State of DW production in the west of Ukraine & future outlook

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Abstract

The report provides information on the state of drinking water sources in the western regions of Ukraine. Using open sources of information, data on the operation of centralized water supply systems in the individual western regions of Ukraine has been systematized. A characteristic feature of these systems is significant physical and moral depreciation of the main assets. The report also includes an assessment of the damages to Ukraine's water supply and sewerage systems due to Russia's aggression, which requires continuous additional resources for restoration and maintaining the stability of such systems, as well as taking additional measures to ensure the minimum drinking water needs for the population living in active combat zones. The report thoroughly analyzes changes in Ukrainian regulations concerning drinking water quality and compares them with the EU standards. The regulatory and legal framework of Ukraine regarding the requirements for materials and substances that come into contact with drinking water has been analysed. Since the end of 2023, there has been a revision of the regulatory framework concerning materials for water purification. Information about water management organizations at the national and regional levels, of different ownership forms, has been presented. The conclusions characterize the prospects for the restoration and modernization of Ukraine's water supply systems based on best European practices.

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Abbreviations

DWSS	Drinking water supply system
DSanPiN	National sanitary rules and standards
DSTU	State standard of Ukraine
DWI	Drinking water intake
EC	European Commission
EQS	Environmental quality standards (for priority substances determined by the Ministry of Ecology and Natural Resources of Ukraine dated January 14, 2019)
EU	European Union
GOST	Gosudarstvennyy Standart = national state standard
WU	Western Ukraine

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1. Introduction

This report systematizes information on water supply sources and the state of centralized water supply and sewerage systems in Western Ukraine (WU). The report provides information about the impact of the war on the state of water supply and sewerage systems in Ukraine. A comparison of drinking water (DW) standards in Ukraine and the EU is made. An analysis of the regulatory framework of Ukraine about materials that come into contact with DW is conducted. The report provides information on Ukrainian organizations operating in the field of water management.

Open sources of information were used when writing the report.

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2. Drinking Water Sources in the west of Ukraine

Administratively, the western part of Ukraine consists of nine regions: Vinnytsia region, Volyn region, Transcarpathian region, Ivano-Frankivsk region, Lviv region, Rivne region, Ternopil region, Khmelnytsk region, Chernivtsi region.

2.1. Water withdrawal and usage, discharge of wastewater, and pollutants in water bodies

In 2023, 5,667 million cubic meters of water were withdrawn from natural sources (5,657 million cubic meters of freshwater), including 813 million cubic meters from groundwater sources, of which 203 million cubic meters were from mine and quarry waters.

By river basin in the western region of Ukraine, the water withdrawal was as follows: the Danube River basin: 953 million cubic meters; the Dnister River basin: 424 million cubic meters; the Southern Bug River basin: 254 million cubic meters; the Vistula River basin: 68 million cubic meters.

By the economic sector in 2023, the main water users were: Section E (water supply, sewage, waste management) – 31.3% of total water withdrawal; Section D (electricity, gas, steam, and air conditioning supply) – 30.2%; Section A (agriculture, forestry, and fishing) – 28.3%; Section C (Manufacturing) – 4.8%; other sectors – 5.4%.

In total, the freshwater use in Ukraine in 2023 for various needs amounted to 3,573 million cubic meters, including 1,163 million cubic meters for DW and 2,410 million cubic meters for technical purposes. A total of 355 million cubic meters of DW quality was used for industrial purposes, of which 94 million cubic meters were from municipal water supply systems.

In 2023, 19 million cubic meters of wastewater, 18 million cubic meters of collector-drainage water, and 45 million cubic meters of mine-quarry water were discharged. The total water volume in closed-loop and consecutive water supply systems amounted to 18,835 million cubic meters.

Water losses during transportation for own needs were 597 million cubic meters (10.5% of the total withdrawn water).

The main causes of surface water pollution are the discharge of polluted municipal and industrial wastewater directly into water bodies or via the urban sewage system, as well as the inflow of pollutants into water bodies through surface runoff from developed areas and agricultural land.

The largest volumes of polluted wastewater were discharged in the Lviv region (118 million cubic meters, 78.9% of the total volume of discharges in the region) and Poltava region (16 million cubic meters, 22.1% of the total discharges in the region).

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2.2. Groundwater resources and their utilization

The total estimated groundwater resources of Ukraine amount to 22,516,485 m^3/a, of which 20,972,170 m^3/a have mineralization levels (total dissolved solids, TDS) of up to 1.5 g/L. The availability of forecasted groundwater resources per capita across regions varies between 300–5500 m^3/day, with an average of 1.3 thousand m^3/day. The distribution of forecasted groundwater resources across regions is uneven due to differences in geological structures and physical and geographical conditions. Most of these resources are concentrated in the northern and western regions of Ukraine. The highest amount of groundwater resources is found in Chernihiv region (8,326.7 thousand m^3/day), while the lowest is in Chernivtsi (405.3 thousand m^3/day) and Mykolaiv (441.6 thousand m^3/day) regions [1].

As of January 1, 2024, 223 groundwater deposits have been explored and approved by the State Commission of Ukraine on Mineral Reserves [2, 3], covering 1,528 sites, including 1,523 sites with balance reserves, 3 sites with non-balance reserves, 2 sites with both balance and non-balance reserves. In 2023, 490 sites were under development, with no groundwater extraction from non-balance reserves.

The total operational reserves of groundwater in the west of Ukraine amount to 3.77Mio. m^3/day, including balance reserves – 3,73 Mio m^3/day, of which: A+B+C1 categories – 3,63 Mio m^3/day, C2 category – 0,1 Mio. m^3/day, non-balance reserves – 43.085 thousand m^3/day.

The detailed distribution of explored groundwater deposits and their balance reserves across WU in 2023 is shown in Table 2.1.

Groundwater utilization by administrative regions and Ukraine is given in Figure 2.1.

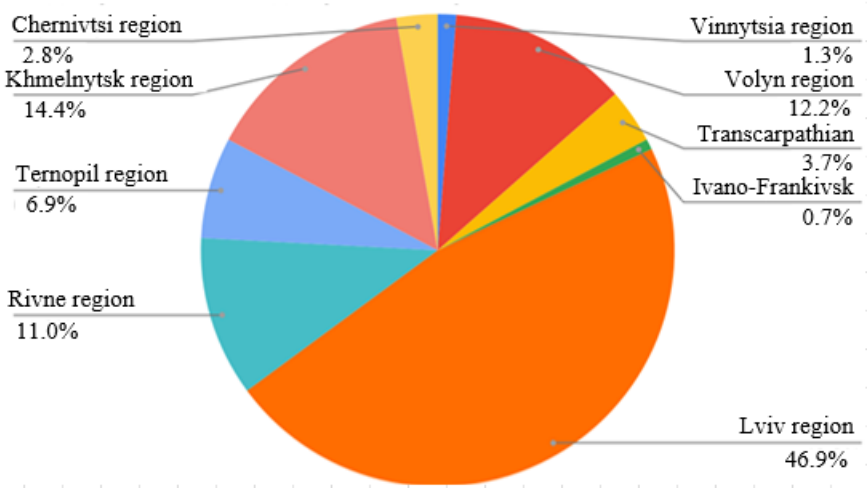

Figure 2.1. Groundwater utilization by administrative regions and Ukraine

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Extraction data for WU and the country as a whole are presented in Table 2.1 and Table 2.2.

Table 2.1. Summary data on operational reserves of drinking and technical groundwater by administrative units of the western region of Ukraine as of January 1, 2024

Administrative unit	Number of depo-sits	Number of sites		Operational Reserves, thousand m³/day				Extraction, thousand m³/day	% utiliza-tion of reserves (A+B+C1)
		Total	Incl. developed	Balance					
				A+B+C1	C2	Incl. developed			
						A+B+C1	C2		
Vinnytsia	30	63	22	142.0	10,16	24.26	0.17	6.97	4.22
Volyn	10	26	15	332.3	21,8	192.55		67.67	19.66
Transcarpathian	23	31	12	349.6		172.56		20.65	5.9
Ivano-Frankivsk	21	36	8	289.8		14.31		3.95	1.24
Lviv	63	105	62	1258.3	45.0	805.54	30.00	259.62	19.43
Rivne	20	47	23	435.8		208.45		60.57	11.12
Ternopil	17	27	9	296.8		147.82		38.34	12.87
Khmelnytsk	32	60	32	350.2	22.1	199.88		79.81	18.02
Chernivtsi	7	15	4	174.1		31.90		15.53	8.77
Total for the west of Ukraine	223	410	187	3628.9	99,1	1797.28	30.17	553.11	11.25
Total for Ukraine	745	1528	490	15183.2	979,1	4202.15	101.29	982.86	6.03
Western % from Total for Ukraine	29.9%	26.8%	38.2%	23.9%	10,1%	42.8%	29.8%	56.3%	

Groundwater in Ukraine is used for domestic drinking needs, industrial and technical purposes, irrigation, bottled water production, and supply to secondary users. A portion of the extracted groundwater, primarily from mining operations, is discharged without using. In 2023, this unused water in the western part of Ukraine amounted to 48.013 thousand m³/day, representing 9.5% of total regional extraction and 71.2% of the national total.

In 2023, groundwater utilization in the western part of Ukraine was as follows: domestic DW needs – 477.254 thousand m³/day, industrial and technical purposes – 26.441 thousand m³/day, bottled water production – 1.404 thousand m³/day.

Detailed data on groundwater utilization by administrative regions and nationwide is presented in Table 2.2.

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Table 2.2. Utilization of Operational Reserves of Drinking and Technical Groundwater in the western part of Ukraine as of January 1, 2024

Administrative unit	Utilization, thous. m³/day	Incl.			Utilization without discharge
		Household drinking	Industrial and technical	Bottling	
Vinnytsia	5,995	3,352	1,845	0,798	0,978
Volyn	65,333	64,18	1,148	0,005	2,342
Transcarpathian	20,641	20,634	0,001	0,006	0,005
Ivano-Frankivsk	3,586	3,527	0,027	0,032	0,364
Lviv	244,512	231,162	13,339	0,011	15,109
Rivne	48,474	44,367	4,095	0,012	12,095
Ternopil	38,186	37,826	0,05	0,31	0,154
Khmelnytsk	63,112	56,946	5,936	0,23	16,7
Chernivtsi	15,26	15,26			0,266
Total for the west of Ukraine	505,099	477,254	26,441	1,404	48,013
Total for Ukraine	915,411	812,412	98,162	4,231	67,451
Western % from Total for Ukraine	55,18%	58,75%	26,94%	33,18%	71,18%

2.3. Surface Water Sources for Water Supply

In the western regions of Ukraine, there are five river basins (Figure 2.2):

1) the Dnipro River basin, specifically the Prypiat River sub-basin (Volyn, Rivne, Lviv regions);

2) the Vistula River basin (the Western Bug and the San Rivers) (Volyn and Lviv regions);

3) the Dniester River basin, including the sub-basins of the Tisza, the Upper Dnister, the Prut, and the Siret Rivers (Lviv, Ternopil, Ivano-Frankivsk, Khmelnytsk, Chernivtsi regions);

4) the Southern Bug River basin (Khmelnyskyi region);

5) the Danube River basin (sub-basins of the Prut, the Siret, and the Tisza Rivers) (Transcarpathian, Chernivtsi regions).

Five river basins are located in this area:

1. The Dnipro River basin, specifically within the Prypiat River sub-basin.

2. The Vistula River basin (Western Bug and San Rivers).

3. The Dnister River basin, including the sub-basins of the Tisza, the Upper Dnister, the Prut, and the Siret Rivers.

4. The Southern Bug River basin.

5. The Danube River basin (sub-basins of the Prut, the Siret, and the Tisza Rivers).

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The highest river network density in Ukraine is found in the Carpathians, ranging from 0.94 km/km² in the Prut river basin to 2.5 km/km² in the White Cheremosh River basin. In the Dnister River basin, the river network density near the source varies between 1.0 and 1.7 km/km². In the Southern Bug River basin, the density in the upper reaches of the river ranges from 0.40 to 0.73 km/km² [5].

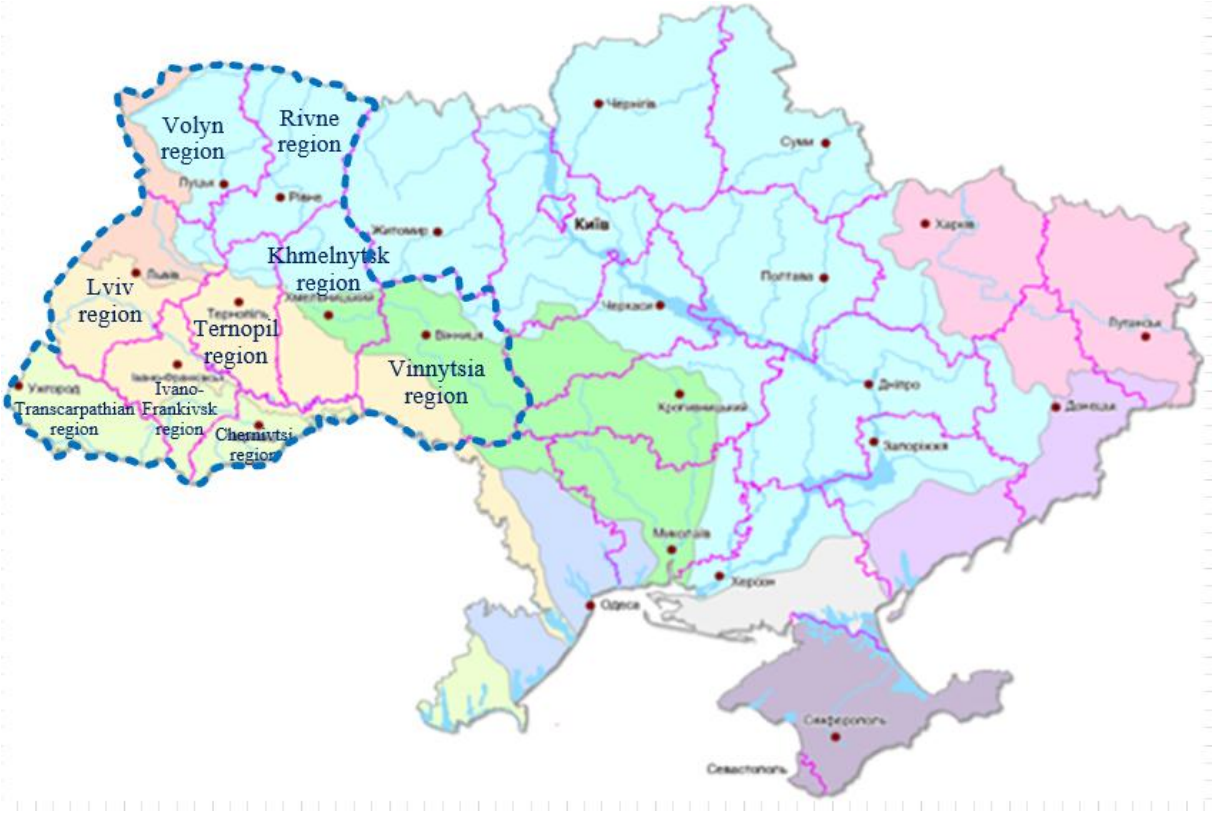

Figure 2.2. Distribution of river basins across Ukraine

Monitoring the quality of water bodies in Ukraine is carried out in accordance with the State Water Monitoring Program [4] (in the part of diagnostic and operational monitoring of surface waters) within the State Agency of Water Resources, according to hydrographic zoning. For the western region of Ukraine, monitoring data for 2023 is available, while data for 2024 is not available yet.

The Dnipro River basin. According to the monitoring results, the quality of surface water masses in places where DW intakes are located (cities of Khmelnytsky, Novohrad-Volynskyi, the Sluch River) was satisfactory. Fluctuations in biogenic compound levels were observed, with ammonium ion content exceeding the norm (0.10-2.04 mg/L, norm – 1.28 mg/L). Organic pollution was within the average annual concentrations, with fluctuations in BOD_5 (1.4-3.5 mgO_2/L, norm – 3 mgO_2/L) and COD (11.7-62.8 mgO/L, norm – 15 mgO/L). There was an excess of manganese content (1.1–4.8 times the norm).

The Dnister River basin. In the Dnister River basin, monitoring was carried out at 93 monitoring points, including 20 DWI points (100% of those planned by the program). According to the monitoring results, the indicators of the state of surface water at DWI points were as follows:

- the Dnister River (DWIs in Kamianets-Podilskyi, Chernivtsi, Odesa): Organic and biogenic indicators were within the norm [6]. However, there was an exceedance in chemical oxygen demand (COD) up

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to 42.8 mgO/L (norm – 15.0 mgO/L). A one-time exceedance in copper content (3 times the norm) was recorded. Petroleum products and nickel content were within the environmental quality standards.

- the Bystrytsia Nadvirnianska River and the Bystrytsia Solotvynska River (DWIs in Ivano-Frankivsk): Quality indicators were within the standard range. No chemical substances (priority or basin-specific) were found.

- the Seret River (DWI in Ternopil): Organic and biogenic indicators were within the norm [6], with a slight exceedance in COD (up to 23.0 mgO/L, norm – 15.0 mgO/L). Copper content exceeded the norm by 3–4 times.

- the Slonytsia River (water intake by "Truskavetsoblvodokanal"): Organic and biogenic indicators were within the norm [6], with a COD exceedance up to 28.0 mgO/L (norm – 15.0 mgO/L). Manganese content exceeded the norm by 1.5 times.

Chemical substances in the water used for DW supply included dichloromethane, trichloromethane (chloroform/TCM), metolachlor, atrazine, acetochlor, and terbuthylazine.

The concentrations of pesticides, polycyclic aromatic hydrocarbons, and volatile organic compounds did not exceed environmental quality standards (EQS) [7].

The Danube River basin. In the Danube River basin, monitoring was carried out at 101 monitoring points, including 11 DWI points (100% of those planned by the Program). According to the monitoring results, the indicators of the state of surface water at DWI intake points were as follows:

- the Danube River (DWIs in Vylkove and Kikiya): Organic and biogenic indicators were within the norm [6], except for ammonium ions (0.10–3.37 mg/L, norm – 1.28 mg/L). Copper content exceeded the norm by 3 times, and cadmium and lead exceeded the EQS (1.3 times for cadmium, 7.5 times for lead).

- the Tisza River (DWI in Tiachiv): Organic and biogenic indicators were within the norm [6], but copper content exceeded the norm by 3–7 times.

- the Prut River (DWIin Chernivtsi): Organic and biogenic indicators were within the norm, with one-time copper content exceeding the norm by 3 times. Nickel content was within EQS [7].

As part of the study of chemical substances (both priority and basin-specific) in surface water bodies used for drinking water supply, the following substances were detected: alachlor, dichloromethane, metolachlor, terbuthylazine, trichloromethane (chloroform/TCM), and fluoranthene.

The concentrations of the detected pesticides, polycyclic aromatic hydrocarbons, and volatile organic compounds did not exceed environmental quality standards (ENQ).

The Vistula River basin. In the Vistula River basin, monitoring was carried out at 23 monitoring points (100% of those planned by the Program). Surface waters in this basin are not used to supply drinking water. Groundwater reserves meet the needs for drinking water. The main sources of pollution in the Vistula basin are municipal and industrial enterprises in the Lviv region, while the impact of enterprises in the Volyn region on the quality of the Western Bug river is insignificant.

Chemicals found in surface water masses in the Vistula basin exceeded the environmental quality standards (EQS) [7] for heavy metals, such as cadmium (1.3 times) and lead (1.4 times at the Western Bug River in Kamianka-Buzka), and pesticides (dichlorvos, cypermethrin, terbutylazine).

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The concentrations of alachlor, atrazine, anthracene, polycyclic aromatic hydrocarbons, tetrachloromethane, terbuthylazine, trichloromethane (chloroform/TCM), fluoranthene, and dicofol were detected without exceeding environmental quality standards (ENQ).

The Poltva River, a left tributary of the Western Bug, is the most polluted river in the basin, as it serves as a wastewater collector for the city of Lviv.

According to monitoring results, the Poltva River (near the village of Kamyanopil) shows excessive levels of organic and biogenic pollution indicators. Specifically, biochemical oxygen demand (BOD) exceeds the norm [6] by up to 21 times, chemical oxygen demand (COD) by up to 12 times, ammonium ions by up to 42 times, and phosphate ions by up to 3 times. The concentrations of metals also exceed limits, with manganese exceeding by up to 5 times and copper by up to 16 times.

The study of priority chemical substances indicates high levels of volatile organic compounds (trichloromethane, trichloroethylene, dichloromethane), polycyclic aromatic hydrocarbons (fluoranthene, anthracene), and pesticides (alachlor, acetochlor, metolachlor, terbuthylazine, terbutryn). Exceedances of environmental quality standards were recorded for heavy metals (mercury, cadmium, nickel) and pesticides (dichlorvos).

The Southern Bug River basin. In the Southern Bug River basin, monitoring was conducted at 50 monitoring points, including 15 DWI points (100% of those planned by the Program). According to the monitoring results, the indicators of the state of surface water at DWI points were as follows:

- the Southern Bug River (DWIs of Vinnytsia, Ladyzhyn, Khmilnyk): Exceedance of organic and biogenic pollution indicators was observed, such as BOD_5 up to 14.7 mgO_2/L (norm – 3.0 mgO_2/L), COD up to 69.3 mgO/L (norm – 15.0 mgO/L), and ammonium ions up to 1.69 mg/L (norm – 1.28 mg/L). Petroleum product content exceeded the norm by 3.4 times, and manganese and copper content exceeded the norm by 1.4 and 5 times, respectively.

Research on chemical (priority and basin-specific) substances in surface water revealed alachlor, dichloromethane, terbutylazine, trichloromethane (chloroform), and metolachlor. Their content was within environmental quality standards (EQS).

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3. The State of Water Supply Systems in the west of Ukraine

In the Vinnytsia, Volyn, Transcarpathian, Ivano-Frankivsk, Lviv, Rivne, Ternopil, Khmelnytskyi, and Chernivtsi regions, there are 9,879 settlements [1], including 345 cities and towns and 9,534 villages. Centralized water supply services cover 92% of cities (83.6% of the population) and 18% of villages (15.7% of the population) (Figure 3.1). In the Vinnytsia, Transcarpathian, Rivne, and Khmelnytskyi regions, all cities are covered by centralized water supply services. In 2023, water supply was provided according to a schedule in 8 settlements.

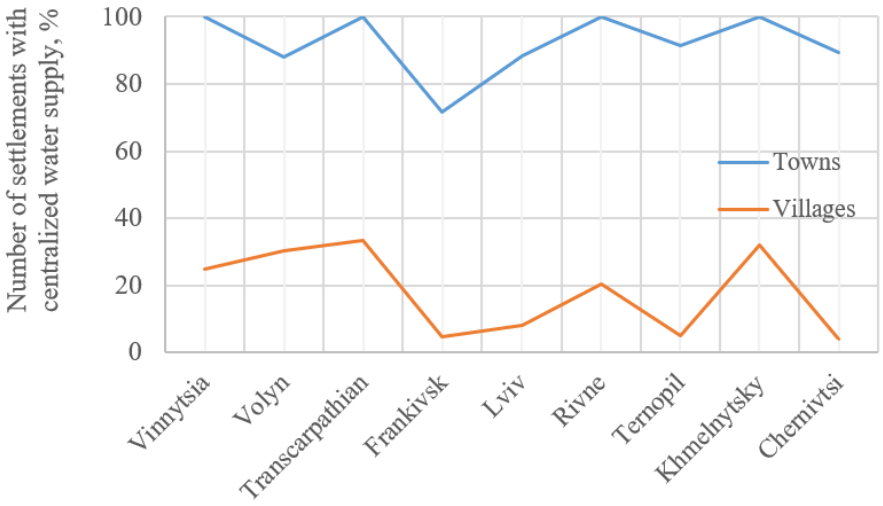

Figure 3.1. Provision of Centralized Water Supply Services to Settlements

Centralized wastewater services cover 270 cities and towns (74.3% of the population) and 118 villages (3.0% of the population). In the western regions of Ukraine, there is no need in water delivered by transport. In contrast, in eight regions of Ukraine (Dnipropetrovsk, Zaporizhzhia, Kirovohrad, Mykolaiv, Odesa, Poltava, Kharkiv, and Kherson), the water delivered by transport is used for 730 settlements, where 0.9% of the country's population resides.

Centralized water supply and sewerage services in the western regions of Ukraine are provided by 413 organizations, including: specialized municipal enterprises – 24.7%, multi-sectoral municipal enterprises – 46.5%, interdistrict enterprises – 0.5%, and departmental enterprises – 6.8%. The predominant form of ownership is municipal, accounting for 63.0%.

Water extraction from water supply sources across the regions ranges from 36 to 175 million m^3 per year (Figure 3.2). Except for three regions (Volyn, Lviv, Ternopil), the main source of water extraction is surface water.

The highest water consumption is in the Lviv region, and the lowest is in the Transcarpathian region (Figure 3.3). In the Volyn, Transcarpathian, Lviv, and Ternopil regions, most water is used for drinking purposes, while in other regions, it is primarily used for industrial needs. Water consumption for agriculture and irrigation (excluding the Lviv region) does not exceed 9%. Specific water consumption in cities ranges from 79 to 180 liters per day per capita, while in villages, it ranges from 27 to 113 liters per day per capita.

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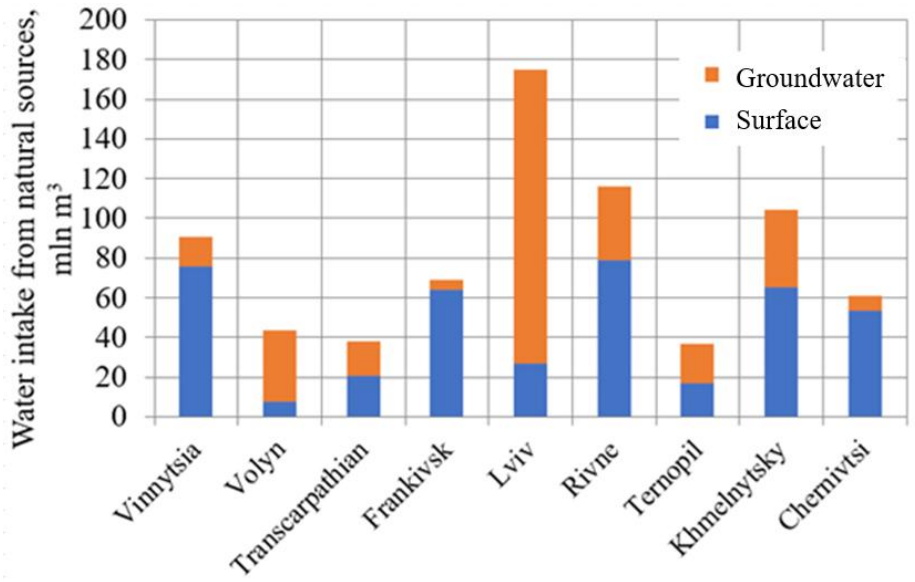

Figure 3.2. Water Intake from Natural Sources

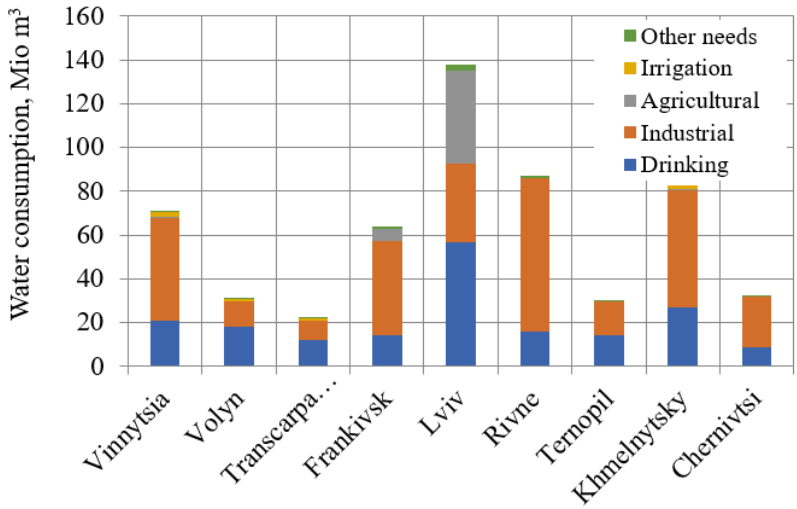

Figure 3.3. Water Consumption by Different Consumers

On average, 44.3% of the total amount of collected water is treated in the regions (the highest being in the Volyn region – 82.9%, and the lowest in the Lviv region – 11.5%); 94.1% is disinfected (all water in the Ivano-Frankivsk and Chernivtsi regions); 64.9% is sold (the highest rate in the Ternopil region – 80.7%, and the lowest in the Chernivtsi region – 39.5%). At the same time, the average water loss in the water supply systems of the western regions of Ukraine is 35.1%, while the national average is 37.2%. The highest water losses are observed in the Chernivtsi region, exceeding 60% (Figure 3.4). The best performance is observed in the Ternopil (19.3%), Transcarpathian (30.6%), and Rivne (26.9%) regions.

The total number of water intakes in the western regions of Ukraine is estimated at 989, including 40 surface water intakes. There are 2954 registered water intake wells. The need for additional intake capacity is estimated at 47.3 million m³/year.

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In the western regions of Ukraine, about 2010 water pumping stations are in operation, with over 3500 pumping units installed. The actual capacity is estimated at 830 million m³/year. A characteristic feature of pumping stations is that the actual capacity is several times lower than the design capacity. More than 40% of the pumping units need replacement. The electricity consumption in the centralized water supply and sewerage systems of Ukraine is estimated at 2.28 TWh, with 0.26 TWh in the western regions. The specific electricity consumption in the water supply systems of the western regions ranges from 0.86 (Khmelnytskyi region) to 1.06 (Chernivtsi region) kWh/ m³ of water.

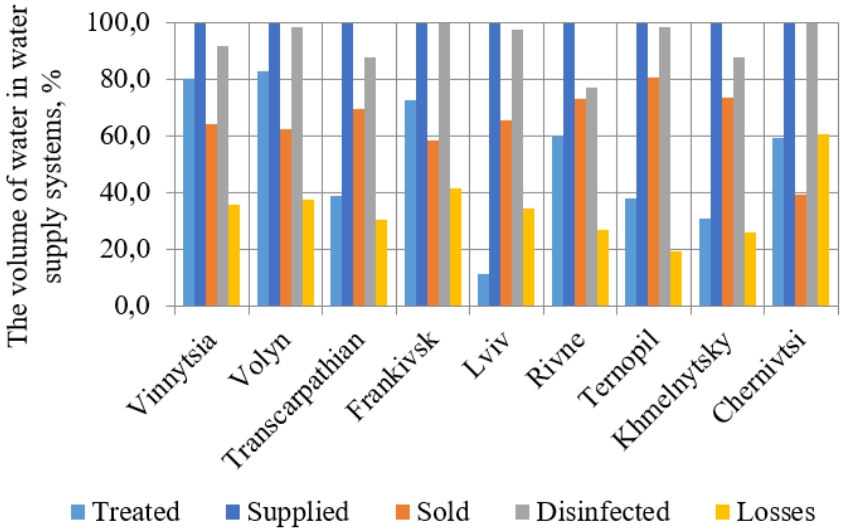

Figure 3.4. Water shares in Water Supply Systems

Water supply networks made of metal (cast iron, steel) and non-metallic pipes (polyethylene, polypropylene, reinforced concrete, and others) are in operation. The total length of the water supply networks is estimated at 23,900 km, which accounts for 22% of the total length of water supply networks in Ukraine. About 31% of the networks are in an state of advanced deterioration and structural vulnerabilities. This indicator is the worst in the Volyn region (51.8%), and the best in the Transcarpathian region (12.8%). The average rate of critical conditions in water supply networks is 1.08 accidents per kilometer per year (Figure 3.5).

In the water supply systems of the western regions of Ukraine, there are 1,456 pressure-regulating structures (including reservoirs and water towers). The total volume of these structures is estimated at 1.4 million m³ for reservoirs and 225,000 m³ for water towers. Only in the Volyn and Rivne regions these structures do meet the required volume. The total need for new pressure-regulating structures is 93,000 m³, with the Lviv region requiring the most at 80,000 m³.

As of the beginning of 2024, 37.9% of entrances of the apartment building and 91.6% of apartments are equipped with commercial water metering devices.

In 2023, the monitoring results indicated that the water quality in the centralized water supply sources did not meet the standards based on sanitary and chemical indicators in 6.8% of samples and bacteriological indicators in 4.3% of samples. For underground water sources, the non-compliance was 5.4% and 5.3%, respectively. In decentralized water supply sources, the rates were 22.7% for sanitary and chemical indicators and 33.9% for bacteriological ones. For centralized water supply systems, the corresponding figures were 5.9% and 4.6%, and for rural water supply systems, 26.5% and 11.0%. The

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largest non-compliance was noted in the Rivne and Ternopil regions. The water did not meet the standards for parameters such as odor, total iron, manganese, hardness, turbidity, color, pH, total microbial count, and total coliforms.

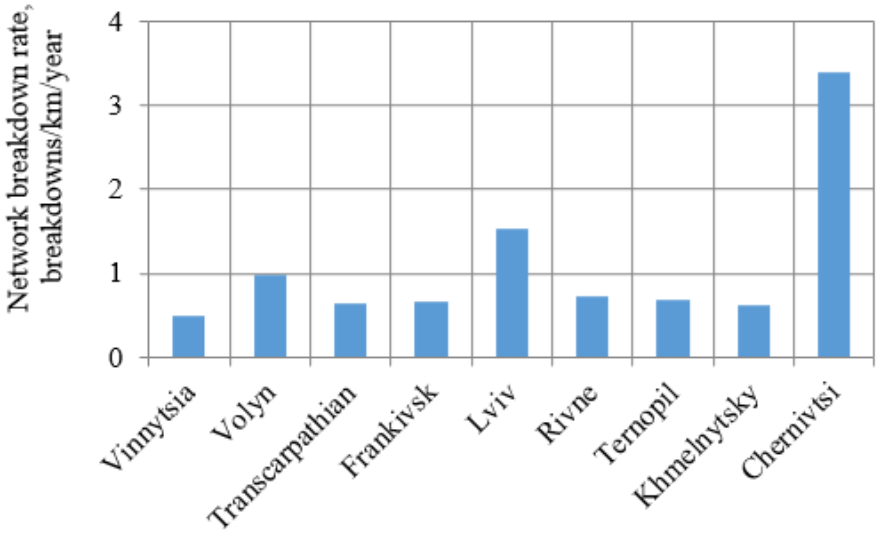

Figure 3.5. Annual emergency rate of Water Supply Networks

4. Impact of the War on the Ukraine's Water Supply

According to the Joint Rapid Damage and Needs Assessment (RDNA4) released by the Government of Ukraine, the World Bank Group, the EC and the United Nations, as of December 31, 2024, the total cost of reconstruction and recovery in Ukraine is estimated at €506 billion over the next decade. This is approximately 2.8 times higher than the projected nominal GDP of Ukraine for 2024 [8]. In 2025, with donor support, the Ukrainian government allocated €7.12 billion to address priority tasks in key sectors of Ukraine's economy, including the water supply sector. The total funding gap for recovery and reconstruction needs in 2025 is €9.62 billion.

Since the beginning of the full-scale invasion, Ukraine's water supply and sewerage sector has suffered enormous losses, with the total amount of damage estimated at $4.6 billion [9]. Most of the damage is concentrated in frontline regions, where critical infrastructure has been destroyed or is operating in emergency mode. The restoration of the water supply and sewerage sector will require $11.3 billion over the next 10 years. The priority is the reconstruction, modernization, and compliance with EU standards.

As of the end of 2024, direct losses of water supply, sewerage, and waste management infrastructure amount to $3.5 billion [10]. The infrastructure of utilities has become one of the targets of Russian missile and artillery strikes. The most affected are the frontline regions. Of the ten regions that were occupied and share a border with the Russian Federation or have access to the sea, more than 90% of the total amount of direct losses occurred. Russia continues to strike assets in other regions, so among the heavily affected regions is also Dnipropetrovsk. The assessment of direct losses in water supply and wastewater systems in populated areas is shown in Table 4.1.

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Table 4.1. Assessment of direct losses in housing and utility infrastructure [10]

Indicator	Units of measurement	Initial Quantity	Destroyed	Damaged	Estimated losses, billion USD
Water treatment plants	unit	400	7	18	0.36
Wastewater treatment plants	unit	967	23	28	1.03
Water pumping stations	unit	5 646	109	73	0.24
Sewage pumping stations	unit	2 908	63	120	0.35
Water supply networks	linear meter	98 076 470	1 947 026		0.54
Sewerage networks	linear meter	37 053 200	582 863		0.75
Wells	unit	22 134	125	34	0.02
Clean Water Reservoirs	unit	2 129	33	4	0.04
Water towers	unit	695	101	38	0.02
				Total:	3.35

Thus, centralized water supply and sewerage systems have encountered serious problems. First and foremost, there has been the physical destruction of the elements of water supply and sewerage systems, leading to the cessation or interruptions in providing the population with drinking water. For example, due to pipeline damage, most areas of Mykolaiv city were without centralized water supply for an extended period. The restoration of the pipelines was only possible after the liberation of Kherson in November 2022, and until then, the city only had technical water, while drinking needs were met with bottled water brought in. The Kakhovka Hydroelectric Power Station (HPS) and the Kakhovka Reservoir were of great importance for Ukraine's water management system. They supported the operation of the Kakhovka, North Crimean, and Alexandriya main canals, as well as the Dnipro-Donbas, Dnipro-Inhulets, and Dnipro-Krivyi Rih pipelines. This system supplied drinking water to the populations of Kherson, Mykolaiv, Dnipropetrovsk, Donetsk, and Zaporizhzhia regions and irrigation water for agricultural systems in the south and southeast of Ukraine. However, in June 2023, the Kakhovka HPS was blown up, causing an extraordinary man-made disaster. As a result, around one million people lost access to drinking water, and the environment and industries of Ukraine suffered enormous damage. To address the aftermath of this disaster, the Ukrainian government has planned the development of an experimental project to construct main water pipelines from the Karachunivske Reservoir to Kryvyi Rih and the Southern Reservoir, as well as from Marhanets to Nikopol, and from Khortytsia (DVS2) to Tomakivka [11]. The project includes building three main water pipeline links: from Inhulets to Kryazheve (Kryvyi Rih) - 400,000 m³ of water per day, from Zaporizhzhia to Tomakivka - Marhanets - Nikopol - Pokrov - 150,000 m³ of water per day, which will ensure sufficient provision of drinking water to the affected populations.

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As a result of power outages at key energy supply sources, there have been constant disruptions in the supply of potable water, flooding of sewerage pumping stations, and emergency discharges of untreated wastewater into surface water bodies within settlements. This, in turn, disrupts the ecological balance of environmental water systems. The lack of electricity and voltage fluctuations in equipment also lead to the unsatisfactory operation of sewerage treatment facilities, which function as multi-stage settling tanks. The absence of backup power sources has made it necessary to use generators. As a result, the cost of electricity has significantly increased, and the current tariffs for water supply and wastewater services do not cover these additional costs. Most facilities, such as treatment plants, are unable to connect to generators due to high-voltage pumps, which complicates the operation of water utilities during emergency power outages. There are significant gaps in emergency response plans related to power outages. According to estimates [12], 85% of the 37 largest water utilities, which serve approximately 15 million people, are unable to provide stable water supply in the event of a power outage. About 78% of water utilities are also unable to maintain the functioning of wastewater systems under similar conditions.

Ukraine has become critically dependent on the supply of reagents for water treatment and disinfection.

Water and sewerage enterprises are experiencing a significant shortage of engineering and technical staff, largely due to the insufficient number of reservists. Improving the efficiency of service delivery to water users requires the training and retraining of personnel according to European standards.

A particular concern is the absence of modern water quality monitoring laboratories at water and sewerage enterprises. For water supply and sewerage systems in small settlements, such laboratories are virtually non-existent.

Significant population migration, especially from the front-line regions of the country, has led to a decrease in actual water supply and sewerage service usage. As a result, networks, pumping stations, and treatment facilities are operating in non-optimal modes. In relatively safe regions of the country, there has been an increase in the number of water users, particularly in large cities, which has increased the load on centralized water supply and wastewater systems.

This situation is further complicated by the moral and physical wear of the main assets, and the financial situation of water and sewerage enterprises is extremely unsatisfactory.

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5. Comparison of drinking water quality standards in Ukraine and the European Union

The role of drinking water regulations in water supply is critical, as it is the control and implementation of regulatory requirements in the water treatment process that ensure water quality, safety and control potential risks to consumer health. These types of regulatory documents require flexibility and continuous improvement, considering current changes in the social, scientific, natural, governmental and technological environment.

Currently, Ukraine has undergone significant changes in the national context, which have an impact on the emergence of public health risks, as well as concerns about the insufficiency or inconsistency of existing standards. Considering these facts, there is a need to analyse national water quality regulations in the historical context, along with a comparative analysis of the relevant EU regulations, in order to develop recommendations for improving Ukrainian regulations and their adaptation to European ones.

Therefore, it is necessary to analyse the national water quality regulations, in particular, considering the path of development - from the Soviet Republic to independent Ukraine and to the current state at war. The results of such an analysis should identify the main trends in changes in approaches, priority control parameters, strengths and weaknesses of individual documents, disadvantages and gaps in previous and current Ukrainian regulations. This will allow to focus on critical points when conducting a comparative analysis with EU norms.

Moreover, a similar analysis of the EU drinking water quality standards and their subsequent comparison with the Ukrainian standards will identify the main common and distinctive features, both in changes in control parameters and requirements, as well as in approaches and priorities. Considering the best practices of EU countries in the field of drinking water safety and quality, the results obtained can serve as a basis for the next process of adaptation EU norms into Ukrainian standards.

5.1. Analysing of the development and current state of Ukrainian drinking water quality regulations

The first stage in the development of regulatory documents on the quality of drinking water in Ukraine is characterised by a long period of validity of ***GOST 2874-82 'Drinking Water. Hygienic requirements and quality control'*** until December 1996 [13]. Thus, during the first 5 years of independence and withdrawal from the Soviet Union, Ukraine did not achieve a sufficient level of development in this area. Moreover, the Soviet standard was accepted in 1985, which increases the number of years it was in force to 11. Thus, the level of drinking water quality at the first stage was limited due to the prolonged use of outdated standards.

According to GOST, hygienic requirements for drinking water quality included monitoring of three main groups of control indicators: microbiological indicators, toxicological indicators and organoleptic indicators. With regard to microbiological indicators, this standard provided for control over only two parameters. Furthermore, the toxicological indicators of water characterising the hazardousness of its chemical composition, had 10 indicators in their list. The organoleptic indicators were divided into two groups - those that indirectly affected the organoleptic properties of water, as well as indicators of the organoleptic state of water. Furthermore, this standard provided additional control over residual

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chlorine and ozone concentrations in the presence of appropriate disinfection processes during water treatment. The total number of indicators was 26.

Along with the list of quality indicators, the Soviet regulation provided the basic requirements for the monitoring of water quality. The main entities that were obliged to implement the relevant control were water suppliers themselves. The control requirements differed depending on the type of water intake - for groundwater intake and for surface water intake. Moreover, the number of control measurements required varied depending on the presence/absence of a disinfection process, the time of year, the population size and local natural and sanitary conditions.

At the second stage of the development of regulatory documents on drinking water quality in Ukraine, the State Sanitary Rules and Regulations 'Drinking Water. Hygienic requirements to the quality of water of centralised household and drinking water supply' was developed and introduced by the Order of the Ministry of Health No. 383 dated 23.12.96 [14].

The new regulation provided for control over the concentrations of residual disinfectants during water disinfection, in particular, the concentrations of residual chlorine (free and bound) and ozone. At the same time, the 1996 DSanPiN (Derzhavni Sanitarni PiN (Pravyla i Normy) = national sanitary rules and standards) introduced the concept of a drinking water toxicity index, which allowed regulating the levels of potential contamination of drinking water with unknown toxic compounds and chemicals, which was not provided by the Soviet GOST.

However, the most significant changes were made to the list of indicators for monitoring the quality of drinking water. Compared to the GOST, the 1996 DSanPiN introduced two new groups of indicators, including parasitological and radiological. At the same time, the existing groups of indicators were expanded, including microbiological indicators with 3 new ones, organoleptic indicators with 1 new one, and toxicological indicators with 8 new ones. The total indicators number was 36.

Analysing main indicators, it can be argued that for some common indicators, the 1996 DSanPiN had lower permissible values (, arsenic, selenium, lead), for some higher values (dry residual, total hardness), and for some identical values to those set by GOST (CFU, Bacterial coliform index). It can be concluded that the requirements for the quality of drinking were tightened.

Moreover, the 1996 DSanPiN introduced a list of physiological adequacy of the mineral composition indicators, which determine the adequacy of drinking water mineral composition to the biological needs of the human body. This list is the opposite of the previous ones, as it does not reflect restrictions on the content of components in terms of negative risks, whereas reflects the optimal values of the mineral components content in drinking water.

On the other hand, DSanPiN of 1996 provided the basic requirements for state sanitary and epidemiological monitoring of water quality in centralised DWSSs. The frequency of such control was determined by the type of water source, the volume of water supplied to the population and the location of control points. At the same time, there were 6 main types of water quality monitoring: full, general physical and chemical, shortened, special epidemic safety control, special toxicological control, and special radiation safety control.

Thus, it can be concluded that the new standard, which was developed to replace the Soviet standard, is qualitatively superior due to the increased number of water quality control indicators groups, the introduction of physiological adequacy of the mineral composition indicators, and clearly established norms for monitoring.

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At the third stage of the development of regulatory documents on drinking water quality in Ukraine in 2010, a new document was developed and put into force, in particular, the ***State Sanitary Norms and Rules 'Hygienic Requirements for Drinking Water Intended for Human Consumption' (DSanPiN 2.2.4-171-10)*** [15].

The section on hygienic requirements for the safety and quality of water intended for human consumption contains a significant number of additional norms that are not included in the two previous standards: the use of additional materials in water treatment, water storage periods, requirements for bottled water, description of preliminary laboratory tests of water before utilisation of new sources, standardisation of accompanying information for drinking water, requirements for drinking water from wells and boreholes, etc.

Nevertheless, the most significant difference is in the classification of indicators and the number of control indicators groups. DSanPiN 2.2.4-171-10 provides for the implementation of a hygienic assessment of the safety and quality of drinking water and control over the following groups of indicators: epidemiological safety indicators (microbiological, parasitological), sanitary and chemical (organoleptic, physico-chemical, sanitary-toxicological), and radiological. Additionally, it is distinctive that for all groups of indicators (except for radiological) regulatory values are provided separately for the types of drinking water: for tap water, water from wells and boreholes, bottled water. The total indicators number is 85.

Furthermore, new regulatory document exceeds the parameters number of GOST by 59 units, and DSanPiN 1996 by 49, and includes the absolute majority of parameters that were regulated in the two previous standards. The exception is Barium from the 1996 DSanPiN. In particular, compared to the previous DSanPiN, 4 new microbiological parameters have been added (Enterococci, Pseudomonas aeruginosa, Enteroviruses, Adenoviruses). Furthermore, in 2015 and 2022, the groups of physicochemical and sanitary-toxicological indicators were significantly improved due to a wide list of parameters, including substances of hazard class I and II. Moreover, the new standard introduces deeper control over radiological indicators, in particular by total alpha and beta activities, and in cases of excess - by a number of 6 individual isotopes. In December 2024, the Specific activity and Indicated Dose indicators were added [16].

In addition, comparing the normative values of the parameters common to the two DSanPiNs, it was found that DSanPiN 2.2.4-171-10 is characterized by lower permissible values for the *E.coli* indicator, color, total iron, manganese, sulfates, dry residue, chlorides and nickel. In contrast, higher permissible values are characteristic of the following indicators: total organic carbon, pesticides (total), nitrates and turbidity. At the same time, such indicators as residual polyacrylamide, fluorides (by climatic zones), molybdenum, zinc and polyphosphates were not included in the DSanPiN of 1996, while are regulated by GOST and DSanPiN 2.2.4-171-10. According to DSanPiN 2.2.4-171-10, residual polyacrylamide, fluorides (by climatic zones), molybdenum and zinc have lower permissible values compared to GOST. Moreover, such quality control parameters as beryllium, selenium, strontium were added to DSanPiN 2.2.4-171-10 later, in particular selenium since January 1, 2015, and beryllium and strontium since January 1, 2022.

Moreover, the current standard provides the main requirements for production monitoring of the safety and quality of drinking water. DSanPiN 2.2.4-171-10 provides for 3 main work programs for the relevant monitoring: full, shortened and shortened periodic monitoring. The regulatory document defines the main places for control: at water intake points, before entering the water supply network and in the distribution network. In addition, standard regulates the difference in the monitoring frequency depending on the type of sources, as well as depending on the number of people supplied

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with drinking water from the water supply system. Moreover, separate regulation of quality indicators is provided for production of bottled drinking water and for drinking water from boreholes, wells and spring catchments. Thus, in terms of requirements for monitoring of the safety and quality of drinking water, the developed DSanPiN 2.2.4-171-10 is much more advanced than the Soviet GOST and DSanPiN of 1996, as it consider the greater variability of water treatment processes at various enterprises, considering a greater number of influencing factors.

At the fourth stage of the regulatory document's development on the quality of drinking water in Ukraine, a new standard "State Sanitary Norms and Rules "Safety Indicators and Certain Indicators of Drinking Water Quality in Conditions of Martial Law and Other Emergency Situations" was put into force on May 25, 2022 [17].

This standard is applied in conditions of martial law and during emergencies of a different nature in a separate territory for a certain period of time by decision of the relevant regional or local commission on technogenic and environmental safety and emergencies. Furthermore, the validity of DSanPiN 2.2.4-171-10 does not cease, and the 2022 standard is applied locally by decision of the relevant authority.

Considering the parameters of epidemiological and radiological safety of drinking water according to DSanPiN 2.2.4-171-10, the total number of control parameters for standard under martial law is 60 units, which is 25 units less than in the main current standard. At the same time, 2 new parameters have been approved that are valid exclusively within the framework of DSanPiN under martial law - Chlorates and the Chemical Oxygen Demand (COD). Analysing changes in normative values for individual parameters, a significant increase in permissible levels is identified. Thus, the quality of drinking water that is permitted for water supply according to this standard is lower than that regulated by the previously considered standards.

Therefore, analysing all 4 Ukrainian regulatory documents, it is possible to form comparison diagram for parameters subject to monitoring in the processes of water treatment and ensuring high quality of drinking water (Figure 5.1). Data from Figure 5.1, indicate a clear increase in the number of groups and parameters of drinking water quality control.

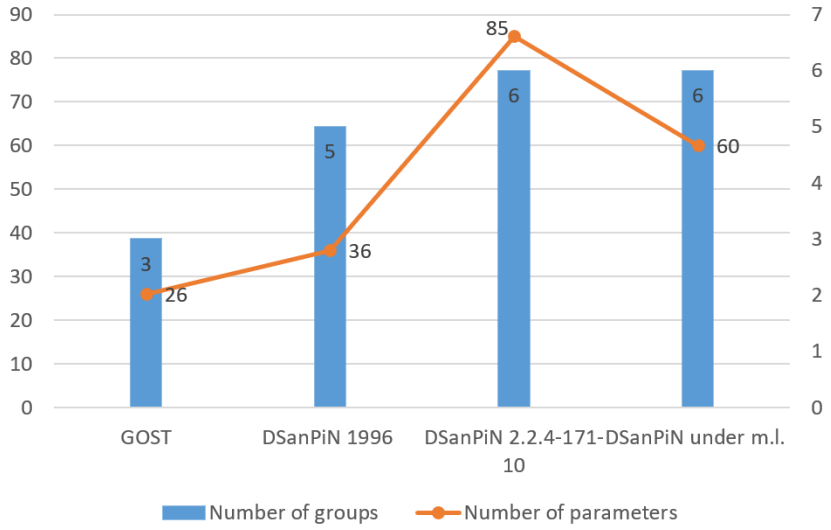

Figure 5.1. Change in the number of drinking water quality control indicators within the development of the regulatory standards in Ukraine

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Consequently, based on the results of the analysis of the development and current state of Ukrainian drinking water quality regulations, it can be concluded that regulatory documents are in the process of constant development and have been repeatedly edited, in particular, three complete State Sanitary Norms and Rules have been developed and implemented. A comparative analysis of these documents together with the Soviet standard identified a clear trend towards expanding the subject issues and deepening control over the quality and safety of drinking water, in particular through the introduction of new parameters and indicator groups considering the development of science and practice, as well as the development of new monitoring programs. Particularly, the current DSanPiN provides three types of monitoring for three different types of drinking water, for different types of water intake sources according to a list of more than 80 indicators, which allows to guarantee a high level of epidemiological, sanitary-chemical and radiological safety of drinking water. Furthermore, the developed requirements for the physiological adequacy of the drinking water mineral composition allow to ensure its high quality. Moreover, the developed standard under martial law should be considered, which on the one hand provides the possibility of supplying drinking water to consumers in the territories affected by hostilities, while on the other hand limits the safety and quality of drinking water by significantly increasing the permissible normative values of control parameters. To determine the opportunities for improving Ukrainian and adapting EU standards, the next stage requires an appropriate analysis of European regulations.

5.2. Analysis of the development and current state of European drinking water quality regulations

Firstly, the ***Council Directive 98/83/EC of 3 November 1998*** on the quality of water intended for human consumption is considered, as amended in 2015. This Directive consists of a preamble and main body in the form of 19 articles and annexes [18].

The main body of the Directive define the main purpose of the document - the protection of human health from the adverse effects of any pollution of water intended for human consumption. Moreover, it is clearly defined that drinking water is considered to be water intended for domestic purposes, as well as water used in food enterprises. Additionally, cases are determined for which this Directive does not apply.

The regulation outlined that drinking water must comply with the normative values of the control parameters at the certain points: at the point of exit from the distribution network, at the point of filling from the tanker, at the point of bottling/container filling, at the point of utilisation in a food enterprise. Furthermore, in case of non-compliance with the normative values, Member States must ensure that appropriate measures are provided to reduce or eliminate the risk of non-compliance by the responsible water supply entities. In addition, any derogations or unregulated violations of the standards must be followed by simultaneous informing consumers and the Commission about the situation.

The total indicators number is 50. Parameters analysis indicate that this standard already in 1998 provided comprehensive control of drinking water quality, in particular by microbiological, chemical, indicator and radiological parameters. This document establishes that the normative values of the parameters should be reviewed every 5 years considering scientific and technical progress. In order to control quality parameters, it is outlined to establish and implement appropriate monitoring programs with clearly defined objectives and main components of such programs by the Directive.

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According to the Directive, to determine the frequency of measurements in monitoring programs, parameters are divided into two groups: A (*Escherichia coli* (*E.coli*), coliform bacteria, colony count 22 °C, colour, turbidity, taste, odour, pH, conductivity, ammonium and nitrite, aluminium and iron, as well as other relevant indicators may be included) and B (the remaining indicators). The frequency of monitoring is determined primarily by the volume of water distributed or produced daily within the water supply zone. However, for parameters of group A, the number of measurements per unit volume of water will be higher than for parameters of group B. Furthermore, the standard determines the implementation of a risk assessment, based on the results of which the number of parameters and the frequency of monitoring for a particular indicator group may be increased or, conversely, slightly shortened.

Furthermore, this Directive states that each Member is obliged to publish a report on the quality of drinking water every three years, in order to inform consumers. Additionally, the Commission examines the reports of the Member States and publishes a consolidated report on the quality of drinking water in the EU every three years. Thus, a clear reporting mechanism has been developed between the Member States and the EU Commission.

Therefore, the Council Directive 98/83/EC was a regulatory document that provided not only complete control of the quality and safety of drinking water according to a wide list of parameters, but also such important components as a separate classification of parameters in monitoring programs, consideration of the risk assessment results, a clear system of international reporting, which provided the publication of relevant data with access for the consumer, as well as the mandatory development of standards depending on the development of science and new experience.

Secondly, at the current stage, ***Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020*** on the quality of water intended for human consumption has been developed and adopted. This regulation has a similar structure to the previous one and consists of a preamble and main body in the form of 28 articles and annexes [19].

In the general obligations, in addition to ensuring the wholesome and purity of drinking water, an assessment of the water losses level within individual member states with the subsequent presentation of an action plan for measures to reduce these levels is provided. Moreover, the norms regarding informing the population are more advanced, in particular, the requirement to ensure easy access to information on the condition and quality of drinking water is established, even in case of the request from the consumer absence.

A large block of four separate articles addressing the issue of a risk-based approach to water safety is implemented, which was not fully covered by the previous Directive. Such norms provide guarantees by Member States that the supply, treatment and distribution of water intended for human consumption is a subject to a risk-based approach covering the entire supply chain from the catchment area, capture, treatment, storage and distribution of water to the point of compliance.

Furthermore, the new Directive outline specific minimum hygiene requirements for materials in contact with water intended for human consumption. Additionally, Directive ensures the development and adoption of European positive lists, which should contain only starting substances, compositions or components authorised for use in materials in contact with drinking water. The lists of requirements for authorised organic polymer materials, metallic, cementitious and ceramic materials, and enamels are clearly defined.

The total indicators number is 57. Parameters analysis indicate that the total number of quality control parameters has increased by 4 units compared to the previous standard. At the same time, there are

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indicators that are not included in the new document, in particular: 2 microbiological indicators, cadmium and radiological parameters. Regarding radiological parameters, their control must be now implemented in accordance with Council Directive 2013/51/Euratom, which will be described below. In addition, a completely new group of indicators used to assess the risks of internal distribution systems has been added. Furthermore, new control parameters have been added, particularly in the group of chemical parameters: Bisphenol A, Chlorates, Chlorites, Microcystin, Per- and polyfluoroalkyl substances (PFAS) and Uranium. There are minor changes in the normative values of individual indicators, particularly, more stringent values have been adopted for Lead and Chromium and less stringent values for Selenium and Boron.

Furthermore, Directive 2020/2184 contains new monitoring requirements, particularly, monitoring programs must consider the results of the risk assessment of water catchment areas for water intake points and supply systems. Monitoring programs must include monitoring in water supply systems, internal distribution systems, monitoring of the substances content included in the watch list, monitoring of hazardous events and operational monitoring. Moreover, inclusion of microplastics, per- and polyfluoroalkyl substances, pharmaceuticals and endocrine disrupting compounds (Beta-estradiol and nonylphenol) in the control list is outlined. Thus, the monitoring system has undergone significant changes compared to the Directive 98/83/EC.

Additionally, the measurement frequency is determined by the volume of water supplied per day. However, for conventional monitoring, the indicators are divided into groups A and B, as in Directive 98/83/EC. Furthermore, the measurement frequency for parameters of groups A and B is determined by the volume of water distributed or produced daily within the water supply area.

In addition, Directive 2020/2184 provides the following self-assessment by Member States in order to develop amendments. Particularly, it is outlined to assess the experience that Member States will gain after the adoption of this standard over the next 15 years. The following points are separately highlighted for assessment: the risk-based approach, requirements for free access to drinking water, free access of the population to information on the state and quality of drinking water, the watchlist (microplastics, pharmaceuticals). Moreover, the need to review the normative values of parameters every 5 years is determined.

Thus, it can be argued that Directive 2020/2184 differs qualitatively from the previous regulation by a number of new emphases and trends, particularly: assessing the level of water losses and developing appropriate compensatory measures, easy and free access to information on the state of drinking water quality and safety, a developed risk-based approach to water safety that involves risk assessment and management, the introduction of positive lists of substances permitted for use and contact with drinking water, the introduction of emerging substances watchlist, and the clear mechanism for the further development of this Directive.

As already mentioned, the requirements for control by radiological indicators of drinking water quality and safety were not included in the new Water Directive, while were defined within a separate document - ***Council Directive 2013/51/Euratom*** of 22 October 2013 [20]. This regulation consists of a preamble and the main body described in 10 articles with annexes and outlines requirements for the protection of public health in terms of the presence of radioactive substances in water intended for human consumption.

This Directive provides a list of quality control parameters that must be monitored at similar compliance points as by the Water Directive 2020/2184, totally 3 parameters. Compared to the list regulated by Directive 98/83/EC, which included only Tritium and Indicative Dose, the current regulation adds Radon. Thus, Directive 2013/51/Euratom is limited in terms of the main radioactive

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compounds-controlled number. However, Member States may, if necessary, include other radionuclides in their monitoring plans if their potential presence is locally determined, e.g. Pb-210, U-238, U-234, Sr-90, Co-60, Cs-137, etc.

The number of measurements required within the monitoring programs is determined by the volume of water distributed or produced daily within the water supply area. Monitoring includes screening for selected radionuclides and the measurement of gross alpha and gross beta activity.

Thus, Directive 2013/51/Euratom allowed the EU Member States to ensure a higher level of control over radiological safety and drinking water quality through a new approach of separate and systematic control over this group of parameters within a separate standard.

Hence, analysing all three EU Directives, it is possible to form generalised comparison diagram for parameters subject to monitoring in the processes of water treatment and ensuring high quality of drinking water (Figure 5.2).

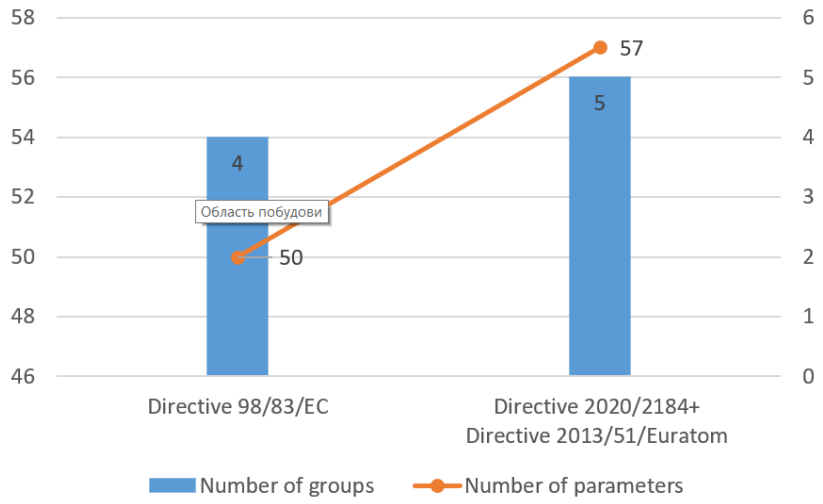

Figure 5.2. Change in the number of drinking water quality control indicators within the development of the regulatory standards in EU

The data from Figure 5.2 shows a slight increase in the number of groups and the control parameters of drinking water quality. Thus, there are no crucial changes in the list of main parameters for monitoring the drinking water quality. Therefore, based on the results of the development and current state of EU regulations on drinking water quality analysis, it can be concluded that the regulations are in the process of constant development. Moreover, this development consists in not only increasing the number of control parameters and diversifying groups, but in fundamental changes and the introduction of new approaches. As a result, new requirements are being introduced for the most accessible and open information policy in the field of drinking water quality, for the intensive development of risk assessment and management processes, and for the regulation of water losses and availability. The results obtained require further comparison with the results of the Ukrainian standards analysis.

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5.3. Comparative analysis of Ukrainian and EU regulations

Thus, based on the results of the analysis of the development and current state of Ukrainian and EU regulations, it is possible to form generalised comparison table and diagram for parameters subject to monitoring in the processes of water treatment and ensuring high quality of drinking water in the regulations that are in force (Table 5.1, Figure 5.3).

Table 5.1. Generalised table of drinking water quality control parameters according to Ukrainian and EU standards in force

№	Parameter	DSanPiN 2.2.4-171-10	DSanPiN under m.l.	Directive 2020/2184+ Directive 2013/51/Euratom
1	Total microbial count at t 37 °C - 24 h	≤ 100 CFU/cm^3	-//-	-
2	Total microbial count at t 22 °C - 72 h	-	-	No abn. change
3	Total coliforms	0 CFU/100cm^3	-//-	0 number/100 ml
4	*E.coli*	0 CFU/100cm^3	-//-	0 number/100 ml
5	Enterococci	0 CFU/100cm^3	-//-	0 number/100 ml
6	Pseudomonas aeruginosa	-	-	-
7	Pathogenic enterobacteria	0 Presence in 1 L	-//-	-
8	Coliphages	0 BFU/L	-//-	-
9	Enteroviruses, adenoviruses, antigens of rotaviruses, reoviruses, hepatitis A virus and others	0 Presence in 10 L	-//-	-
10	Pathogenic intestinal protozoa	0, cells, cysts in 50 L	-//-	-
11	Intestinal helminths	0, cells, eggs, larvae in 50 L	-//-	-
12	Clostridium perfringens (including spores)	-	-	0 number/100 ml
13	Legionella	-	-	< 1 000 CFU/l
14	Odor	≤2 points	3 points	No abn. change
15	Color	≤20 degrees	35 degrees	No abn. change
16	Turbidity	≤1.0-2.6 NTU	3.5 NTU	No abn. change
17	Taste and aftertaste	≤2 points	3 points	No abn. change
18	Conductivity	-	-	2500 µS cm^{-1} at 20 °C
19	pH	6.5-8,5	6.5-9.0	6.5-9.5
20	Carbon dioxide	-	-	-
21	Total iron	≤0.2 mg/L	1.0 mg/L	200 µg/L
22	Total hardness	≤7.0 mmol/L	10 mmol/L	-
23	Total alkalinity	-	-	-
24	Iodine	-	-	-
25	Calcium	-	-	-
26	Magnesium	-	-	-
27	Manganese	≤0.05 mg/L	0.5 mg/L	50 µg/L
28	Copper	≤1.0 mg/L	2.0 mg/L	2.0 mg/L

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№	Parameter	DSanPiN 2.2.4-171-10	DSanPiN under m.l.	Directive 2020/2184+ Directive 2013/51/Euratom
29	Polyphosphates (PO_4^{3-})	≤3.5 mg/L	-	-
30	Sulfates	≤250 mg/L	500 mg/L	250 mg/L
31	Dry residue	≤1000 mg/L	1500 mg/L	-
32	Free residual chlorine	≤0.5 mg/L	-	-
33	Chlorides	≤250 mg/L	350 mg/L	250 mg/L
34	Zinc	≤1.0 mg/L	-	-
35	Residual bound chlorine	≤1.2 mg/L	-	-
36	Oil products	≤0.1 mg/L	-	-
37	Anionic surfactants	≤0.5 mg/L	-	-
38	Volatile phenols	≤0.001 mg/L	-	-
39	Chlorophenols	≤0.0003 mg/L	-	-
40	Aluminium	≤0.2 mg/L	≤0.5 mg/L	200 µg/L
41	Ammonium	≤0.5 mg/L	≤2.6 mg/L	0.5 mg/L
42	Chlorine dioxide	≥0.1 mg/L	-	-
43	Cadmium	≤0.001 mg/L	≤0.005 mg/L	
44	Silicon	≤10 mg/L	-	-
45	Arsenic	≤0.01 mg/L	-//-	10 µg/L
46	Molybdenum	≤0.07 mg/L	-	-
47	Sodium	≤200 mg/L	-//-	200 mg/L
48	Nitrates (as NO_3)	≤50 mg/L	-//-	50 mg/L
49	Nitrites	≤0.5 mg/L	≤3.3 mg/L	0.5 mg/L
50	Residual ozone	0.1-0.3 mg/l	-	-
51	Mercury	≤0.0005 mg/L	≤0.001 mg/L	1.0 µg/L
52	Microcystin-LR	-	-	1.0 µg/L
53	Lead (Plumbum)	≤0.01 mg/L	-//-	5 µg/L
54	Silver	-	-	-
55	Fluorides (II, III, IV climatic zones)	≤0.7 mg/L ≤1.2 mg/L ≤1.5 mg/L	≤1.5 mg/L	1.5 mg/L
56	Chlorites	≤0.2 mg/L	≤0.7 mg/L	0.25 mg/L
57	Chlorates	-	≤0.7 mg/l	0.25 mg/L
58	Cobalt	≤0.1 mg/L	-	-
59	Nickel	≤0.02 mg/L	-//-	20 µg/L
60	Selenium	≤0.01 mg/L	-//-	20 µg/L
61	Total chromium	≤0.05 mg/L	-//-	25 mg/L
62	Beryllium	≤0.0002 mg/L	-	-
63	Boron	≤0.5 mg/L	≤2.4 mg/L	1.5 mg/L
64	Bromate	-	-	10 µg/L
65	Barium	-	-	-
66	Strontium	≤7.0 mg/L	-	-
67	Antimony	≤0.005 mg/L	-//-	5.0 µg/L
68	Cyanides	≤0.05 mg/L	-//-	50 µg/L
69	COD	-	No abn. change	-

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№	Parameter	DSanPiN 2.2.4-171-10	DSanPiN under m.l.	Directive 2020/2184+ Directive 2013/51/Euratom
70	Residual polyacrylamide	≤2.0 mg/L	-	0.1 µg/L
71	Formaldehyde	≤0.05 mg/L	-	-
72	Benz(a)pyrene	≤0.005 µg/L	≤0.01 µg/L	0.01 µg/L
73	Bisphenol A	-	-	2.5 µg/L
74	Dibromochloromethane	≤10 µg/L	-	-
75	Pesticides	≤0.0001 mg/L	≤0.1 mg/L	0.1 µg/L
76	Pesticides (total)	≤0.0005 mg/L	≤0.5 mg/L	0.5 µg/L
77	Trihalomethanes (total)	≤100 µg/L	-//-	100 µg/L
78	Chloroform	≤60 µg/L	-	-
79	Benzene	≤0.001 mg/L	≤1.0 mg/L	1.0 µg/L
80	1,2-dichloroethane	≤3 µg/L	-//-	3.0 µg/L
81	Epichlorohydrin	-	-	0.1 µg/L
82	Polycyclic aromatic hydrocarbons	-	-	0.1 µg/L
83	PFAS Total	-	-	0.5 µg/L
84	Sum of PFAS (20 named PFAS)	-	-	0.1 µg/L
85	Carbon tetrachloroethylene	≤2 µg/L	-	-
86	Trichloroethylene and tetrachloroethylene (total)	≤10 µg/L	-//-	10 µg/L
87	Uranium	-	-	30 µg/L
88	Vinyl chloride	-	-	0.5 µg/l
89	Permanganate oxidizability	≤5.0 mg/L	No abn. change	5.0 mg/L O_2
90	Total organic carbon	≤8.0 mg/L	-	No abn. change
91	Total alpha activity	≤0.1 Bq/L	-//-	-
92	Total beta activity	≤1.0 Bq/L	-//-	-
93	Total activity of the natural mixture of U isotope	≤1.0 Bq/L	-//-	-
94	Specific activity- ^{226}Ra	≤1.0 Bq/L	-//-	-
95	Specific activity- ^{228}Ra	≤1.0 Bq/L	-//-	100 Bq/L
96	Specific activity- ^{222}Rn	≤100 Bq/L	-//-	-
97	Specific activity- ^{137}Cs	≤2.0 Bq/L	-//-	-
98	Specific activity- ^{3}H	≤100 Bq/L	-//-	100 Bq/L
99	Specific activity- ^{90}Sr	≤2.0 Bq/L	-//-	-
100	Indicative dose (ID)	≤0.1 mSv	-//-	0.1 mSv
	Total	**85**	**60**	**57**

The data from Tables 5.1 and Figure 5.3 shows that Ukrainian standards are characterised by a larger number of parameter groups and parameters of drinking water quality control. Furthermore, the Ukrainian standards have a more complex classification grid of control parameters. On the other hand, the same control parameters in Ukrainian and European standards can be assigned to different classification groups. Moreover, it can be argued that for most parameters, the normative values are identical for both the EU Directives and the Ukrainian DSanPiN. In addition, the Ukrainian norms do

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not consider a number of relevant indicators provided in the Water Directive's watchlist of emerging substances (e.g. PFAS). However, the DSanPiN 2.2.4-171-10 have stricter requirements than the Directives for the following parameters: pH, Copper, Mercury, Selenium, Boron and Benz(a)pyrene. In contrast, the Directives have stricter requirements for Polyacrylamide, Chromium, Chlorates and Lead. Additionally, the requirements of the DSanPiN under martial law are the least stringent.

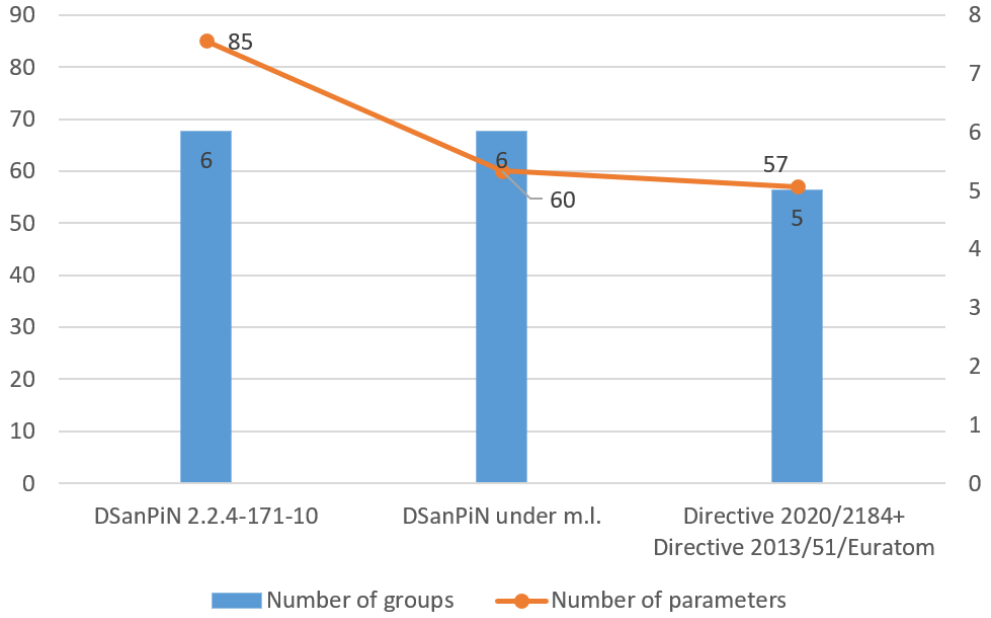

Figure 5.3. Comparison of the number of drinking water quality control parameters within Ukrainian and EU standards in force

However, a large number of parameters and their complex classification grid do not guarantee the supply of drinking water of the highest quality, considering the Ukrainian practice. Particularly, there is a problem of inconsistency between the regulated parameters of drinking water quality control, monitoring programs and the actual control measurements, due to the poor material resources of the relevant enterprises. This is evidenced by numerous publicly available drinking water quality analysis reports of domestic water suppliers. Furthermore, the actual situation is complicated by the inforced DSanPiN under martial law, which simplifies the requirements for quality control.

In order to identify the norms that can be considered in the context of future adaptation in the Ukrainian regulations, it is necessary to summarise common and distinctive characteristics with the relevant EU regulations that were analysed. Thus, the following has been highlighted:

1) Common characteristics**:**

- Ensuring the safety and high quality of drinking water for the needs of the population as the main goal**;**
- Ensure regular control and monitoring of water quality according to defined plans and with defined frequency**;**
- Lists of quality control parameters for each individual monitoring program are defined, with many common control indicators and similar normative values for the EU and Ukraine**;**
- State control and a clear reporting system on the quality and safety of drinking water**.**

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2) Distinctive characteristics**:**

- Existence of simplified regulations in Ukraine due to martial law;
- Classification of the main groups of drinking water quality control parameters;
- Radiological indicators are regulated by a separate Directive, in contrast to Ukrainian legislation;
- Having a quantitatively wider list of control parameters, Ukrainian regulations have a lack of certain relevant indicators (microplastics, PFAS, etc.) while the EU has developed a watch list mechanism to address new emerging compounds;
- Classification of monitoring programmes, and the division of control parameters into groups A and B in the Directive;
- Lack of international reporting in Ukraine;
- A clearly defined mechanism for the EU standard development and the absence of such norms in the DSanPiN;
- European positive lists of starting substances, compositions and constituents, methods and procedures and the absence of such lists in Ukraine;
- **The risk-based approach is regulated by the Water Directive, which is absent in the DSanPiN**;
- The Water Directive aims to combat the loss of drinking water and provides a clear mechanism for developing measures to reduce this problem;
- The Water Directive is very specific about the requirements for large-scale facilities and requirements on informing of consumers about the quality and safety of drinking water.

In describing adapting of European standards, Ukraine already has such a process in place, particularly, DSTU 7525:2014 'Drinking Water' states that it implements the basic requirements of Council Directive 98/83/EC of 03.11.1998. Furthermore, DSanPiN 2. 2.4-171-10 and the DSanPiN under martial law should comply with some of Council Directive 2013/51/Euratom of 22 October 2013 requirements in accordance with the Order of the Ministry of Health No. 1984 of 29 November 2024 [16 21]. However, this process still requires significant efforts in the present and future.

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6. Standards for Materials in Contact with Drinking Water

Article 1 of the Law of Ukraine "On Drinking Water and Drinking Water Supply" [22] defines drinking water as water intended for human consumption (from water supply systems, bottled water, water from wells, distribution points, mine wells, and spring captures), for use by consumers to meet physiological, sanitary-hygienic, household, and economic needs, as well as for the production of goods that require its use, the composition of which meets hygienic standards according to organoleptic, microbiological, parasitological, chemical, physical, and radiation indicators. Drinking water is not considered a food product in the DWSS and in points for ensuring the quality of drinking water.

In turn, hygienic requirements for the quality of drinking water are determined by the State Sanitary Norms and Rules "Hygienic Requirements for Drinking Water Intended for Human Consumption" [23]. The sanitary norms set requirements for the safety and quality of drinking water intended for human consumption, as well as the rules for production control and state sanitary and epidemiological supervision in the drinking water supply sector. Section 3.11 defines that materials, substances, and compounds (coagulants, flocculants, disinfectants, preservatives, containers, packaging, sealing agents, cleaning and disinfecting agents, equipment, building materials, etc.) that are approved by the central executive authority in the field of ensuring sanitary and epidemiological well-being of the population for use in this field may be used in the drinking water supply sector. The residual concentrations of chemicals and compounds in drinking water must not exceed the limits established by hygienic standards. The disinfectant doses requirements are determined by the State Sanitary and Epidemiological Inspection. Similar requirements are defined in Section 5.10 of State Construction Norms (SCN) B.2.5-74:2013 "Water Supply. External Networks and Structures. Basic Design Provisions" [24]. Section 12.21 [24] states that pipes and materials for DWSSs must be used in accordance with Section 3.11 of State Sanitary Norms and Rules 2.2.4-171.

Starting from 01.10.2023, sanitary and hygienic conclusions (conclusions from Sanitary and Epidemiological Stations) will no longer be issued, as the Law of Ukraine "On the Public Health System" [25] came into force, which repealed the Law of Ukraine "On Ensuring the Sanitary and Epidemiological Well-being of the Population", which previously required the state sanitary and epidemiological examination of products.

Starting in 2024, 45 national standards in the field of drinking water supply [26] will be repealed – methodologies for measuring water quality indicators and materials for water purification, including:

- DSTU EN 12902:2004. Testing methods: Materials for water purification intended for human consumption. Inorganic materials for the support layer and filtering materials.
- DSTU EN 12903:2004. Powdered activated carbon: Materials for water purification intended for human consumption.
- DSTU EN 12904:2004. Sand and gravel: Materials for water purification intended for human consumption.
- DSTU EN 12909:2004. Anthracite: Materials for water purification intended for human consumption.
- DSTU EN 15798:2020. Filter media: Chemicals used for pool water purification.

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Currently, the principles for introducing non-food products into circulation in Ukraine and ensuring their safety are defined by the laws of Ukraine: “On the Public Health System,” “On the General Safety of Non-Food Products,” and “On State Market Surveillance and Control of Non-Food Products.” First and foremost, safe non-food products are any products that, under normal or reasonably foreseeable conditions of use (including with respect to service life and, if necessary, the requirements for commissioning, installation, and maintenance), do not pose any risk or pose only minimal risks that are considered acceptable and do not threaten public interests.

One of the main requirements of the Law [27] is Article 4, which states that manufacturers (importers, authorized representatives) are obliged to introduce only safe products into circulation. In turn, Article 5 of this Law, “Proving Product Safety,” stipulates that:

1. A product is considered safe if it meets the requirements for ensuring product safety as established by legislation.
2. In the absence of safety requirements for the product, as defined in part one of this article, the product is considered safe unless the state market surveillance authority proves that the product is unsafe.
3. Proof of product safety is its compliance with national standards harmonized with the corresponding European standards (EU Directive 2020/2184 (Article 11)). The list of such harmonized national standards is formed by the central executive authority responsible for implementing state policy in the field of standardization. This list is published on the official website of the central executive authority implementing state policy in the field of standardization as of January 1 of each year.
4. In the absence of safety requirements for the product, as defined in part one of this article, or in the absence or non-application of national standards as defined in part three of this article, the state market surveillance authority, when proving that the product is unsafe, may take into account the following in this sequence:
    a) national standards of other countries regarding product safety, harmonized with the corresponding European and international standards;
    b) regional standards for product safety in accordance with Ukraine’s international agreements;
    c) Ukrainian standards for product safety, except for those defined in part three of this article;
    d) established practices for ensuring product safety in relevant industries;
    e) scientific and technical advancements in the field of product safety;
    f) consumer (user) expectations regarding product safety under normal or reasonably foreseeable conditions of its use (including with respect to service life and, if necessary, the requirements for commissioning, installation, and maintenance).
5. A product cannot be considered unsafe solely because there is a possibility of achieving a higher level of product safety or because another product is offered on the market.

Based on the above, the following conclusions can be drawn:

1. If a certain type of product is not subject to technical regulations or other industry standards, then there are no requirements regarding product safety in the legislation of Ukraine.
2. When such requirements are absent, the product is considered safe, and the state market surveillance authority must prove otherwise if it sees grounds for doing so.

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3. Currently, there is a list of National Standards approved by the Ministry of Economic Development [28]. At the time of writing this report, this list does not include standards for materials that may be used in contact with drinking water.
4. It is advisable to pay attention to the use of standards from other countries (certificates, declarations, quality passports, etc.), regional standards in accordance with international agreements, and the latest advancements in science and technology. In particular, on January 23, 2024, the EC adopted new minimum hygiene standards for materials and products that come into contact with drinking water [29]. These standards will go into force from December 31, 2026, to materials and products used in new installations or during the repair of existing equipment. These standards will prevent the multiplication of microbes and reduce the risk of harmful substances leaching into drinking water. The new hygiene standards will apply to materials and products intended for use in new systems for extracting, purifying, storing, or distributing water, or for repair work involving the use of pipes, valves, pumps, water meters, fittings, and taps. This will make drinking water safer and reduce the administrative burden on companies producing relevant materials and products, as well as on national authorities. Materials and products that comply with the new EU standards will receive an EU declaration of conformity and special EU labeling. Thus, the product will be able to be sold throughout the EU without any restrictions related to potential environmental or public health issues. It is also important to recognize the further acceptance of EU hygiene standards in Ukraine

Therefore, all manufacturers and importers in Ukraine who have already received conclusions from the Sanitary and Epidemiological Stations have certain buffer time to resolve all legal issues in the relevant fields. Others will need to act at their own risk, considering the potential for ambiguity in interpreting the legal requirements regarding safety. Clearly, in such a situation, some companies will become hostages of market surveillance, which will be able to decide on the issue of safety evaluation in its own way.

The current legislation of Ukraine defines the state registration of disinfectants, which is regulated by Article 48 of the Law of Ukraine “On the Public Health System” [26]. The registration and consideration of the application for state registration of a disinfectant are carried out in accordance with the Law of Ukraine “On Administrative Procedure” [30]. During the examination of the registration materials, the expert institution:

1. verifies the compliance of the documents submitted by the applicant for state registration of the disinfectant with the requirements of [26];
2. evaluates the disinfectant based on documents confirming its safety, quality, and effectiveness;
3. prepares a conclusion regarding the quality, safety, and effectiveness of the disinfectant.

The conclusions of the state sanitary and epidemiological examination are carried out by the Medved Research Center of Preventive Toxicology, Food and Chemical Safety, Ministry of Health of Ukraine.

The central executive authority responsible for forming state policy in the field of healthcare makes a decision on the state registration of the disinfectant or refusal of state registration based on the corresponding recommendation in the expert conclusion, within 30 working days after receiving the conclusion.

The decision on the state registration of a disinfectant includes:

1. the name of the disinfectant and the content of active substances;
2. information about the manufacturer and applicant of the disinfectant;

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3. the registration number of the disinfectant;
4. a brief description of the disinfectant;
5. the objects of use, conditions, and restrictions for the use of the disinfectant;
6. the validity period of the state registration of the disinfectant.

Within three working days after the decision on the state registration of the disinfectant is made, the central executive authority responsible for forming state policy in the field of healthcare enters the information about the disinfectant from the decision into the State Register of Disinfectants [31]. The disinfectant is considered registered from the moment the information about it is entered into the State Register of Disinfectants. The validity period of the state registration of a disinfectant is five years. If no scientifically confirmed facts are established during this period that the disinfectant does not meet the requirements of sanitary legislation regarding human health safety, the re-registration period for this disinfectant is extended by five years, provided that information confirming the effectiveness of the disinfectant is submitted.

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7. Organizations in the Field of Water Management

The Cabinet of Ministers of Ukraine (https://www.kmu.gov.ua/) plays a key role in the field of water supply and sewerage, providing strategic leadership and legal regulation. Various ministries, services, and inspections of Ukraine carry out the implementation of state policy in this field.

The Ministry for Development of Communities and Territories of Ukraine (https://mindev.gov.ua/) is responsible for developing strategies and legal frameworks to ensure quality water supply and sewerage in communities. It monitors the condition of infrastructure at the local level and ensures compliance with environmental standards. The Ministry supports innovative projects aimed at upgrading water supply and sewerage systems, reducing water loss, and improving energy efficiency. It coordinates the allocation of state and international funds for reconstruction and construction of systems and equips communities with tools for independent water resource management, thereby strengthening their capacity to address local issues.

The Ministry of Health of Ukraine (https://moz.gov.ua/) establishes sanitary and hygienic standards for drinking water and monitors compliance with these standards. It controls the state of water resources to prevent the spread of waterborne infectious diseases, participates in drafting legislative documents regulating sanitary requirements for water supply and sewerage, and conducts public awareness campaigns on the importance of clean water for public health.

The Ministry of Environmental Protection and Natural Resources of Ukraine (https://mepr.gov.ua/) develops laws and regulations that define environmental standards for water supply and sewerage. It monitors the condition of surface and groundwater, develops strategies for the conservation and protection of water bodies, and implements integrated water resources management principles at the river basin level. The Ministry also oversees compliance with environmental standards by water supply and sewerage enterprises and participates in international projects and programs aimed at protecting and sustainably using water resources.

The Ministry of Energy of Ukraine (https://www.mev.gov.ua/) ensures the supply of electricity for the operation of pumping stations, treatment facilities, and other water infrastructure. It promotes the implementation of energy-efficient technologies and supports the use of alternative energy sources such as solar and wind power. The Ministry also takes part in setting electricity tariffs, which influence the overall costs of water utilities.

The National Commission for State Regulation of Energy and Public Utilities (https://www.nerc.gov.ua/) sets tariffs for centralized water supply and sewerage services, issues licenses to enterprises providing these services, monitors service quality, contributes to the development of regulatory documents that define the rules of operation in the utility services market, and handles consumer complaints, helping resolve disputes between consumers and providers.

The State Emergency Service of Ukraine under the Ministry of Internal Affairs (https://mvs.gov.ua/uk/contacts/state-emergency-service) coordinates emergency responses to accidents in water supply and sewerage systems under difficult conditions. In emergencies, the service ensures the delivery of drinking water to affected regions, assesses risks related to water resources (such as flooding or contamination), develops preventive measures to avoid accidents at water facilities, and cooperates with local authorities, utility companies, and other structures to maintain uninterrupted water supply.

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The State Service of Geology and Mineral Resources of Ukraine (https://www.geo.gov.ua/) maintains the national inventory of groundwater and manages the water cadastre. It conducts groundwater studies to assess reserves, quality, and usability. The service issues special permits for the use of subsurface resources, including groundwater, and monitors their usage. It also oversees the geological environment, including water resources, to prevent pollution.

The State Agency of Water Resources of Ukraine (SAWR) (https://davr.gov.ua/) is the central executive body whose activities are directed and coordinated by the Cabinet of Ministers of Ukraine through the Minister of Environmental Protection and Natural Resources. SAWR implements state policy in the development, management, use, and restoration of surface water resources. Its key tasks include implementing government policy in these areas and proposing initiatives for the formation of such policies. In fulfilling its responsibilities, SAWR cooperates with other state bodies, auxiliary services formed by the President or the Cabinet of Ministers of Ukraine, local governments, civic organizations, trade unions, employers' associations, international organizations, and enterprises. SAWR operates through the following territorial divisions: Central-Western Interregional Sector (Vinnytsia and Khmelnytskyi regions); Western Interregional Sector (Volyn and Lviv regions); Southeastern Interregional Sector (Zaporizhzhia, Dnipropetrovsk, Donetsk, and Luhansk regions); Southwestern Interregional Sector (Chernivtsi, Transcarpathian, and Ivano-Frankivsk regions); Central Interregional Sector (Kirovohrad and Cherkasy regions); Southern Interregional Sector (Mykolaiv, Odesa, and Kherson regions); Northeastern Interregional Sector (Chernihiv and Poltava regions); Northwestern Interregional Sector (Rivne and Ternopil regions); Eastern Interregional Sector (Sumy and Kharkiv regions); Northern Interregional Sector (Zhytomyr and Kyiv regions).

The State Service of Ukraine on Food Safety and Consumer Protection (https://dpss.gov.ua/sluzhba/teritorialniorgani) checks the compliance of drinking water with sanitary and hygienic standards to ensure its safety for consumers; monitors adherence to environmental standards in the wastewater disposal process to prevent environmental pollution; receives and processes citizens' complaints regarding the quality of water supply and sewerage services; participates in the development of legislative documents regulating sanitary requirements for water resources.

The State Environmental Inspectorate of Ukraine (https://www.dei.gov.ua/) oversees enterprises' and organizations' compliance with environmental standards in the water supply and sewerage process; controls the rational use of water resources, preventing their pollution and depletion; conducts inspections of the condition of surface water and groundwater, and assesses the environmental impact of wastewater disposal; develops proposals for improving legislation in the field of water resource protection.

Regional (Military) State Administrations develop and implement regional programs for the development of water supply and sewerage systems; oversee the condition and modernization of water infrastructure systems; provide funding for local water supply projects, including the attraction of national and international funds; in case of accidents or emergencies, they organize measures to ensure water supply to the population; cooperate with local governments, utility companies, and state structures for effective water resource management.

Local self-government bodies are responsible for the sustainable functioning of local water supply and sewerage systems; create local programs aimed at modernizing, expanding, or repairing water infrastructure; monitor service delivery by utility companies to ensure service quality; fund construction, reconstruction, and maintenance projects for water supply infrastructure; organize

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public discussions and consider residents' feedback when planning improvements in water supply and sewerage systems.

In Ukraine, research institutes working on water issues face a shortage of personnel, especially young professionals, due to low wages. Notable among these organizations are The Dumansky Institute of Colloid Chemistry and Water Chemistry of the National Academy of Sciences of Ukraine (http://iccwc.org.ua/); The Institute of Water Problems and Land Reclamation of the National Academy of Agrarian Sciences of Ukraine (https://igim.org.ua/); The State Institution "Marzieiev Institute for Public Health of the National Academy of Medical Sciences of Ukraine", Laboratory of Natural and Drinking Water Hygiene (https://health.gov.ua/structure/research-departments/laboratory-of-natural-and-drinking-water-hygiene/); The Institute of Hydromechanics of the National Academy of Sciences of Ukraine (https://www.hydromech.org.ua/).

Organizations involved in water supply and sewerage may represent large international companies, produce their own products (treatment facilities, pipes, wells, etc.), or perform design and construction works. Most of these organizations are privately owned. However, there is also the Ukrainian State Scientific Research and Design Institute (http://www.uvkp.com.ua/), founded by the Ministry for Development of Communities and Territories of Ukraine.

As a result of the 2024 admission campaign, it was possible to pursue a **Master's degree in the "Water Supply and Sewerage"** degree program at seven higher education institutions in Ukraine: National University of Water and Environmental Engineering, Kyiv National University of Construction and Architecture, O.M. Beketov National University of Urban Economy in Kharkiv, Odessa State Academy of Civil Engineering and Architecture, Ukrainian State University of Science and Technology, Lviv Polytechnic National University, Donbas National Academy of Civil Engineering and Architecture.

There are **over 90 public organizations** in Ukraine that deal with issues of safe water supply, the implementation of sustainable development ideas in the water sector, and the protection and conservation of water resources. Around 40 operate at the national level, while more than 50 function regionally.

The Ukrainian Association of Water Supply and Sewerage Enterprises "Ukrvodokanalecology" (https://ukrvodokanal.in.ua/) is a voluntary intersectoral association of production enterprises, institutions, organizations in the water and sewerage sector, as well as research, design, repair and construction, and other enterprises of various forms of ownership. It aims to coordinate and combine production, research, and other activities to address issues of providing the population with qualitative drinking and utility water, wastewater disposal, efficient wastewater treatment, and improving the ecological state of water resources in Ukraine.

The Ukrainian Water Association (https://ukrainian-water-association.org/) is an independent, non-profit, humanitarian public association that deals with water resource management in Ukraine and humanitarian aid in providing citizens with drinking water.

The All-Ukrainian Water Society "WaterNet" (https://waternet.ua/) is a professional public organization of water treatment specialists founded in 2010 to provide professional support in the sector. WaterNet raises awareness about drinking water quality in Ukraine during wartime and facilitates knowledge exchange on modern water purification methods and technologies. The organization focuses on water quality assessment and information and education outreach.

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The NGO "International Environmental Security" (https://www.facebook.com/IESWorld/), established in 2017, focuses on the following areas: environmental education for everyone; corporate social responsibility for businesses; water resource management.

The NGO "Environmental Initiatives" (https://surl.li/vwvdnh) works in areas such as improving the environmental situation in Ukraine; introducing European environmental protection standards; and disseminating information about the environmental status.

There is experience in uniting public organizations into networks. For example, the Ukrainian Climate Network (https://ucn.org.ua/?page_id=5650) brings together climate-oriented NGOs and initiatives.

The Ukrainian Centre for Water and Environmental Problems (https://cleanwater.org.ua/about/) is a non-profit professional organization created to implement a wide range of projects in the Ukrainian water sector and to promote the adoption of modern innovative water treatment technologies.

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8. Conclusions

The centralized water supply systems of WU are characterized by significant physical and outdated infrastructure. A large portion of the pipelines, pumps, and treatment facilities were built during the Soviet era and have long exceeded their operational lifespan. The high accident rate in water supply systems leads to water losses, which, on average, account for 35%. The financial situation of many water supply and sewerage enterprises is critical. This is due to the insufficient reimbursement of costs caused by low water supply tariffs, which do not cover the real expenses of production, and the rising cost of electricity, which is a major component of the cost of water supply services. Due to low wages and the lack of career prospects, young professionals are reluctant to work in this industry, resulting in a shortage of qualified workers.

Ukraine's water supply and sewerage systems have suffered colossal losses due to the Russian aggression and more than $11 billion is needed for their restoration. The top priority, especially in the front-line areas, is ensuring the resilience of water supply and sewerage systems through various methods, guaranteeing the population with the minimum necessary amount of water of satisfactory quality. Cooperation with international partners and charitable organizations helps implement measures to strengthen infrastructure. In the post-war reconstruction of Ukraine, close ties with European partners will play an important role. This will ensure the implementation of best practices in management and technologies in Ukraine's water supply and sewerage systems.

The fundamental principles are common to both European and Ukrainian regulations, whereas major differences are inherent in the ways of development and the current state of the documents. There is a trend towards more quantitative development of Ukrainian regulations compared to a more approach-oriented development of EU regulations (e. g. risk management approach). It is considered as appropriate to recommend the adapting of the following European norms: The introduction of a risk-based approach, the development of a watch list of emerging substances, the introduction of a clear mechanism for international reporting on the state of drinking water safety and quality in Ukraine, the development of positive substance lists similar to the Water Directive, the introduction of a plan to combat drinking water losses, and the introduction of a clear mechanism for the State Sanitary Norms and Rules of Ukraine in force development. Consequently, it can be assumed that the adoption of the European experience and adaptation of the norms from the above list may improve the level of Ukrainian regulations, reduce the level of risks and hazards to the quality of drinking water, ensure proper drinking water management, and sustainable development in the field of drinking water safety, particularly, considering the conditions of martial law.

Materials, substances, and compounds (coagulants, flocculants, disinfectants, preservatives, containers, packaging, sealing materials, cleaning and disinfecting agents, equipment, facilities, construction materials, etc.) must not cause a deterioration in water quality according to the State Sanitary Norms and Rules of Ukraine. With the enactment of the Law of Ukraine "On the Public Health System," a number of regulatory documents that govern the quality of materials, substances, and compounds in contact with drinking water have been repealed. Additionally, the state sanitary and epidemiological examination of products has been abolished, and sanitary and hygienic conclusions are no longer issued. This situation requires legal regulation at the national level, along with the harmonization of Ukrainian legislation with the European Union's hygienic standards for materials and products that come into contact with drinking water.

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