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Analysis of the usability of treated wastewater for fire protection purposes

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ABSTRACT

Current water management does not fully account for potential crisis situations when dealing with drinking water. It is important to focus on an efficient and at the same time economic approach to water management, including consideration of the ecological aspect. One way is to focus on the use of alternative sources of water. The possibilities of purified wastewater or captured rainwater indicate a certain direction. Current technical possibilities and scientific knowledge offer many opportunities. The priority is to find and increase the way to limit the use of drinking water for economic activities. The more intensive use of alternative water sources is still in the background and neglected. This article provides information on this issue and encourages deeper ecological and economic reflexion.

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1. Introduction

People are an integral part of the environment. One of the fundamental human rights defined by the Constitution and the Charter of Fundamental Rights and Freedoms is the right to a favourable environment, including the right to life. Damage to the environment can be a consequence of endangering the health of the population, the economy, and the functioning of the state. Environmental and climate protection is one of the tasks of Sustainable Development 2030, the Paris Agreement, to which the Czech Republic is a signatory. If we assess the state of the environment in the mid-1990s and now, the improvement of the environment is clearly visible, although some (especially hygienic) limits for water bodies are not fully achieved. Ongoing climate change fundamentally affects the state of the environment [1].

The low retention capacity of the landscape and the inappropriate management of agricultural land, increased urbanisation and increased deforestation due to bark beetle calamity, and energy-intensive industrial processes are the main reasons for the absence of water in the landscape. When building new settlements, we encounter the fact of missing infrastructure and the provision of fire water. Building a water supply and sewer network is economically very demanding in remote areas with low population density. The importance of surface water sources, rainwater, recycled, and purified wastewater is growing, which represents a non-negligible resource that can solve any local shortage of water for fire-fighting purposes. These sources, in the form of storage tanks, have a justification not only for firefighters, but also for a certain relaxing and aesthetic element in the landscape.

Water is a very rare and necessary natural resource for human survival. Society and, by extension, emergency services are currently facing two basic challenges, namely, floods and drought, which are connected by a common denominator, water. Significant and unexpected weather fluctuations, the extreme nature of meteorological phenomena, have a signify-cant impact on both populated areas and on the subsequent activities of fire rescue services. The increased proportion of impervious surfaces (concrete, asphalt) and their inadequate drainage have two sites, a large amount of 'uncontainable' water, which could be used purposefully if properly collected, and an inadequate, inadequate sewage network. The latest data from leading scientists show unprecedented changes in the climate of the world. The rising temperature of the planet is causing increasingly large and, in some cases, irreversible changes in precipitation patterns in all parts of the world, according to the latest report of the Intergovernmental Panel on Climate Change (IPCC). We are already observing the effects of climate change in the European part of the continent today, and the intensity of these effects will definitely increase [1]. Are emergency services adequately prepared for the factors mentioned above? Isn't it time to join the conservation stream,

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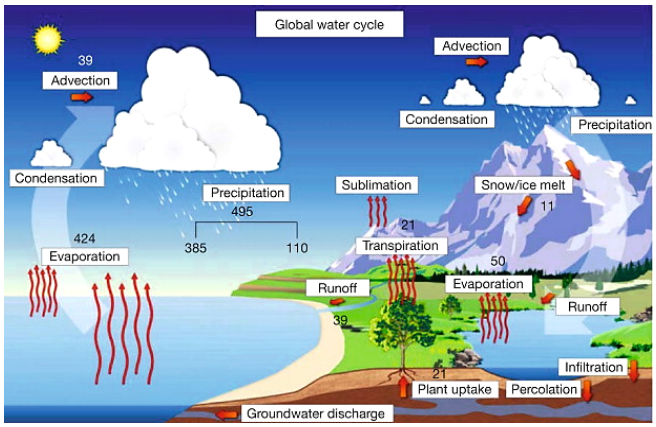

Figure 1. The global water cycle [3].

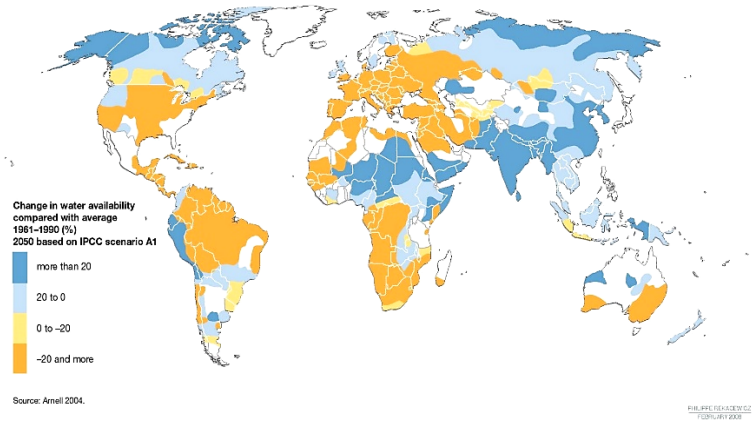

Figure 2. The availability of water resources in the year 2050 [6].

combine firefighting and environmental thinking using alternative resources? [2].

2. Water - A source of survival

Water is a very rare and necessary natural resource for human survival, a phrase we hear every day from the mouths of scientists, parents, or the media. But seriously, do we take this important fact seriously or just wave our hands? Let us look at some statistical values.

Water is one of the basic conditions of life on the 'blue' planet Earth (Figure 1) [3]. The water of the seas and oceans covers 71% of the Earth's surface. The stated amount of salty water is 97% of the total amount of water on the planet. The rest of the hydrosphere is 'fresh' water, which is only 3%, and 69% is stored in the polar regions in the solid form of glaciers. Water stored below the surface, i.e., underground water, makes up 30% and less than 1% is made up of surface and atmospheric water. Is this enough to ensure the survival of human species, considering the behaviour of the human community, ongoing climate change (melting glaciers), and increasing population and industrial activity?

2.1. Lack of quality water

During the last 50 years, the population has doubled globally, the assumption is that it will further increase by 50% by 2025, behind this population increase we need to see an increase in population mainly in developing countries, migration, increasing standard of living, urbanisation and industrialisation, which leads to a demand for water. Water as a global resource is becoming both a physical and virtually a tradable commodity on an international scale, and will certainly require political decisions, both on a macro- and microscale [4].

Climate change is a new and widespread environmental risk for many governments. The driving force behind all changes, in addition to those already mentioned above, will certainly be all challenges to water management. Environmental and sociodemographic changes are an unprecedented challenge for humanity. The provision of available and usable fresh water in small proportions is no longer sufficient to meet the ever-increasing needs of the population in general. Many countries around the world suffer from water stress and water scarcity. More than 50% of the global population will experience a high level of water stress by 2050 (Figure 2) [5,6].

2.2. The issue of climate change

Water scarcity is an evident worldwide phenomenon that is intensified as a result of increasing pressure on the need for water (Figure 3) [7]. Low levels of precipitation, global warming, drought, but also sudden significant rapid precipitation, tornadoes, or climatic excesses have a significant effect on the availability of quality water sources for the supply of the population. The leaders of the world economy, led by the USA, Canada, and the EU, are making significant investments in the area of water management, that is, in technologically sophisticated water treatment plants to secure water from alternative sources [5]. Government authorities at the general level must take a unified proactive stance in campaigns to protect and ensure quality water.

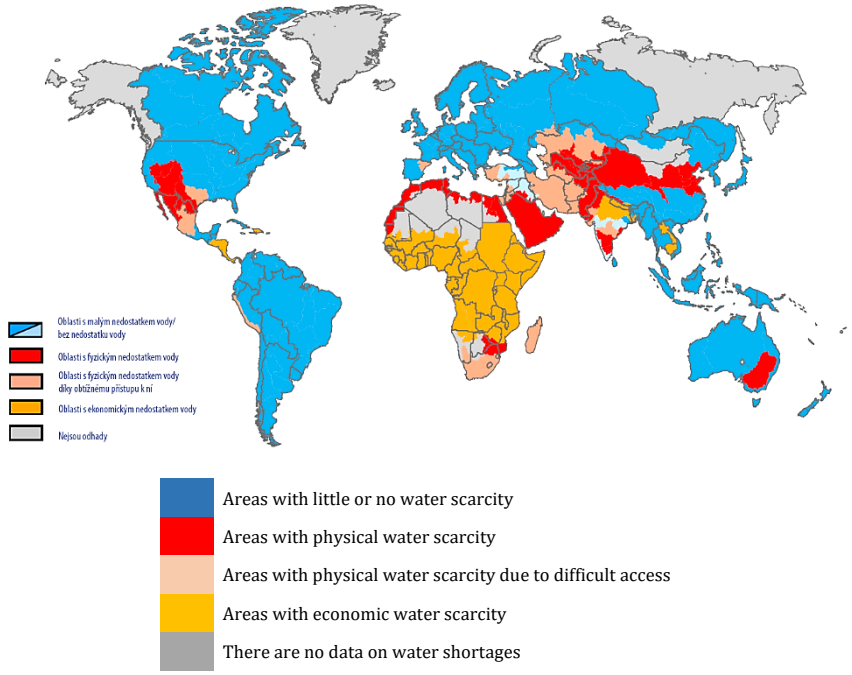

Figure 3. Physical and economic water scarcity by country 2006 [7].

In this regard, the media also play a significant role in reliable publishing and supporting the awareness of the general public in the efficient and economical use of water. Dimensions that affect consumers are financial, physical, psychological, and social.

Is it possible to separate water usage from economic growth? According to the example of Australia, where consumption fell by 40% between 2001 and 2009, while the economy grew by more than 30%, it is possible. Retaining water in the landscape is one way, but is it really necessary to invest in megalomaniac projects such as canals and dams, which are not entirely sustainable from an environmental point of view, and we can discuss the economic viability, or is it enough to return to the roots of our ancestors? [5,8].

2.3. Central Europe - Water sources

Humankind and natural ecosystems are closely connected, and this is no different even within Europe and its central part, which is expected to experience an increase in the frequency and intensity of extreme weather events [1]. Climate change and its associated water scarcity is a key current issue. Due to its Mediterranean location, the Czech Republic is called the 'roof' of Europe. All streams originating in our territory drain water from the territory of the Czech Republic. The territory of the state receives water exclusively from precipitation. The amount of rainwater does not change essentially, but due to global climate change, its distribution changes over the seasons. There is no sufficient water supply in the form of snow and ice in winter, spring comes earlier, and autumn lasts longer, and therefore higher average temperatures with higher evaporation do not create sufficient reserves in the soil profile or groundwater. Surface sources such as rivers, streams, ponds, or lakes that dry up are also affected. Surface water (still water and watercourses) occupies 2% of the area of the Czech Republic. The quality of water in the Czech Republic has improved significantly over the past 30 years, but in the short-term comparison, there is rather stagnation. At the national level, water protection is anchored in the Water Act No. 254/2001 Coll., possibly also in individual basin plans [2,9]. Natural surface resources are one of the cornerstones of the fire protection of the territory, when fire brigade units have to preferentially use these resources from the point of view of the ČSN 75 2411 standard [10]. Firewater sources are divided into sources of natural origin, man-made, and multipurpose. We further divide sources of natural origin into underground and surface water. Man-made sources include fire water mains, wells, and fire water tanks.

When assessing fire safety in cities and municipalities, it is necessary to take into account the provision of fire water, whether in a combined way, that is, surface water sources and public water supply, or just one of these alternatives. If there is no sufficient resource that provides the necessary capacity in the built-up area, the supply must be secured from the public water supply network. A system of hydrants is part of every public water supply network. Most fire brigade units make full use of this system, which is the backbone of built-up areas, but somewhat forget the fact or possibility of using natural resources. Another aspect is the fact that not all hydrants meet the conditions of a fire hydrant. These hydrants often serve only the operational purpose of the water company without guarantees of hydraulic efficiency [11].

Germany, with its 82 million inhabitants, also lies in the center of the European continent. The total volume of water supply to households is sufficient, but there are already regional and seasonal shortages. Extremely high population densities have intensified agricultural and industrial activity, with an impact on water quality. The main problem is the renewal and adaptation of existing systems and the need to satisfy the population in the face of changing population density and climate change. The expected effects of climate change are a reduced amount of precipitation with a subsequent lower availability of raw water in the summer. These indications show that Germany may be reaching its limits with the increased demand for drinking water and the current sewage treatment system. The water supply in Germany is coordinated locally, it is the basis of national and international regulations such as the Water Framework Directive 2000/60/EC, Agenda 21 of the UN [12].

Table 1. Water consumption by fire brigades in the Czech Republic [15].

Year	Water consumption in case of fire (thousands of m³)	Number of fires (thousands)	Average water consumption (m³)
1997	354.8	20.70	17.14
1998	140.5	23.10	6.08
1999	102.2	20.10	5.08
2000	112.7	20.20	5.58
2001	655.4	16.50	39.72
2002	925.6	18.50	50.03
2003	161.2	28.40	5.68
2004	106.3	20.90	5.09
2005	806.5	19.80	40.73
2006	103.9	19.70	5.27
2007	111.5	21.83	5.11
2008	98.6	20.40	4.83
2009	110.9	19.68	5.64
2010	120.0	17.30	6.94
2011	119.2	20.51	5.81
2012	167.3	19.91	8.40
2013	105.6	16.56	6.38
2014	93.2	16.85	5.53
2015	35.8	19.69	1.82
2016	88.9	15.73	5.65
2017	117.5	16.25	7.23
2018	268.2	20.28	13.22
2019	149.5	18.36	8.14
2020	152.5	16.94	9.00
2021	107.1	15.71	6.82

Table 2. Water consumption and fire number for Fire Station Přerov.

Years	Water consumption (m³)	Fire number
2010	172.5	203
2011	262.1	216
2012	458.6	265
2013	174.6	161
2014	244.9	153
2015	483.7	186
2016	290.0	176
2017	208.0	203
2018	608.9	230
2019	1013.0	168
2020	462.6	150
2021	710.2	202

2.4. Alternative source – wastewater treatment plants

The Czech Republic already has experience with the consequences of long-term drought and excessive pumping of water for human consumption. The drop in both underground and surface water levels (drop in river levels, dams, drying up of mountain streams) and the resulting local problems with drinking water supply are ominous evidence. In this context, it is important to think about the use of fire water from the water supply network by fire brigade units in times of shortage-crisis situations with water in general [13]. Water Supply and Sewerage Act No. 274/2001 Coll. in accordance with Act 239/2000 Coll. enables the pumping of water from water distribution systems free of charge to deal with extraordinary events – rescue and liquidation works [14].

The consumption of fire-fighting water is decreasing compared to previous years (if we ignore the fact of large fires in industrial units), see Figure 3 and Table 1, which shows the consumption of fire-fighting water in the Czech Republic from 1997 to the present. There is a noticeable downward trend in the amount of water for extinguishing. However, the human factor is not taken into account here. Commanders who are still rooted in a conservative method of extinguishing still work with the tactical procedures of the 1980s and 1990s of the last century. And the data mentioned above capture the fact that as the number of fires decreases, the amount of extinguishing water consumed increases. It is important for further development in the use of water for extinguishing to establish a new direction, which is partly reflected in the given data. The fluctuations in the graph are caused by fires in industrial areas during the given period with a high consumption of firefighting water. The statistical data of the fire brigades of the Czech Republic do not distinguish the source of water. However, we can say that a large percentage of the water used to extinguish the event is drawn from the hydrant system. Hydrant systems are the main source of water for supplying the population. This is where a conflict may arise in the future; a conflict of priorities. Above all, it is important to ensure the supply of drinking water to the population. No less important is also the fire protection of the territory, which, however, can be solved in other ways, e.g., with natural resources or alternative sources. The data given in Table 1 on the water consumed from the hydrant network provided by the Fire and Rescue Service - Prerov fire station [15].

Table 2 shows the situation much better at the regional level. The development graph (Figure 4) presents a clear development of water consumption in the Přerov district for the years 2010-2021. The situation is distorted by fires with excessive water consumption in relation to the number of fires, regardless of the expertise and conservatism of the response commanders.

By changing the tactical procedures when fighting fires, there is also a change in water consumption during the intervention, especially water taken from the hydrant network. Here it is clearly visible that all water replenished at the fire station after reaching the base can be completely replaced by an alternative source in the form of purified waste water stored in the station premises (if the construction and layout conditions of the stations allow it), for example, in rubber textile bags with a volume of 50 m³, as shown in the picture from the premises of the airport in Přerov (Figure 5). Extraction from the tank was ensured by a 125 mm suction nozzle. That is, without additional energy requirements. Replenishment to be provided as part of mandatory training for machinists.

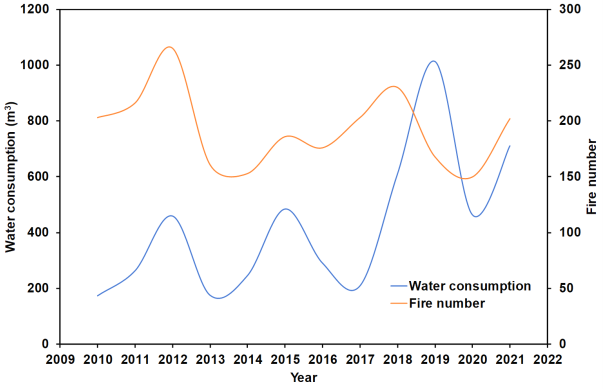

Figure 4. Fire station Přerov – consumption of extinguishing water/fires.

(**a**)

(**b**)

Figure 5. (**a**) Rubber textile bag and (**b**) Rubber textile bag - tank opening - suction flange.

However, is it ethical and professional to pump potable water to dispose of a fire, e.g., a landfill or a stack? Wouldn't it be appropriate to include that part of the standard here and use nearby natural resources? However, when dealing with emergencies, we neglect an important source of fire water treated wastewater.

California (USA) has been exposed to significant climate change in the last decade. The use of recycled water is becoming common throughout the state of California due to reemerging water supplies. The maximum potential is seen in the addition of fire systems. Areas of California, Nevada, Arizona, and New Mexico experienced the driest period in 16 years [16].

3. New directions in the use of non-traditional resources

The European continent (if we leave out the southern part of the continent) has not yet felt a significant lack of water. The situation is different in southern regions such as Spain, Greece and Italy. All partners in the EU must be prepared for the modern crisis, because this crisis is approaching by leaps and bounds. The European Commission is already developing a new regulation on the use of treated wastewater. The countries in the southern part of the EU already largely use wastewater for various economic activities, from agriculture to industrial use (cooling, washing equipment, *etc.*). The reuse of purified wastewater is one of the most important alternatives to solving water shortages. According to the UN, up to 1.8 billion people should live in areas affected by water scarcity by 2025. At the EU level, interest in this topic has increased both among politicians and among scientists and practitioners [17].

3.1. Economic quantification

Water plays an important role in the ecological sustainability of socio-economic systems. It is essential to maintain healthy ecosystems and biodiversity. In recent decades, research on water scarcity on a global and regional scale has documented the critical situation in several regions of the world, including the Czech Republic. What is the price of water for each of us? The answer to the question is about 2 €/m^3 economically in the Czech Republic, but in reality, this price cannot be calculated. Most of the population does not realise the financial value of water, which seems to be free, either in the form of rain or flowing in a river [18]. Monarchs in ancient times were already aware of the strategic importance of water and, therefore, treated water as a precious resource and often protected it with legal decrees. In the Czech Republic conditions, these are precisely the Act on Water and Water Pipes and Sewers and subsequent decrees.

3.2. Water protection

Water conservation is becoming a cliché for many of us in everyday life, but is gaining importance. It is necessary to focus on the problem in a comprehensive way. The construction of catch basins that will not disturb the concept and nature of the landscape and will capture the rainfall to a full extent. Let's just look at the amount of asphalt and concrete surfaces in our surroundings and focus on the efficiency of using every drop that falls on our territory [19].

4. Fire of the hayloft in the village of Želatovice

Possible ways of using water for extinguishing are discussed in the example presented below, including the alternative to using water from the nearest sewage treatment plant and their economic evaluation. We will carry out an analysis of specific events, a fire in a hayloft in a small village, and the use of water for extinguishing, including a possible alternative to the use of water from the sewage treatment plant. Let us think about an event, namely, a hayloft fire in the village of Elatovice, Perov district. On July 14, 2021, a fire in a hayloft

in the village of Želatovice, in which 100 tons of hay and 5 tons of straw were stored, was reported to the Operations and Information Center of the Fire and Rescue Service of the Olomouc Region. Units were sent to the scene of the incident according to the fire alarm plan (I. degree of fire alarm announced). From a tactical point of view, 5 water jets "C" (*i.e.*, flow rate 5×250 L/min) were used to reduce the intensity of the fire, as the structure of the hayloft was made of steel beams and there was a risk of the structure collapsing due to the high temperature of the fire. To support the reduction of intensity, heavy foam was applied to the extinguishing area, and then, a reduction in the admixture of the foaming agent to the level of the wetting effect was also used. Source of fire-protection water hydrant network within the premises of the agricultural cooperative. Here, the first shortcomings or problems manifest themselves, especially in relation to the hydraulic efficiency of the source, that is, insufficient pressure and, therefore, the required quantity. The company's hydrant network is supplied from a reservoir, which is the property of the agricultural company. The ball-type water tank is not only the main operating source, but also an emergency supply for cattle, which the agricultural cooperative is the producer of, in case of failure of the hydrant network of the company managing the local water and sewage network. The tank is continuously replenished from the hydrant network through the pressure station. During the time course of the fire extinguishing process, a situation occurred when the withdrawal was so great that the water reservoir was exhausted and the inflow was unable to cover the need. Therefore, the commander of the intervention, through the Operations and Information Center of the Olomouc Region Fire Brigade, requested that the given pressure zone be strengthened by the local operator of the water and sewage network. Due to the age of the pipeline, it was not possible to grant the request. It was decided to create a pump station in the lower part of the village, also in the hydrant network, and to use the fire tank in the village with a volume of 14 m^3 and to carry out shuttle transport from more distant municipalities (from hydrants). Due to the exhaustion of the reservoir, the hydrant network primarily supplemented the hydroglobe. As a result, the pressure in the home distribution systems was significantly reduced for the residents of the village, and the quality of the water also deteriorated secondarily (turbidity due to the release of impurities in the distribution system). A technological defect caused by significant consumption of fire protection technology. The use of the fire tank solved the bridge of a certain period when the hydrant system was not used, the water reservoir was replenished to a sufficient level, as a result of which the need for firefighting water was reduced. The volume of fire water from the municipal reservoir was not only a volume of 14 m^3, but also the amount flowing in when the replenishment is ensured from the melioration drainage of the fields above the municipality. The amount of water taken was not only the stated volume of 14 m^3, but a certain non-negligible bonus of about 10 m^3. From these sources, the fire was successfully extinguished. The total volume of water consumed was 430,800 litres. The major part was used from the hydrant network, and only a very small part was used from natural sources.

4.1. The possibility of using natural water sources

We should treat water with respect and value it as a resource necessary to ensure further life, not plunder it; thus, we should also consider the economic costs of its treatment and production in the form of drinking water. Someone always pays for these costs, the taxpayer. Yes, the Waterworks and Sewerage Act 274/2001 Coll, in accordance with the Act on IZS 239/2000 Coll, enables free sampling from the hydrant network, but, on the other hand, other possible sources must also be assessed [20,21]. The standard ČSN 752411 Sources of fire water states that "fire water should preferably be provided from sources of natural origin or from multipurpose sources!" [10].

In the context mentioned above, it would be most appropriate to use nearby water resources of a natural nature. In our particular case, there are water sources with sufficient capacity nearby. They are natural ponds owned by the affected municipalities (Tučín, Želatovice, Čechy, Beňov). The commander, within the framework of his authority, has the right to ask the owner to provide material assistance in this case (Act 133/1985 Coll.) [22]. Access to these sources was in the range of 2 to 7 km and the level that was available for fire equipment.

4.2. Alternative sources of fire water - wastewater treatment plants

Another possible source is the accessible sewage treatment plant in the village of Henčlov. The distance to this source is approximately 11 km. The wastewater treatment plant (WWTP) allows, on the basis of a preliminary and telephone agreement, the possibility of using this water for fire extinguishing purposes. For fire brigade units, sewage treatment plants are essentially an inexhaustible source of fire water, where sewage treatment plant premises are an advantageous starting point for setting up pumping stations, either to secure shuttle traffic or as a background to create space for aerial firefighting. Other advantages are a solid access via a road or a non-freezing surface. The distance between WWTP premises and the nearest residential buildings (the buildings are located outside the built-up area) can be understood as both an advantage and a disadvantage. Disadvantage from the point of view of greater driving distance, advantage from the point of view of not bothering citizens with the operation of fire brigade unit equipment.

4.3. Economic evaluation

According to the authors, it is neither the goal nor a task to evaluate the decision-making process of the intervention commander. All intervention activities are within their authority and exclusive rights, and the authors of the article do not want to question this right in any way. However, the economic analysis of the use of individual resources showed one of the important aspects of this time: contradiction economically - environmental. In the evaluation, we take into account two important facts, namely, the price of water and the price of fuel for transportation; everything else is constant. Basic data are: total water consumption 430.8 m^3. The price of diesel fuel is a tabular value set by the decree of the General Director of the Fire and Rescue Service of the Czech Republic (Annex No. 3 to Ref. MV-90559-2/PO-IZS-2021) and is currently set at 1.25 €/L. Eighy CAS (fire truck) vehicles (with different volumes of water tanks) were involved, and all vehicles covered a total of 74.2 km. At a price of 2 € for 1 m^3 of water, the real economic cost to the taxpayer is approximately 862 €. Individual costs are shown in detail in Tables 3 and 4. In fuel consumption, it is necessary to take into account both the driving distance and the engine hours when the pump is working. This means that with a total distance of 74.2 km and an average pump work of 6 engine hours, the economic cost of fuel equals 143.5 €. In total, the real cost for a taxpayer to extinguish the fire with this method, i.e., the use of the hydrant network, is approximately 1005 €. In fact, the water is not charged. So only fuel costs remain.

When using the WWTP water source, the water costs are in the order of 0.0041 €/m^3, so the price for an amount of 430800 L of water is approximately 1.72 €. The number of vehicles remains constant, but when transporting the required amount of water, they travel a total of 946 km considering a distance of 11 km from WWTP to Hayloft.

Table 3. The economy of distance.

Fire engine vehicle	Distance traveled (km)	Average consumption (L/100 km)	Resulting fuel load (L)	Diesel price (€)	Resulting fuel load (€)
CAS-30 Tatra 815 - 7	27	56	15.12	1.25	18.90
CAS-20 Tatra 815 Terrno	14	52	7.28	1.25	9.10
CAS-20 Renault Midlum	11	30	3.30	1.25	4.10
CAS-24 K 101 LIAZ	12	35	4.20	1.25	5.25
CAS-25 Škoda 706 RTHP	15	30	4.50	1.25	5.60
CAS-30 Scania	37	41	15.17	1.25	18.93
CAS-32 Tatra 815	20	54	10.80	1.25	13.50
CAS-32 Tatra 815	25	54	13.50	1.25	16.85
Total	161	352	73.87	1.25	92.20

Table 4. Economics of pump work.

Fire engine vehicle	Pump work (engine hours) real	Pump work (engine hours) avg.	Consumption per engine hour (L)	Resulting fuel load (€)
CAS-30 Tatra 815 - 7	0.0	6	33.6	8.00
CAS-20 Tatra 815 Terrno	0.0	6	31.2	7.50
CAS-20 Renault Midlum	10.1	6	18.0	4.32
CAS-24 K 101 LIAZ	1.0	6	21.0	5.00
CAS-25 Škoda 706 RTHP	16.0	6	18.0	4.32
CAS-30 Scania	9.0	6	24.6	5.90
CAS-32 Tatra 815	5.0	6	32.5	7.80
CAS-32 Tatra 815	5.0	6	32.5	7.80
Total	46.1	48	211.4	50.75

In this case, we must also take into account the necessity of pumping water, so we will increase the amount of pump work by 2.38 engine hours to a total of 8.38 engine hours. The expression of the price of fuel will be 495.5 € in total. Therefore, it is evident from the above calculation that the use of purified wastewater is more economically advantageous to the taxpayer than the use of the hydrant network. If we also take into account the current unstable situation in the fuel field and the ever-increasing price of fuel in general, the difference will be even more striking. The other side of the coin, however, is the need to transport fire extinguishers from greater distances and therefore burden the population with traffic, noise, dust, and emissions of pollutants from exhaust gasses. However, the reality is that the use of water from the hydrant network is reasonable due to the fact that the water is pumped for free. Here we can see the above-mentioned economic-environmental contradiction. The way out of this vicious circle is to use the nearest natural resource. Despite all these facts, we believe that the idea of using purified wastewater has its meaning and justification, especially in the future, when the real price of water will be much higher, by which we do not mean only the financial situation, but from the point of view of human use, the pressure on environmental behaviour in this regard will increase.

5. Conclusion

Climate change is a large-scale and emerging environmental risk. It is a challenge for both a healthy environment and the sustainability of global development. Global sociodemographic and environmental change presents an unprecedented challenge to humanity [4,23]. The use of wastewater raises many controversies in all directions. The appropriateness of using treated wastewater remains a bone of contention among experts [24,25]. However, ignoring wastewater could lead to adverse pollution of the environment and connected ecosystems. If wastewater is professionally managed, its use can be economically beneficial for the company. Urban areas show the potential for reuse of wastewater due to the shorter distance to the fire intervention site, which can be more advantageously connected to the processing site. In the near future, economic systems and infrastructure plans will have to be closely linked with the more frequent use of treated wastewater, not only in the activities of fire brigades. The use of purified wastewater has several advantages, such as an essentially inexhaustible quatity of water, the possibility of using it for many technical activities, or ecological restoration [4,26]. Wastewater is also more reliable than surface water with constant inflow. Recycled water and its reuse are a promising way to increase the availability of water resources. Another possible source is rainwater harvesting. However, in this context, it is also necessary to take into account the atmospheric conditions, when it can be contaminated by polluting particles, microorganisms, heavy metals, or organic substances. It pretty much depends on the catchment area, when, *e.g.*, roads can be a source of substances from brakes, tires, polycyclic, and aromatic hydrocarbons. Therefore, it is necessary to carefully weigh and evaluate risks when using individual possible alternative sources. When using wastewater, it is necessary to consider the possible translocation of pathogenic viruses, bacteria, microorganisms, and parasites that can affect human health [4,27]. Therefore, the current state of knowledge recommends applying the precautionary principle, thus using protection of the respiratory tract and eye mucous membranes.

An analysis of one of the fire brigade unit interventions showed an economic - environmental contradiction in the use of firefighting water. The need to find the right way in the use of water for extinguishing purposes will certainly resonate with this "industry" in the coming years, given the growing pressure on water management in general. The use of purified wastewater is a rational solution to solve problems caused by water shortages due to drought, i.e., climate change. It is important to change the general view of treated wastewater, where a useless component can become a resource with great financial value [26,28,29].

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CRediT authorship contribution statement

Conceptualization: Frantisek Ondrasik; Methodology: Frantisek Ondrasik; Software: Frantisek Ondrasik; Validation: Frantisek Ondrasik; Formal Analysis: Frantisek Ondrasik; Investigation: Frantisek Ondrasik; Resources: Frantisek Ondrasik; Data Curation: Frantisek Ondrasik; Writing - Original Draft: Frantisek Ondrasik; Writing - Review and Editing: Frantisek Ondrasik; Visualization: Frantisek Ondrasik; Funding acquisition: Frantisek Ondrasik; Supervision: Sarka Krocova; Project Administration: Frantisek Ondrasik.

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