Development of the legislative, organizational and scientific framework for water management.

Chapter 3 is incompletely elaborated, but it is intended to focus on water in relation to the population (where there are some desired goals that need to be achieved, such as connection to water and sewage), energy, industry, agriculture, ecotourism and the environment.

Chapter 4 presents a series of measures and actions aimed at:

- development of water monitoring measures and data exchange through international platforms.

- works on water and in connection with water to satisfy the water needs of the uses and to achieve/maintain the environmental objectives. These lack concreteness, being rather objectives of other strategies or plans.

- rehabilitation, maintenance and modernization of existing works. Although the importance of such measures is highlighted, there is no mention of who is responsible, the implementation period, the way of implementation or the sources of funding.

- Non-structural measures for the development, sustainable use and protection of water resources: such as the restoration of longitudinal and lateral connectivity of water bodies or the creation of afforestation in vulnerable areas.

- Consolidation of water education (through a collaboration between educational units and the Romanian National Water Administration), which will lead to the training and improvement of human resources in the water sector.

- The participation of interested parties, communities and local authorities in the implementation of measures and actions in the field of water.

Chapter 5 covers the process of strategic planning in the field of water and the development of public policies. The details regarding the parties involved in achieving

certain strategic objectives, the implementation period and the funding sources are presented in Annex 3 of the Strategy.

Chapter 6 presents the expected results, which, in fact, represent the achievement of the strategy's objectives, and Chapter 7 lists the funding sources: European ones, loans or the state budget.

The last chapter is intended to evaluate the stage of strategy implementation and monitor progress.

4.9.2 National management plan for the national portion of the Danube river basin

Previously, Romania, through the Ministry of the Environment, developed a National Management Plan for the national portion of the Danube river basin (2021), which he updated in 2021. Its content is vast (two volumes: 448 pages + 411 annexed pages), through which the Romanian state aims to:

1. To present the hydrographic areas/basins of Romania.

2. To characterize surface and underground waters - the main categories of water, the pressures on them, the evaluation of the anthropogenic impact on the state of water bodies are presented.

3. To identify protected areas. This chapter classifies protected areas according to their use: drinking water, protecting economically important species, important for habitat, recreation, or areas sensitive to nutrient and nitrate pollution.

4. To present the way in which the water condition is monitored and characterized. Surface and groundwater monitoring networks and programs (quantitative and qualitative) are presented. A characterization of underground and surface water bodies is also done (chemical status assessment, predictions).

5. To define environmental objectives. They are broken down into 3 objectives for:

• underground waters – reaching good quantitative chemical states;

• surface waters – achieving good ecological and chemical status for natural water bodies, and for heavily modified or artificial water bodies, achieving good ecological potential and good chemical status.

• protected areas – achieving the objectives provided by the specific legislation.

6. To make an economic analysis of water use. The analysis is based on economic data at the level of river basins/watersheds, taking into account general indicators such as: population, GDP, gross value added and the correlation of these indicators with water

use both at the resource level and at the service level (water supply, sewage and wastewater treatment).

7. To present programs of measures as well as exceptions from environmental programs;

8. To address climate change and the impact it may have.

The main conclusions are that: the water exploitation index (WEI) indicates a relatively low water stress/deficit, of approx. 4%. After analyzing the trends in the variation of the meteorological parameters and the simulations of the flow evolution, with the exception of the Someş river, whose flow is expected to increase by approx. 6.2%, all other large rivers of the country will decrease in flow.

The forecasted water demand for 2030 in the Someș-Tisa river basin will be in a slight decrease in the urban environment, from 102.96 million m^3 in 2020 to 102 million m^3 in 2030 and in a slight increase in the rural environment, from 88.30 million m^3 in 2020 to 88.96 million m^3 in 2030. Additionally, the water requirement for industrial use is expected to increase from 91.77 million m^3 in 2020 to 113.50 million m^3. Similarly, the water requirement for irrigation is expected to increase from 0 million m^3 in 2020 to 1.30 million m^3 in 2030. In animal husbandry the expected effect will be the opposite, with the water requirement decreasing from 17.38 million m^3 in 2020 to 16.56 million m^3 in 2030.

9. To present aspects of public information and participation. It presents the legal basis according to which citizens can inform themselves and consult with the authorities.

4.9.3 Master Plan of the Someș Water Company (CAS)

According to the information posted in the virtual environment, CAS (2022) communicates to the general public the existence of a master plan aimed at aligning with the requirements of the European Directives in the field of water, sewage and treatment services, as well as the expansion of the water supply and sewage networks in Cluj and Sălaj counties, investments valued at approx. 800 million euros.

The master plan for the drinking water and wastewater sector Someș basin (Cluj-Sălaj) (2006) it was developed in 2006 and updated in 2012. It is structured in 12 chapters, the content of which is public, except for chapter 11, which refers to the complete network plans, information of strategic importance that is not intended for the public.

The material is vast, the 11 chapters having over 1,000 pages + appendices. The overall objective of the Master Plan aims to identify and prioritize investment needs at the lowest costs.

The respective master plan is based on 8 objectives:

1. Improving the quality of drinking water for consumers;

2. Providing water to all consumers;

3. Significant reduction of water losses;

4. Reduction of maintenance and operation costs;

5. Balancing water supply systems;

6. Reducing the number of breakdowns and increasing the level of satisfaction of customer requirements;

7. Elimination of pollution of the environment and watercourses;

8. Improving operational, financial and environmental management performance.

We present below some proposals regarding the strategic documents related to the security of water sources:

I. Romania to develop a National Water Security Strategy, developed in the spirit of the relevant European or national legislation.

II. If Romania will not succeed in developing/implementing a National strategy, the CAS operator should develop its own Strategy based on it’s Master Plan, which will be public, comprehensive and adapted to both the beneficiaries and the partners involved in the ongoing projects.

III. Considering that in the future, depending on the evolution of certain factors such as global warming, pollution, demographic changes, etc. the security of water sources to be part of Romania's National Security Strategy.

5. Proposals

We propose the development of a National Strategy on Water Security in Romania (SNSAR). As a starting point, one can consider England's strategy, which should be adapted to Romania's situation and needs. Later, this can be transcribed into a plan of measures, national or local, Thus, the National Strategy for Water Security in Romania must have some defining characteristics: it must be centered on human and environmental needs, it must be developed in the spirit of relevant European and national legislation, it must be easily adapted in case that reality undergoes changes and to give those who implement it, the autonomy to make their own decisions, in accordance with their own particularities (geographical, social, economic, etc.).

Additionally, SNSAR should be based on strong principles to meet the beneficiaries requirements, whether they are territorial administrative units or individuals, principles such as: legality, transparency, accessibility, predictability, accountability, substantiation based on evidence and guidance. The strategy must be developed in a simple manner, easy to follow, comprehended and assimilated by all concerned. To ensure its success, the Ministry of Environment should be responsible for the development, implementation and monitoring of SNSAR.

We suggest the following structure:

1. The present and future of water in Romania.
2. Water demand
3. Water supply
4. Water quality in the environment
5. Water as an economic good
6. Floods
7. Greenhouse gas emissions
8. Competition and innovation framework.

6. Conclusions

The model proposed by the author regarding the concept of water security is based on consumers needs. They must have easy access at any time to sufficient quality water to satisfy their needs. In the area served by Compania de Apa Someș, the author tried to identify and quantify the main risks, with the aim of suggesting possible solutions that

would contribute to an increased security. Thus, the identified risks are: water waste, the lack of diversity of water sources, legislative deficiencies or terrorism, with the mention that the impact of the latter could vary depending on the targeted objective. Pollution, deforestation and corruption pose a higher risk to water security, and the highest-scoring risk is climate change. After identification and quantification, the author proposed a series of measures for each individual risk, with the aim of reducing, controlling or eliminating it. Some of them can be implemented either by certain public institutions, or by private entities or by each individual consumer. Considering the strategic importance of this asset, national authorities must finalize and implement a National Strategy for Water Management. We propose a National Strategy for Water Security in Romania, which would ensure the security of water resources throughout the country.

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